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ABSTRACT

This set of proceedings documents includes 407 papers representative of the 1,825 papers and posters presented at a conference on undergraduate research. Volume I contains papers on the arts and humanities. Examples of topics include collaborative art, music composition using computer technology, interpreting Roman morality, gay marriage, and individual analyses of many artists and authors. Volume II contains papers on the social sciences. Sample topics are: anthropological and archaeological research, local cultures, early childhood development, dress and nonverbal communication, learning disabilities, depression in the elderly, and political trend analysis. Volume III is on mathematics and engineering and includes such topics as: groundwater nitrate removal, computational electromagnetic scattering, irrigation in developing countries, life-cycle cost analysis, methods of software specifications, and Godel's incompleteness theorem. Biology is the subject of Volume IV and papers cover such topics as: postanesthesia nausea, the human condition in antiquity, habitat selection by American kestrels, and antifungal resistance in opportunistic fungi. Volume V contains papers on the physical sciences. Examples of topics are: electromagnetic field profiles of biomaterials, a method for investigating field disturbances, magnetic resonance imaging techniques, and urban forests and wildlife. (Individual papers contain references.) (DB)

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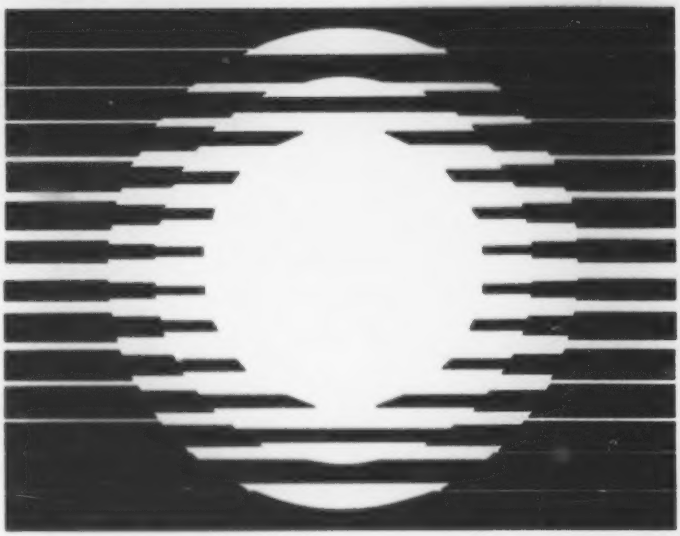

PROCEEDINGS

ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

Robert D. Yearout
Editor

Volume I

HE 030 754

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PROCEEDINGS
ELEVENTH
NATIONAL CONFERENCE
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RESEARCH

VOLUME I

THE UNIVERSITY OF NORTH CAROLINA at ASHEVILLE
JULY, 1997

Foreword for the

Proceedings of the Eleventh National Conference on Undergraduate Research

University of North Carolina at Asheville
April 24-26, 1997

The University of Texas at Austin was pleased to host the 1997 National Conference on Undergraduate Research, affirming its commitment to excellence in undergraduate education and to the research experience in particular. Over 2100 students and faculty attended some 1500+ oral, poster and performing or visual arts presentations scheduled over April 24-26. A special feature of NCUR '97 was a series of more than 30 presentations by faculty members from all disciplines demonstrating the integration of research and teaching with the new technologies. These presentations were capped by a performance on Saturday night of "Ears and Feet," a concert of new interdisciplinary work by student and faculty composers, choreographers, dancers and performers from the UT College of Fine Arts. Electro-acoustic music and modern dance explored interactivity of disciplines and technologies by allowing dancers' movements to control electronic music and robotic lighting by way of a touch-sensitive computer dance floor.

President Robert M. Berdahl opened the conference quoting a Chinese proverb: "I hear and I forget. I see and I remember. I do and I understand." Berdahl praised the research experience as the most practical and potent method to provide students the perspective of inquiry, innovation and exploration as they prepare "for a future that is not so much known to be uncertain, but instead, certainly unknown." That facts and methodologies become obsolete in a world in which developments and advances occur with dizzying rapidity points to the importance of incorporating research activity into the undergraduate experience.

Dr. Berdahl also praised the student-faculty relationships that are fostered by the research process, congratulating the faculty mentor for serving the educational needs of the talented and motivated students by participating in the adventure of exploration and discovery, of cooperation and collaboration which characterize academic life.

Five distinguished plenary speakers addressed conference participants throughout the three days. Dr. Steven Weinberg, Nobel laureate in physics and professor at the University of Texas at Austin, challenged listeners to consider the future of science by posing the questions "The End of Science?". Dr. Robert Williams, Director of the Space Telescope Science Institute, dazzled the audience with the most recent images from the Hubble Space Telescope. From the vastness of space to the minute complexity of genetic research, Dr. Steven McKnight of the UT Southwestern Medical Center at Dallas introduced conference participants to the fascinating work being done in gene regulation and cell differentiation. Friday night's fete "Texas Culture Swing" featured, in addition to an outstanding sampler of culinary and musical styles of the Lone Star state, a mini-plenary address on the multifaceted aspect of Texas border cultures by Dr. Rolando Hinojosa-Smith, distinguished author and professor of Creative Writing. NCUR 97 closed with a resounding standing ovation upon conclusion of "The Challenge of Leadership" by Sarah Weddington, J.D., former Texas legislator and White House assistant, now author, lecturer and adjunct professor.

The University of Texas at Austin is proud of the privilege to share our campus for these few days with the distinguished group of students and faculty whose work is presented here in published form. We congratulate you for your accomplishments and encourage you to continue to participate in the challenge of research.

Susan Wells Howard, Chair, NCUR '97

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PREFACE

The 407 papers published in these five volumes are representative of the approximately 1825 papers and posters presented at the celebration of undergraduate research that was NCUR '97'. The faculty, staff and students of the University of Texas at Austin are to be commended for making NCUR '97' such an enriching experience. The student authors deserve recognition for their hard work and for their persistence in seeing their research through to its final publication.

Special thanks are extended to Dr. Susan Howard, Ms. Kelly Johnson and other members of the NCUR '97' staff. Their help during the days of the Conference was invaluable. Many thanks also to the members of the National Board, who reviewed a large number of papers submitted to the Proceedings under time constraints. Their continued efforts to standardize has raised the Proceedings quality. This project would have not been successful without their assistance.

I would also like to thank the UNCA Editorial Board, who put in many long hours reviewing, checking and organizing papers, and Tracy Walker, and Adam Bradley, who did all the cutting and pasting necessary for these volumes. I owe a special debt of gratitude to Katherine Whatley, Tracy Walker and Mila Cleverdon for their support, encouragement, and mentorship during the entire process of organizing the Proceedings.

To all the students who submitted papers to the Proceedings go thanks for their participation and congratulations for their achievements. Your enthusiasm and achievement will serve as role models for the next group of student researchers - whom we look forward to meeting at the Twelfth National Conference on Undergraduate Research at Salisbury State University, Salisbury Maryland.

Robert D. Yearout
UNC at Asheville
1 July, 1997

PROCEEDINGS OF THE ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

CONTENTS

VOLUME I

FOREWORD iii

PREFACE iv

ARTS AND HUMANITIES

Collaborative Art: A Movement in the Twentieth Century 1
Kristen Jo Kerr (Jane-Allen Mckinney)

Nature and the Natural in the Paintings and Prints of Helen Frankenthaler 6
Danielle G. MacCartney (Debora Rindge)

A Comparison of Frank Lloyd Wright and Michael Graves: Furniture Influenced by Architecture 9
Nieya C. Wallace (Jane-Allen McKinney)

Art Education: Art is Underrated as an Instrument for Teaching Essential Learning and Cognition Skills 14
Jennimarie L. Ward (Jane-Allen McKinney)

Toontown: The Disney Tradition Continues 18
Jennifer Lugg (Dianne S. Macleod)

Political Ideologies of Harlaxton Gardens, Harlaxton, Lincolnshire, England 23
Nicole L. Stutzman (Shirley Schwarz)

Reminders of Death and Lessons for Life: Vanitas and Memento Mori Paintings of the Spanish Golden Age (1556-1700) 27
Wendy Singer (Susan V. Webster)

Visualizing the Human Form: Art and Anatomy in Eighteenth-Century England 31
Erin M. Loos (Philip Wilson)

The American Canon: Great Male Playwrights and Their Female Characters 34
Michelle McGovern (Mark Pizzato)

Henry Purcell's Dido and Aeneas: A 1689 Composition Endures Controversy 39
Stacy M. Dieckman (Patricia Kazarow)

Determining the Authorship of the Toccata and Fugue in D Minor, BWV 565 44
Aaron Juhl (Patricia Kazarow)

Plains Attire: The Individual Expression of Culture, the Cultural Expression of Identity 48
Sherri A. Mainord (Anne Guernsey Allen)

Victim vs. Participant: A Comparison of Dmitri Shostakovich's Lady MacBeth of Mtsensk and Katerina Ismailova 53
Heather Miller (Charles McKnight)

New Possibilities in Composition Through Computer Technology 56
Christopher Watts (Daniel Koppelman)

The Conception of "Poet" in the Work of Bei Dao 61
Jennifer L. Berry (Martin Backstrom)

7

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Bei Dao's Poet 66
Jennifer L. Berry (Martin Backstrom)

"There Is No Loneliness Like Theirs": James Wright's "A Blessing" and C.K. Williams' "On Learning of a Friend's Illness" Examined 71
Kirsten C. Bender (William Aarnes)

Embrace of Dionysus The Presence of African Art In D.H. Lawrence's Women in Love 76
Kristin A. Frey (Eric Chandler)

A Poststructural Analysis of Richard Wright's "Big Black Good Man" 80
James S. Guignard Jr. (Jill Sessoms)

William Shakespeare's Othello: The Moor of Venice A Case Study in the Thermodynamics of Evil 85
Roger A. Harris (Linda K. Barlow)

Wilde's Christ: Exemplifying Aesthetic Morality 89
Elizabeth M. Hendershot (Daniel Born)

Pearl's Scarlet Soul: The Influence of Spenser's Una on Hawthorne's Ideal Vision of Daughters 93
Tracy Ann Kennedy (John C. Bean)

Agrarianism in the American South: From the Vanderbilt Agrarians to Wendell Berry, A Shift from Regional Myth to Practicable Ideal 98
Robin Kidd (John Cawelti and David Hamilton)

Margaret Fuller's Women in the Nineteenth Century: An Appeal for the Inclusive Self 103
Jeanne Kolker (Sara McAplin)

The Paradox of the Crucifixion Allegory in Ben Franklin's "The Kite Experiment" 107
Sandra Argroves Watson (Steven L. Hamelman)

The Doorway to Wildness: Four Poems by Muriel Rukeyser and Adrienne Rich 112
Trace V. Wilson (Richard Chess, Michael Gillum, and Jeff Rackham)

The Relationship Between Cognitive Growth, Journal Writing, and the Development of Critical Thinking 117
Lynn Herink and Anna Long (Larry Nichols)

Images of Health in Health Magazines 122
Travis Bebout (Sarina Chen)

Blissfully Rude: The Diatribe of ACT-UP 127
Mark S. Buchanan (Suzanne E. Lindsey)

Eyewitness vs. Pseudo Reality: A Comparative Analysis of Student's Accounts and the Media Reports of a University Disturbance 132
Ben L. Daniels (Sarina Chen)

Light in the Crevice Never Seen: The Indigenous Voice and the Rhetoric of Resistance Literature 137
Blayne M. Higa (Catherine A. Collins)

Marketer's Use of Semiotics and Symbolic Representation of Children's Packaging 142
Reagan Turok and Heidi Redeker (Lois Smith)

Same-Sex Marriage Politics: The Politicizing of Sexual Orientation 147
Kari Wagener (Phillip Voight)

"Do As Little As Possible" The Transformation of Film Noir's Myths in Chinatown 151
Karen Demski (Chris Hassold)

BEST COPY AVAILABLE

Outside Looking In: Sacred Space of Taos Pueblo 157
Brenda L. Hanson (Anne E. Allen)

Directed By and Starring Cindy: Sherman's Performance Photography 161
Jennifer Lemmer (Cris Hassold)

Reinterpreting Roman Morality 166
Ryan Pesch (Marleen Flory)

Edna St. Vincent Millay: A Feminine Perception of Love 170
Mandy C. Carlson (Lysbeth Em Benkert and Jay Ruud)

The Romantic Paganism of Niccolo Ugo Foscolo: Infancy, Greece, Venus, Exile, Pain, and Death in the Foscolian Artistic Sensibility 174
Mark Anthony Espinosa (Andrea Baldi)

Subject Pronoun Usage in Mexican Spanish in South Texas 179
Javier M. Morin and Carla Chapa (Sandra Baumel-Schreffler)

I, Tituba, Symbol of the Antilles 183
Debbie Officer (Margarite Fernandez-Olmos)

A Profound Cultural Exchange: The Mexican Muralist Movement and the Harlem Renaissance and its Modernist Descendants 187
Alice Psirakis (Raysa Amador)

The Issue of Status in Puerto Rico: Internal Strife in the Search for Status 192
Mandy Robinson (Paul Simon and Maria Dolores Goddard)

Multinational vs. Global Organizations: A Case Study of the Corporate Culture of IKEA 197
Katherine J. Ross and Saturnia Alcala (Peter Hackbert)

The Creation of Christianity: Exploring the Role of Women in the Development of the Ancient Church 202
Jennifer L. Borden and Kevin S. Minoli (John R. Lanci)

For Better or For Worse: The Case For Gay Marriage .205
Kathrine Ehrlich (Laura Purdy)

The Mother-Daughter Relationship of Harriet Taylor Mill and Helen Taylor 210
Amy M. Kuhl (Jo Ellen Jacobs)

Pragmatic Faith in John Dewey and Fyodor Dostoevsky 215
William D. McCracken (Stuart E. Rosenbaum)

Epistemological Conditions: How Plato Anticipates Gettier 220
Andrew T. Cronan (A.M. Weisberger)

Adversity and Sacrifices: The Examination of Two Lives 224
Patience Adibe (Harriette Pipes McAdoo)

The Acquisition of Knowledge According to the Theory of Jean Piaget 229
Donna M. Cain (Ralph Carlson, Dalinda Rodriguez, Raymond Welch, and Keith Turner)

A Descriptive Survey of the Three Contemporary Approaches to Fluency Disorders 234
Peter Golleck (Raymond Welch, Barbara Johnson , Teri Mata-Pistokache, Timothy Meline, and Keri Parchman-Gonzalex)

Cosmos and Chaos: An Analysis of Themes and Issues in Doris Lessing's The Fifth Child 238
Anna C. Long (Hamida Bosmajian)

Toni Morrison's Sula: The Pharmakos of Her Community 243
Joseph Van Mieghem (Hamida Bosmajian)

BEST COPY AVAILABLE

The Search for Innocence in the Art of Jean Cocteau 249
Erin Nicole Parisi (Alexandra Wettlaufer and Jonathan Bober)

Preferences of Positive Reinforcers Among Elementary Students 253
Kelly Schutte (Lian-Hwang Chiu)

Implementation of Civil Rights Policy in Education 257
Autumn Stewart (Carter A. Wilson)

Jewish Resistance to the Nazi Occupation of Lithuania and Belarus during World War II 260
Phillip C. Alloy (L. Wilcox)

Peddling Public Assistance: The Children's Bureau and the Aid to Dependent Children Program in the Social Security Act of 1935 263
Katherine E. Anselmo (Helen Wheatley)

A Case Study of the Tax Reform Initiative by Marylanders 268
Juanita Maria Banks (Abdul Karim Bangura)

Famous and Forgotten: The Life and Death of the Dubuque Dial, 1934-1935. 272
Katherine Dietrich (Michael Anderson)

The Stonor Letters and the Wars of the Roses: Violence and Politics in Fifteenth-Century England 276
Michelle Dowd (Richard Kaeuper)

Thomas Becket and King Henry II A Medieval Drama with a Contemporary Application 281
Lorie Fratz (George Sochan)

The Mushroom of Feeling: American Public Reaction to the Atomic Bomb, 1945. 285
Jason C. Gaskill (Larry Lipin)

Henry Laurens: The Making of a Revolutionary 289
James Hutchinson (Bruce Greenawalt)

Beyond the Imperialist V Anti-Imperialist Dichotomy: American Intellectuals and Fin De Siecle Expansionism 294
Robert James Kijewski, Jr. (David Worbel)

"Being Madame is a Miserable Job" The Letters of Liselotte von der Pfalz, 1672-1722 299
Christie King (Caroline Castiglione)

Fencing out the Foreigner: Influences on the Eighteenth Legislature of Wyoming and its Exclusion of Foreign Physicians 304
Susan Macki (Eric Kolher)

A Woman's Place: Female Tavern and Inn Keepers in Early Pennsylvania 310
Sarah E. Morgan (Larry Eldridge)

The Debates and Arguments Leading to the Passage of the Seventeenth Amendment 314
Tara M.E. Yencha (Deborah A. Rosen)

Jane Addams: Women-Based Political Actor as Role Model 320
Oona Besman (Susan Harrison)

Lesbian Perspectives on Love, Sex and Relationships: Adult vs. Youth 325
Angelica Victoria Hernandez (Mary L. Alpaugh)

Women's Body Image: Effects of Media Imagery and Anorexia Nervosa 330
Grace Lager (Susan Harrison)

Testing the Effects of Sample Composition and Context on Radiocarbon Dating from Mammoth Cave, Kentucky 335
Sarah McCloskey (Kenneth B. Tankersley)

Three-Dimensional Mapping of the Bluff Greathouse Archaeological Site 339
Natasha Psenicka (Lawrence B. Conyers)

Scholarly Sightseeing in Rome, Ravenna, and North Africa: The Differences in Early Christian Centrally Planned Vaulted Structures 344
Benjamin D. deLee (Christine Colley)

Self-Perceptions and Representations of Hawaiian Identity, Ke Kanaka and Ke Kane Ikaika 349
Cheryl Nohealani Olivieri (Margarite Fernandez-Olmos)

Mexican Catholicism: The Syncretic Result of the Spanish and Indigenous Religions in Contemporary Mexico 352
Helena E. Colyandro (Susan Deans-Smith)

Rocky Road: The Long Journey to Educational Freedom in Prince Edward County 357
Randy A. Jones (George Bagby and Lowell Frye)

VOLUME II

SOCIAL SCIENCES

Preclassic Maya Pottery From Colha, Belize 362
Sharon Hankins (Fred Valdez, Jr.)

Deciphering the Secrets of Skeletal Remains from Hellenistic Abdera, Greece 367
Thomas P. Bolioli and Tara M. Kirkpatrick (Anagnosti P. Agelarakis)

Japanese Unknown Women Under the Japan's Alliance Capitalism: The Complementarity of the Pre-Existing Structures and the Changing in Identity 373
Yumi Kobayashi (Jeffrey Broadbent)

Window Into the Past: Diachronic Aspects of Three Ancient Human Skeletal Populations from the Khao Wong Prachan Valley in Central Thailand 377
Anna Konstantatos (Anagnosti P. Agelarakis)

Whole Vessels from Kichpanha, Belize: Implications of Increasing Social Complexity 382
David A. McDow (Fred Valdez, Jr.)

Form and Function of Late Preclassic Maya Pottery 387
Angela Milliman (Fred Valdez, Jr.)

Southern Plains Powwow Culture: Exploring the Identity of the Drum 392
Cindy Stout (Sue Tuohy)

The Sexual Oppression of Women in South Korea 397
Tuesday M. Tamburri (Leslie Miller-Bernal)

Evaluation of a Summer Orientation Course for New College Students: Critical Reading and Reasoning 403
Hernan E. Diaz (Sharon L. Pugh)

The Association of Peer Acceptance and Social Behavior in Early Childhood 406
T. Gayle McLemore (Leslie Phillipsen)

The History of the Civil Rights Movement in Prince Edward County, VA (1951-1964) 411
Steven L. Turner (Susan H. Bagby)

Qualitative Research on the Teaching Methodology of Genetics 348: A Hands on Approach 416
Tia Fluegge (Sandra Tutwiler and Presley Martin)

Spatial Distribution and Socio-Economic Profile of Asian Indians 421
Aaron Otto (Jayati Ghosh)

Intra-Asian Direct Investment and Indian Economic Liberalization 426
Susanne Peters (Jayati Ghosh)

The Spatial Distribution of the Hispanic Population in the United States: An Analysis at Various Geographic Scales 431
Stephanie M. Sheetz (Robert Douglas)

A Quantitative Study of Communication Apprehension and Self-Esteem 436
Mattie Marie Butler (Abdul Karim Bangura)

Attraction Factors Involved in Internet Relationships 441
Karen Chain, Christopher Gill, and Dawn Kujawski (Dean Thomlison)

Wartime Benevolence: A Portrait of Northern Philanthropy During the Civil War 446
Kevin Davis (Bruce S. Greenawalt)

Media and the Construction of Identity: Young Women's use of "Friends" 451
Kristi L. Eaves (David B. McLennan)

Dress and Nonverbal Communications 456
Barbara Heinemann (Joanne B. Eicher)

Confronting Learning Disabilities: A Proactive Approach for Parents 461
Holly Kapp (George Sochan)

Public Perceptions of Television Versus Newspaper Credibility: A Local Study 465
Andrea Lawson (Mark D. West)

The Evidentiary Impact of the Likelihood Ration and Assessment of Diagnosticity 470
Nir Liberboim (Jonathan Jay Koehler)

Solitary Confinement: A Study of Prisoners' Access to the News Media 475
Michael O'Sullivan (Ann Marie Major)

The Conveyance of Socioemotional Cues in Computer-Mediated Communication: A Content Analysis of Internet Relay Chat 480
Kimberly K. Schaefer (Denise Bostdorff)

You Eat What You Are: An Investigation of Key Environmental Variables on Food Choice 485
Laurel Y. Shanaman (James Brancato)

The Nurse-Patient Continuum: A Nursing Model 489
Jackie Boak, Elizabeth Dickerson, Melissa Jackson, Teri O'Quinn, and Cathleen Fabiani (Margaret Erickson)

Assessing the Effects of HIV/AIDS Peer Education on High School and College Freshmen 493
Cara Catalino, Erin Clune, Megan Gordon, and Marie Neilan (Patricia A. Bailey and Donna R. Carpenter)

Relationships of Self-Perception of Balance, Technological Measures of Balance, and Fall Events Among Individuals with Parkinson's Disease 496
Kativa L. Leal (Nancy E. Dayhoff)

Depression: Prevalence, Causes, Manifestations, and Repercussions Associated with Elderly Disability 501
Nicole Lovell (Clyde B. Killian)

Medical Costs and Correlates of Gunshot Wounds in Travis County, 1995 506
Jennifer L. Moren (L. Michelle Issel)

Family Caregivers' Perceptions of Pallidotomy Surgery: Expectations, Satisfaction, and Health Dysfunction 511
Polly K. O'Brien (Jane Backer)

Living on the Health Care Drawing Board: An Analysis of the Availability of Health Care to Low-Income Families in Los Angeles 515
William Ortiz (Leslie Howard and Cheryl Swift)

Fathers, Food, and Fun: A Nutrition Education Program for Low-Income Urban Fathers and their Children 520
Donald C. Sweet, Lisa Gemlo, and Jennifer Ruffing (Debra Palmer Keenan)

Accounting for the Effects of Hurricane Hugo 523
Tulani Giscombe (Mary Jones Phillips)

Changes in Smokeless Tabacco Utilization Patters Among School-Aged Children 526
Mark A. Robinson (Don Lisnerski, Bob Yearout, and Cheryl McClary)

Detecting Hidden Periodicities in Business Cycles of Fifteen Countries Using Fourier Analysis 530
Peter Hlavaty (Edward Gamber and James DeVault)

Effects of Foster Care on Perceptions of Family and Family Functioning 534
Judy Meyer (Beverly Curry)

Retailer Country Bias Cues: An Experimental Approach 538
Erin C. Miller (Sherry L. Lotz)

Matching Cultural Value Orientations to Ad Appeals: Exploring the Role of Individualism-Collectivism in the USA Versus Mexico 543
Michael Mosley (James M. Munch and Gary D. Gregory)

Vertical Integration and Profitability 548
Cecelia Ruth Buchanan (Stephen Schmidt)

NAFTA and Jobs in the United States 553
Kristina Carrico (Rutilio Martinez)

Gender Differences in Investment Expectations 558
Teresa D. Harrison (Rosemary T. Cunningham)

Do Dollars Make a Difference? The Relationship Between Expenditures and Test Scores in Pennsylvania's Public Schools 563
Jonathan M. Klick (Charles Zech)

The Income Distribution Effects of IMF Balance of Payments Stabilization Tools: A Case Study of Monterrey, Mexico 569
Charlotte Opal (Perry Patterson, Michael Lawlor, and Dan Hammond)

Tests of the Induced Innovation Hypothesis in Indian Agriculture 574
Anthony Walsh (Kailash Khandke)

A Qualitative Study of the 1994 Voter Turnout in Prince George's County Executive Election 579
Kirk A. Gordon (Abdul Karim Bangura)

A Test of the Efficacy of the University of Maryland College Park Affirmative Action Program 584
Shamica Monique Jackson (Abdul Karim Bangura)

From Critique to Consensus: Stephen White's Pursuit of a Postmodern Politics 589
Ingrid A. Jendrzejewski (David Gugin)

A Quantitative Study of the High School Attrition in Prince George's County, Maryland 594
Dorothy Lyons-Wilson (Abdul Karim Bangura)

Race in the Balance: Case Study of Escambia Treating Company 599
LaRuby May (Carolyn Johnston)

Aid in Transition: Explaining Post Cold-War Trends in House Foreign Aid Voting 604
Scott R. Meinke (John R. Baker)

A Quantitative Study of the Essence of Federalism: Who Does it Benefit: 609
Kim Odoms (Abdul Karim Bangura)

The Concepts of Community and Individualism in Twentieth-Century Presidential Nomination Acceptance Speeches and Inaugural Addresses 614
Stephen V. Potenza (James E. Underwood)

A Comparative Study of the Levels of Political Socialization of Children in Two New Hampshire Towns 619
Kathleen M. Ridolfo (Clark Hubbard)

A Qualitative Study of Minority-Majority African-American Congressional Districts and African-American Representation in Congress 623
Marvin M. Silver (Abdul Karim Bangura)

A Quantitative Study of the Longevity of Vietnam-Era Disabled Veterans 628
Joseph L. Singleton, Jr (Abdul Karim Bangura)

BEST COPY AVAILABLE

The 1996 Albanian Elections: Corruption? Or a Catalyst for Democracy? 632
Christopher Thomas Johnson (Karen Vogel)

The Role of the International Law of the Non-Navigational Uses in International Watercourses in Resolving the Disputes Over Access to Freshwater in the Middle East 637
Jason Woolwine (Gary Prevost)

Trends in the Eisenhower Administration: A study of Inflation, Unemployment, and Presidential Popularity 642
Shadya Y. Yazback (James Lindeen)

Strategizing Advocacy: Theoretical Frameworks in Grass Roots Social Organization 646
Tamie M. Aceves (Manuel Carlos)

Peering into the Success of Peer Feedback: Understanding how Feedback Works in Elementary-Aged Writers 651
Laura Angyal (Matthew Olson)

The Impact of Acculturation Type, Stress, and Social Support Among Mexican-American Adolescents 655
Elsa C. Arroyos (Enedina Garcia-Vazquez)

Physiological Responses to Racist Stressors Among African-American College Students 660
Jamar Barnes, John A. Oliver, and Foye Smith (Vernessa R. Clark)

Gender Differences in Perceptions of Martial Infidelity: Sexual Versus Emotional Cheating 664
Anne-Marie Bartos and Allison D'Auteuil (Ralph J. McKenna)

Childhood and Adolescent Abuse, Fear of Negative Evaluation, and Social Interaction Self Statements: A Correlational Analysis 670
Patti Beth (Barbara Beaver)

Coping Strategies Among African-American and Caucasian Female College Students 675
Ayannah A. Brower, Afiya Ricks, and Foye A. Smith (Vernessa R. Clark)

The Effects of the Administration of Methysergide and Ritanserin, Two Serotonin Antagonists, on the Behavioral Repertoire of Zebra Finches (Taeniopygia guttata) 679
Megan B. Bruther (Wendy L. Hill)

Context and Quality of Social Interaction of Children with Severe Language Delays in a Full Inclusion Preschool Program 684
Amy Buchanan and Krista DeZerega (Lawrence V. Harper and Karen McCluskey)

Characteristics Associated with Premature Drop Out in Client-Centered Play Therapy 689
Valerie A. Campbell, and David B. Baker (Sue Bratton and Jennifer Cleveland)

Helping Behavior Rates and Demographics: A Comparative Analysis 694
Jennifer D. Carlson-Weiberg (Nancy Steblay)

Parents' Marital Status, Father-Daughter Intimacy and Young Adult Females' Dating Relationships 698
Kristen J. Clark (Korrel Kanoy)

Investigating Physiological Responses to Sexual Harassment 703
Shaunta K. Clark, Carina De Fazio, Jamar D. Barnes, and Foye A. Smith (Vernessa R. Clark)

Peace Builders Case Study: Combating Violence Through the Exercise of Positive Choices in an Elementary School in California 707
Charlotte M. Contreras (Manual Carlos)

The Psychobiological Effects of Narcolepsy: Its Causes and Treatments 711
Sara Cronin (Charles Kutscher)

Racial Similarity, Cost to Helper, and Sex as Determinants of Helping Behavior 717
Heather A. Dooner and Margaret M. Blake (Patricia Oswald)

Sex Role Type and Effectiveness of Women Speakers at a Religious Presentation 722
Catherine E. Dundas (Lynn New)

Alpha-Ganzfeld: An Experimental Study on Alpha Rhythms Under the Ganzfeld Condition 727
Darin Dutcher and Joshua Johnson (Dorothee Dietrich and Matt Olson)

The Relationship Between the Extent to Which Adolescents are Taught Not to Trust Strangers During Childhood and Interpersonal Skills 732
Laurie Harrier (Francis Terrell)

The Relationships Among Eating Attitudes, Loneliness; and Self-Monitoring 737
Patricia L. Hart (Cynthia Crown)

Readability of Websites with Various Foreground/Background Color Combinations, Font Types and Word Styles 742
Alyson L. Hill (Lauren F.V. Scharff)

The Relationship Between the Protestant and Catholic Religions and Guilt 747
Caramin C. Johnson (Emily Hause)

Locus of Control and Superstitious Behavior: A Visit to the Putting Green 751
Mark W. Jones (Ralph J. McKenna)

Effects of Long-Term Ad Lib. Feeding on the Weight and Health of Differentially-Reared Laboratory Rats 756
Gary L. Lawrence & Kimberly M. Murrell (Karen E. Brakke & Jeanne M. Stahl)

Drug State Dependent Performance of Rats on a Hampton Court Maze 761
Shawana N. Lewis and Gary L. Lawrence (Karen E. Brakke and Jeanne M. Stahl)

Child Abandonment in St. Petersburg, Russia: Effect of Early Intervention 766
Natalya M. Lvoff (H. Banis)

Parent and Adolescent Relationships as Predictors of Post Divorce Functioning 770
Marisa Manzi, Joan Garten (Michelle Wierson)

Doing Field Research in an Electronic Environment 775
Tracee S. Matlock (Manuel Carlos)

Irrelevant Speech Eliminates the Word-Length Effect 779
Rebecca Mazzorana (Ian Neath and Aimee Surprenant)

Activational Effects of Testosterone On Sound-Guided Spatial Navigation 782
Eric J. Moseley (Mark C. Zrull)

Effects of Employment on College Students' Academic Performance and School Involvement 787
Laura A. Schwarber (Cynthia L. Crown)

Gender Differences In Coping Strategies and Cardiovascular Responses to Stress 791
Eric Shaw and Foye Smith (Vernessa R. Clark)

An Extension of the "Two-Baskets' Theory of Self-Cognitions to Native Americans 794
Mandy D. Smith (David Trafimow)

The Relationship Between Self-Esteem and Extraversion 797
Wendy S. Peterson (Cynthia Crown)

Chicano Gangs in California: Analytical Analysis of the Structure and Dynamics of Chicano Gangs from Street Corner to Prison Cell 801
Brenda J. Pobre (Ruben Mendoza and Manuel Carlos)

The Relationship Between Parents' and Adolescents' Values 807
Heather Reynolds, Corinne Auman, Ilona Teleki, and Laura Batz (Maureen Vandermass-Peeler)

Attitudes of College Students Toward Using Animals in Research 813
Katina V. Robinson and Lisa Harris (Karen E. Brakke and Jeanne M. Stahl)

Transitive Inference in Undergraduate College Students 818
Rhea Watson (Julianna Lancaster and John Batson)

Conflicts of Interest in the Early Stages of Intimate Relationships 822
Susan Russell (Renate Klein)

Social Adjustment of Children and Adolescents with Juvenile Rheumatoid Arthritis: Parent Report 826
Stacie M. Arthur (Robert B. Noll)

The Relationship Between Nicotine and Alcohol Dependence: Treatment Implications: 831
Meenakshi Garg (Barbara J. Mason)

Social Isolation of Nursing Home Residents and Their Perceived Health 833
Jennnifer Langford (Jerry Pankhurst)

The Effects of Minority Influence on Group Polarization 838
Kelly Murphy (Jennifer J. Dose and Jeff Ratliff-Crain)

Scottish Soccer Violence and Religion 843
Megan O'Neill (Len Berkey)

A Content Analysis of Children's Television Commercials 848
Rachel D. Sgaglio (Michelle E. Barton)

A Critical Analysis of Current State Responses to the Problem of Child Maltreatment 852
Elise L. Siddell, Eileen T. West and Emma S. Gavino (Madeline Lovell)

The Assessment of College Students' Perceptions and Attitudes Towards Academic Dishonesty 857
Sarah Acton, Jennifer Thetford (Irene Staik and John Burling)

Changing Pedagogy: Using a Computer Simulator to Teach Ethnographic Methods 862
Gregory R. Blaza (Manuel L. Carlos)

The Influence of Pretrial Publicity on Juror Decision-Making: A Meta-Analysis 866
Jasmina Besirevic (Nancy Steblay)

North America by Bus: A Study of Interaction and Personal Space 871
Lisa Marie Bosner (Natalie Rosel)

The Assessment of College Students' Attitudes Toward the Social Aspects of Their Own Aging 876
April M. Chambers and H. Perry Swindall (John Burling and Irene Staik)

Exploring the "GenderedPerspective" in Early Adolescents' Interpretations of Popular Music 881
Anastasia M. Pharris-Ciurej and Kristine M. Ward(Jodi O'Brien)

An Examination of Gift Giving in Post-Modern Society 886
Megan Kathleen Donovan (Martha Huggins)

Learning to Hate Yourself: How Homophobia Teaches Girls to Devalue Women 889
Jennifer L. Engle (Harriet Adams)

The Effect of the "Year of the Woman" on the 103rd Congress 894
Emily C. James (Nadia Rubaii-Barrett)

Popularity: The Crisis and Culture of Adolescent Girls 899
Cinnamon Reiheld (Harriet Adams)

Production Scheduling of Flexible Manufacturing Cells 904
Jeffrey D. Erickson (Bijayananda Naik)

Physical Attributions of Racial Sterotypes 908
Lori Dixon (B. Runi Mukherji)

18

Volume III

Mathematical and Engineering

Groundwater Nitrate Removal for the Main San Gabriel Basin, California 911
Chad Blais, Katina Burl, Adam Nazaroff, Peter Tonthat, Vinh Truong and Justine Yu (Julie Wei)

Occupant Dynamics in Stationary and Moving Vehicles Subjected to Vertical Impacts: An Experimental Study 915
Peter D. Layson (Toufic M. Hakim and Orion P. Keifer)

SubzeroCam: Design of a World Wide Web-Based Digital Camera for Sunrayce 97 920
James A. Johnson (Richard R. Schultz)

Using Java for Computational Electromagnetic Scattering 925
Jared Martin (Lyle Long)

Flat Oceans and Satellite Radar Anomalies 930
David L. Mickler (Chester J. Koblinsky)

Cyberprint: Creating Alternative Medical Visualization Tools Using Architectural Metaphors 936
Jim Agutter (Julio Bermudez)

Sustainable Building: Planning and Design of a Family Residence and Education Center Using Local Building Materials 940
Geoffrey B. Grace (Rebecca Fish Ewan)

An Analysis of Ancient Maya Obsidian Artifacts from Belize 946
Rissa M. Trachman (Fred Valdez, Jr.)

Effects of Detention Time on Sedimentation Performance 951
Ben Ehrhart (A.R. Jarrett)

Characterization of Waste Sites in Greater Newark Area Using Geographic Information Systems (GIS) 956
Jelena Balorda (Sima Bagheri)

Electrochemical AC Impedance Technique to Investigate the Inhibition Efficiency of an Inhibitor for Steel Rebar in Concrete 960
Octavio Cervantes, Elaine Lopez & Rudolph Martinez (Behzad Bavarian)

Prototype Designs of Concrete-Filled Steel Tube Composite Building Frames 965
Katherine Fetterer (Jerome F. Hajjar)

Removal of Ammonia from Contaminated Air Stream by Biofiltration 970
Annie W. Chou (Ruihong Zhang)

Comparison of Analysis Methods for Non-Classical Structures with Added Viscoelastic Damping 975
James P. Horne (Douglas K. Nims)

Field Testing of Stone Masonry Arch Bridge #143 in Chester County, PA 978
Allyson Karper (Thomas Boothby)

Determining Suitability of Irrigation in Developing Countries 983
Carl McGloughlin (Roger Ruggles)

Development of a Generic, Robust, and Reliable Networking Protocol for a Motorola Microcontroller 988
Mary Frances J. Austin (Charles Bennett)

Ideal Case Modeling of Optical Preamplifer Receivers at the 10Gb/s Data Rate 993
Deborah S. Hart (Y.K. Park, Lucent Technologies, Lightwave Subsystems)

Nonlinear Filtering and Enhancement of Digital Ultrasound Imagery 998
Melissa L. Kurtz (Richard R. Schultz)

Mathematical Modeling of a Fuzzy V-Chip 1002
Daniel J. Landherr (Marian S. Stachowicz)

Effect of Thin Film Disk Texture on Magnetic Recording Head-Medium Clearance Measurements 1007
Daniel Yau (Chorng H. Chang)

A Self-Evaluation Tool for Life-Cycle Cost Analysis 1012
Fabiola Gaytan and Pablo Santos (John Wilson)

Excessive Noise Levels Enhance Special Effects, Are You Aware? 1017
K. Osborne (D. Lisnerski and R. Yearout)

Surface Estimation of Machined Parts 1022
Gustavo Perez (Prasad Gavankar)

The Use of the GRAFCET Approach to Automation of PLC Programming & Control 1027
Janice R. Sansberry (Shueh-Ji Lee)

Counting Arrangements of 2's and -1's 1031
Robert S. Sielken (Donald Bailey)

Magic Squares as Matrices 1036
April Warn (Donald Bailey)

The Structural Design and Electronic Control System for a Large Segmented Space Reflector Test-bed 1041
Anibal Jaimes and Efrain Velazquez (Helen R. Boussalis, Maj Mirmirani and Khosrow Rad)

The Effects of Stretching and Aging on the Tensile Properties of A1-Cu-Li (2195) Alloy 1046
Michael C. Abernathy and Clarence Adkins (Reza Mirshams and Zhixian Li)

Resolvents of m-Accretive Operators in Banach Spaces 1050
Eric Lehr (David Kerr)

Numerical Model for Ice Melting in a Rectangular Enclosure with Density Extremum Effects 1055
Makeda Smith (Khoudir Medjani)

Nanofabrication and Resistance Testing of Metal Coated Silicon Microcontact Arrays 1060
Jeffrey A. Yap (Jack M. Blakely)

The Effect of Razor Notching Techniques on the Fracture Toughness of Polymeric Materials 1063
Dora C. Arevalo (Carlos R. Corleto)

Assessment of In-Plane Strength of Carbon/Epoxy Laminates 1067
Jill Hahl (Ronald Bucinell and Alan Nettles)

The Design and Development of a Phantom Model for Hyperthermia Cancer Treatment 1071
Jennifer Lelas (Ann Anderson)

International Virtual Design Studio: Design of a Vehicle Without Wheels or Wheel-like Contact with the Floor 1075
Carmen McMurtry (Ronald B. Bucinell)

Heat Transfer Enchancement on a Printed Circuit Board 1079
Gretchen R. Voegler (Ann M. Anderson)

A Study of Data Issues in the GIS Environment 1084
Jesus Acosta and Lori Alvarado (Ann Q. Gates)

Quick Write vs. Quick Run: Implementation Methods for Goal Definition 1088
Kellie Alexander and Yolanda McCullough (Scott Anderson)

A Study of Environments for Successful Component Reuse in System Development 1093
Debbie Bowles (Mary Lynn Manns)

Digital Simulation of the Acoustic Guitar: A Physical Model Abstraction 1098
Adam D. Bradley (Wayne Lang)

A Parallel Solution of a Second Order Elliptic System 1103
Andre Da Breau and Lwanga M. Phillip (Okon H. Akpan)

Formulation of a Parallel Recursive Substructuring Method for Finite Element and Finite Difference Solutions 1108
Derek O. Bruff (Hayden S. Porter, Jr.)

Comparing a Particle-System Based Simulation to Other Methods in Modeling Special Effects 1113
Joshua Buckner and Ryan Mitchell (Gerald N. Pitts)

An Examination of Mentoring Methodologies in Object Technology 1118
Janet E. Cody-Mehaffey (Mary Lynn Manns)

3D Special Effects: Modeling Reflective Surfaces In Real-Time 1123
Daniel P. Cornell (Gerald Pitts)

Formal Methods for Software Specifications: A Case Study 1128
Michelle Dillinger (Ken Abernethy)

Truth Maintenance Techniques for Verification of Knowledge Bases 1134
Mark R. Finn (Neli P. Zlatareva)

Computer Assisted Data Reduction: Optimizing the Astrophysicist 1139
Dan Greenspan (Karen Magee-Sauer, Michael Mumma)

Hierarchical Planning with Definite Clause Grammars 1143
Tarik Vance-Harris (R. Raymond Lang)

Algorithm Animation: Programming on the World Wide Web Using Java 1148
Stephanie Hitchcock (Kevin Treu)

Formal Methods for Software Specification 1153
Amanda Hoffman (Ken Abernethy)

RSL, A Language for Distributed Parallel Solution of Sparse Matrix Systems 1157
Chad Huneycutt (Hayden Porter)

A Parallel Solution of a Parabolic System on a SIMD Processor 1162
Adrain Ironside and Ramaiz Mansoor (Okon H. Akpan)

Evolutionary Confusion: When and How to Apply the Genetic Algorithm 1167
Michael G. Jones (Gerald Pitts)

Visualization of a Global Atmospheric Model with Iris Explorer 1171
Elizabeth C. McAliley (Hayden Porter)

Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity 1176
Ramgopal Mettu and Yuke Zhao (Vijaya Ramachandran)

An Implementation of Particle Systems for Special Effects 1181
Ryan Mitchell and Joshua Buckner (Gerald N. Pitts)

Parallel Programming: A Disparate Architectures Approach 1186
Jason Pounds (Maurice Eggen)

A Traceability Tool: Linking Knowledge Programs 1191
Francisco Saenz and Tom Watson (Ann Q. Gates)

Commonsense Knowledge Representation for Russian Folktales 1196
Damon Stewart (R. Raymond Lang)

Gödel's Incompleteness Theorem and Turing's Solution to the Halting Problem: Linking the Foundations of Mathematics and Computer Science 1201
Philip Rash (David B. Teague)

Java Security 1206
Hnatyshin Vasil (Bob Neveln)

DARWIN: Software to Identify Dolphins in Digital Images 1211
Daniel J. Wilkin (John H. Stewman)

Wavelength Division Multiplexing Coupler Based on Talbot Self-Imaging in Planar Optical Waveguides 1215
Cadet Diana Kuykendall and Cadet Christopher L. Reitsma
(Tristan J. Tayag, David M. Mackie, Lorna J. Harrison,
Gary W. Euliss, and Richard P. Leavitt)

Proceedings — NCUR XI (1997)

VOLUME IV

BIOLOGY

In Search of Aspects of the Human Condition in Antiquity: The Case of A Hellenistic Population from Abdera, Greece 1220
Pia Economou (Anagnosti Agelarakis)

Abnormalities in Occlusal Surface Wear and Enamel Integrity in Tehuelche Dentition 1224
Alberto Silva (Silvia Dahinten and Daniel de Lamo)

Design of the Acetylcholinesterase Enzyme Using Brownian Dynamics Simulation: A Novel Therapeutic Approach to Alzheimer's Disease 1229
Brent A. Hanks (Walt Potter, Kerry Burns and Vicente Villa)

Postanesthesia Nausea and Vomiting 1234
Aaron Shaw III (Paul Loubser)

A Study of the Risk Factors for Cerebrovascular Accidents in African-Americans 1239
Tera R. Hurt (Dennis E. Daniels)

The Effect of Training Position on Leg Flexor Power in Untrained Males and Females 1244
Dawnelle Diedrich and Ryan H. Robinson (Anthony Caterisano)

Measurement of Anaerobic Power in Elite Wheelchair Athletes: Absolute Load Optimization of the Wingate Test Using the Monark 881 Arm Crank Ergometer 1247
Stephen E. Mercer (Pamela J. H. Beehler)

The Effects of the Raised Mutation of Sexual Behavior in Drosophila Melanogaster Females 1252
Jeannine Caesar and Joshua Bradner (Scott P. McRobert)

The Influence of Menstrual Cycle Phases on the Chaotic Behavior of Electrocardiograms in College-Age Women 1257
Maria M. Mountis, Meghan Ginty and Sharee Livingston (James J. Watrous)

Pollinated Maize Ovaries are Resistant to Infection by the Smut Fungus Ustilago maydis 1262
Margaret Carfioli (Karen Snetselaar)

Genetic Characterization of the AXR5 Gene 1267
Ibrahim Carvan, Donovan Chance, Joseph Mazzie, Rina Pineda and Shabnam Shah (Lawrence Hobbie)

The Competitive Relationship between the Perennial Cardaria draba and the Annual Lepidium virginicum 1272
Maria Conley (Steven Carroll)

Self-Incompatibility: a Model for Pollen- and Pollen Tube-Mediated Signal Transduction in Petunia inflata 1276
Chandreyee Das (Teh-hui Kao)

Investigating Temperature Sensitive Mutants of Ustilago maydis 1282
Janet Gervaiss, Jason Lotkowski (K. Snetselaar and M. McCann)

Partial Purification and Properties of Putrescine Oxidase from Candida albicans 1287
Uma Gunasekaran, Johnny Thomas and Louis McDonald (Muthukumaran Gunasekaran and Elias K. Manavathu)

Role of Host Plants in Egg Hatching of the Soybean Cyst Nematode 1292
Renee Poupard and Lou Casta (Paul M. Tefft)

BEST COPY AVAILABLE

Coat Protein Analysis of Tomato Mosaic Virus (ToMV) 1297
Victor Huber, Nicole Kimmes and Jesse Barthel (N. Bharathan)

Feeding Behavior of the Tropical Stick Insect Extatosoma tiaratum: A Study in Palatability of Thirty-one North American Plants 1302
Karla J. Johannes (James Poff)

Monitoring the Release of Acid Phosphatase in Pitcher Plant Fluid after Feeding with Insects 1305
Matthew Jones (Diane Melroy)

Elucidating Mechanisms of Pulmonary Fibrosis: Intracellular and Extracellular Events when the Platelet-derived Growth Factor Receptor System is Up-regulated by Air Pollution Particles and Interleukin 1-beta (IL-1ß) 1309
Patricia O. O'Brien, Annette Badgett and James C. Bonner (Sandra Gilchrist)

Determination of RNA Binding Domains of the Nucleocapsid Protein of Tomato Spotted Wilt Virus 1314
Patricia M. Stickler (Sandra Gilchrist and Tom German)

Characterization of an Auxin-Resistant Mutant of Arabidopsis thaliana 1319
Shabnam Shah, Ibrahim Carvan, Donovan Chance, Joseph Mazzie and Rina Pineda (Lawrence Hobbie)

Comparison of Microbial Consortia and Environmental Condition of Two Granite Outcrop Plant Communities 1324
Keri Randolph and Lisa M. Knauff (Sandra T. Bowden)

Characteristics and Purification of Agkistrodon controtrix laticinctus Venom 1328
Xavier G. Aranda, Elda Sanchez (John C. Perez)

The Purification and Characterization of Crotalus Viridis Oreganus Venom 1332
Gloria R. Chapa and Elda Sanchez (John C. Perez)

The Purification and Characterization of Agkistrodon piscivorus leucostoma Venom 1337
Celia Garcia and Elda Sanchez (John C. Perez)

Purification and Characterization of Crotalus viridis lutosus Venom 1342
Maria Susana Ramirez and Elda Sanchez (John C. Perez)

The Use of Electrophoretic Titration Curves as a Tool in Predicting the Separation of Crude Crotalus atrox Venom by High Performance Liquid Chromatography 1347
Maria Elisa Perez-Johnson (John C. Perez)

Development of a Rapid Detection Method for Determining Bacterial Guild Structure in Mining-Impacted Freshwater Sediments 1352
Todd Christensen (Frank Rosenzweig)

Purification and Biochemical Characterization of Antibacterial Antibiotics Produced by Soil Streptomyces 1356
Victoria C. Heverly (Robert W. Morris and Richard T. St. John)

The Microbial Activity in Saltmarsh Tidal Creek Waters Determined by Oxygen Metabolism 1360
Kenneth C. Hayes and Alan J. Lewitus (Eric T. Koepfler)

Efficiency of Latex Gloves as Barriers to bacterial and Viral Pathogens 1365
Erica Jo Hughes (Robert McLean and Carolyn Benjamin)

Oyster Reef Impact on Microbial Food Web Dynamics in Tidal Pools in North Inlet Estuary 1369
LeRoy F. Humphries, Alan J. Lewitus, Leah L. Gregory and Bonnie M. Willis (Eric T. Koepfler)

24

The Molecular Evolution of HLA-A 1374
Kristie A. Mather (Carrie Grimsley and Carole Ober)

Restriction Endonuclease Analysis of Plasmid DNA from Methicillin Resistant Staphylococcus aureus 1379
Janey Phelps (Betsy Wilson)

Macrorestriction Patterns and Genome Sizes of Two Strains of Bdellovibrio 1384
Theresa Scognamiglio (John J. Tudor)

Effects of Specific and Non-Specific Transport ATPase Inhibitors on Gill and Rectal Gland Tissues of the Little Skate, Raja erinacea 1389
Tanisha Wilkins (Gregg Kormanik)

Effects of Wood Frog (Rana sylvatica) Predation on Spotted Salamander (Ambystoma maculatum) Oviposition Site Selection 1392
Joyce E. Cacka (James W. Petranka)

Consequences of Opportunistic Predation by a Primary Consumer (Rana) on a Predator (Ambystoma) 1397
Andrea Rushlow (James W. Petranka)

The Role of Visual Cues in Determining Recognition Behaviors in Poecilia Latipinna and Poecilia Velifera x Poecilia Latipinna 1402
Joshua Bradner and Jeannine Caesar (Scott P. McRobert)

The Effect of the Lipid Content of the Diet of Blue Crabs, Callinectes sapidus, on Osmoregulation 1407
Sarah E. Hazzard (Lee Ann Clements)

Short-Term Effects of UV-B Radiation on Salt Marsh Vegetation 1412
Christopher D. Raleigh (Eva Koch & Laura Murry)

The Study of the Oxidation of CZT with H_2O_2 Using XPS 1417
Brandy Granderson (De Tang Shi, W. Eugene Collins and Muthukumaran Gunasekaran)

The Effects of Precocene 2 on The Predatory Insect Tenodera aridifolia sinensis Saussure 1422
Emily C. Whiteley (Diane Melroy)

Interspecific Interference and Resource Partitioning Among Males of Three Dragonfly Species (Odonata: Libellulidae) 1427
Michael Wolyniak (Vicky McMillan)

Habitat Selection by American Kestrels (Falco sparverius) Wintering in Northwestern Ohio 1432
Tami L. Parker (J. Eric Juterbock)

The Role of Calcium in Wound-Induced Cell Proliferation 1437
Quoc-Huong Tran (Paul J. Sammak)

Isochore Related Amino Acid Substitutional Biases 1442
Allen J. York (Dan E. Krane)

Effects of Thallium on Inositol Polyphosphate Receptors and Nitric Oxide Synthase in Rat Cerebellum 1447
Chadrick Anderson and Tanya Wright (Chella S. Chetty and Muthukumaran Gunasekaran)

Initiation of Expression and Cell-Specific Localization of Nitric Oxide Synthase (NOS) in Pre-Implantation Mouse Uterus 1452
Preeti Gupta (Yvette M. Huet-Hudson)

Characterization of Urethral Blockage in a New Mutant Diabetic/Obese Mouse 1456
Michael Villarroel (John G. Vandenbergh)

BEST COPY AVAILABLE

One-Dimensional and Two-Dimensional SDS-PAGE of Total Protein in the fungus Ustilago maydis 1459
John G. Devlin (Karen Snetselaar and Michael McCann)

Regulation of Superoxide Dismutase Synthesis in Candida albicans 1464
Uma Gunasekaran, Anita Austin and Louis McDonald
(Muthukumaran Gunasekaran, Elias Manavathu and C.S. Chetty)

Antifungal Resistance in Opportunistic Fungi: Isolation and Characterization of Amphotericin B-Resistant Mutants 1469
Uma Gunasekaran, Anjana Challa, Dinita Scurry and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

In Vitro Susceptibility of Clinical Isolates of Opportunistic Fungi to Antifungal Agents 1474
Uma Gunasekaran, Tanya Wright and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

Aye-Aye Gruel Presentation Preference 1479
Heather Ann Lynch (Joan H. Eisemann)

Modification of the Binary TBP-DNA Complex by Pluramycins 1483
Sameer Ambady (Lawrence Hurley)

Characterization of a Mutant dnaA-dnaN Gene Region that Suppresses a Temperature Sensitive Defect in the dnaX Gene of Salmonella typhimurium 1487
Farhang Amini (James R. Walker)

Conservation of Proto-Oncogenes, Tumor Suppressor Genes, and V (D) J Recombinase Genes Across Species 1492
Lucy A. Aplan (Rob Young)

An Analysis of Lipid Bilayer Studies of Single Ion Channels using M2 as an Example 1496
Erin E. Grimm (Carl Helrich)

Metal Regulated Gene Expression in Pseudomonas fluorescens 1501
Marsha L. Kukuk (Silvia Rossbach)

The Development of a PCR-Based Test to Identify the Red Factor Coat Color Genotype in Horses by RFLP Analysis 1506
Staci Murguia (Ann T. Bowling)

Differentiation and Classification of Bdellovibrio bacteriovorus using Random Amplified Polymorphic DNA (RAPD) Analysis 1509
Bao-Dan T. Nguyen (John T. Tudor)

QTL Mapping of a Genetic Marker for Longevity in Drosophila melanogaster 1513
Amy Resler (Jim Curtsinger)

Stability of Heterochromatin in Voles from Chernobyl 1518
Lara Wiggins (Robert J. Baker)

Isolation and Functional Analysis of three Non-Human Primate CXCR4 Genes 1521
Brigitta Zoltay, Jay Vasudevan and Greg Shaeffer (David Camerini)

Proceedings — NCUR XI (1997)

Volume V

PHYSICAL SCIENCES

Modification of an Interference Pattern Through Particle Statistics: Experimental Study 1526
Niranjan Sharma (Willard Fadner)

Nuclear Structure of the Stable Tellurium Nuclei 1531
Brian Champine, Peter Burkett, Christopher Davoren, Stephen Etzkorn, William Faulkner, Bernard Meehan, and Mark Skubis (Jeffrey R. Vanhoy and Sally F. Hicks)

Pulse Propagation in a 1-D Physical Lattice 1536
Jonathan Tuminaro and Joseph Winkler (H. David Sheets)

An Investigation to Measure Mechanical Strain in Structures using Optical Fiber Interferometry 1540
Satyender Mahajan (Zolili Ndlela)

CO Adsorption on Cobalt Particles Supported on Chromia - An FTIR Study 1544
Caribee Collier and Agegnehu Tsega (Murty A. Akundi and A.N. Murty)

Solar Cells Using Organic Pigment Nanoparticles 1549
D.J. Hilton and E.W. Forsythe (B.R. Hsieh and Y.Gao)

Calculating O_3 9.6 μm Absorption as a Function of Atmospheric 0_2 1553
Hilary L. Justh (James F. Kasting)

Electromagnetic Field Profiles Inside Biomaterials 1558
Pedro L. Melendez, Dimaries Nieves, Ramon A. Rivera (Idalia Ramos and Fredy Zypman)

Thermal Modeling of the Marcy Anorthosite Massif, Adirondack Highlands, New York: Implications for Depth of Emplacement 1563
Kevin M. Myer (J. Alcock)

Ultra Sensitive Diode Laser Based Monitors for Toxic Environmental Gas NO_2 1568
Jessica Owens (G.N. Rao and M.N. Reddy)

Sample Heating and its Effects on Diffusion Depth 1573
J. Reed Patterson (Peter A. Barnes)

The Hyperpolarizabilities of Phthalocyanines 1578
Tiffiani R. Williams (Beatriz H. Cardelino)

Simulated Super Resolved Imaging of Compact Radio Sources 1583
Erika Barth (David Hough)

A Study of the Lobe-Dominated Superluminal Quasar 3C263 1588
Philip J. Beyer (David Hough)

Global Imaging of the Cusp Region of the Earth's Magnetosphere 1593
John W. Colson (J.D. Perez)

3D Circuit Networks Simulate Biomaterials 1596
Edsel Ruiz, Pedro Melendez (Idalia Ramos and Fredy Zypman)

A Two-Year Climatology of Radiation Budget and Cloud Properties for the ARM SGP Site 1601
Stephen G. Strum (Thomas P. Ackerman)

Nonlinear Optical Properties of Halogenated Porphyrin 1606
Angela Benloss (Beatriz H. Cardelino, Craig E. Moore)

A Novel Method for Investigating Phase Disturbances 1611
Rex L. Blair Jr. (Thomas R. Moore)

BEST COPY AVAILABLE

An X-ray and Optical Study of Galaxies in Pairs 1616
Sarah Cousineau (Mark Henriksen)

Optically Driven Pendulum 1621
David Coy and Michael Molnar (Randall Peters and LTC Thomas Moore)

Surface Morphology of CdZn Te Crystals Grown by Physical Vapor Transport 1626
Montiquilla Davis (Arnold Burger, Henry Chen, Kuo-Tong Chen and Muthukumaran Gunasekaran)

Avalanche Segregation of Granular Media 1631
James Koeppe and Michael Enz (James Kakalios)

Magnetic Susceptibility (MS) and Visual Spectral Reflectance (VIS) Measurements: Paleoclimate Estimates for Pleistocene Europe 1636
James R. Marlatt (Brooks B. Ellwood)

Diamond Film Coatings on Titanium Alloy Using Chemical Vapor Deposition 1641
Andrea Nelson (John T. Tarvin and Yogesh K. Vohra)

Purification and Crystal Growth of Lead Iodide 1646
Danielle Robinson (Kuo-Tong Chen, Arnold Burger, Henry Chen and Muthukumaran Gunasekaran)

Recalibration of the Wilson-Bappu Effect Using the Singlely Ionized Magnesium k and h Lines 1651
Frederick Scoville (Jose Mena-Werth)

Analysis of X-ray Sources in Galaxy Clusters 1656
Dean Smith (Mark Henriksen)

Using FTIR-Reflection Absorbance Spectroscopy to Study the Structure of Thin Ice Films 1659
Jennifer L. Spillman, Govind Mallick and Robert M. deGroot (Marin S. Robinson)

CHEMISTRY

Large DNA Fragment Sizing by Flow Cytometry 1664
Angela R. Cameron (Jeffrey T. Petty)

Enchancement of Asymmetric Induction in the Aqueous Diels-Alder Reaction of (L)-Menthyl Acrylate with Cyclopentadiene by β-Cyclodextrin 1669
Kristen Daniell, Terry E. McInytre, Poh Ai Ling (Moses Lee)

Effect of Lipid Peroxidation Products, 4-hydroxy-2-trans-Nonenal and Malondialdehyde, on Erythrocyte Membranes 1674
Michael Green, Ram Subramaniam (Allan Butterfield)

The Synthesis and Decomposition of Single Source CVD Precursors 1679
Tadd Kippeny (D.S. Amenta, J.W. Gilje, and T.C. DeVore)

Thermal Remediation of Model Chloropesticides Utilizing Reactions with Sodium Salts 1684
James W. Parrett, Jr. (Thomas C. DeVore)

Determining the Effect of Substitutions on the Hyperpolarizabilities of Tricyanoquinoline-Dimethanes 1689
Jamarcy L. McDaniel (Beatriz Cardelino)

Better Magnetic Resonance Imaging Contrast Agents for Tumor Detection 1694
Leah C. Saunders (Thomas R. Cundari)

Computational Analysis of the Electronics of Substituents on Aromatic Systems 1699
Lumelle A. Schmiedekamp (Judy L. Ozment)

Isolation of a Compound Responsible for the Biochemical Control of Dimorphism in Candida Albicans 1704
Joseph J. Tasto (Kate J. Graham)

Adsorption Behavior of NO and CO on Pd/Al_2O_3: An FT-IR and Mass Spectrometric Study 1707
Chad D. Marten and Barry W. Smith (Dilip K. Paul)

Structural Studies of a Modified Oligonucleotide using 2-D NMR Techniques 1712
Thanh Ta, Shannon Teeters and Brigette Semler (Dale G. Ray III, Mark McDougall, Jim Holecek, Lorraine Rellick)

Effects of Additives, pH, and Buffers on the Chemiluminescence of Phenyl Acridinium Ester 1717
Carolyn Snider, John Rollag (D.S. Hage)

Dynamic Surface Tension and Surface Adhesion Detection for the Rapid Analysis of Surfactants 1722
Dana Alloway (Robert Synovec and Kristen Skogerboe)

Interactions of the Domains of Myosin's Regulatory Light Chain with the Heavy Chain: A Photocross-linking Study 1727
Lisa Nguyen (Jennifer J. Olney and Christine R. Cremo)

Thermodynamic Melting Point Studies of a Native and Modified Thirteen Base Pair Oligonucleotide containing 5-Nitroindole using UV Spectrometry 1732
Jamie Doone and Chad Willis (Lorraine Rellick, Dale G. Ray, Jim Holecek, and Mark G. McDougall)

Chitosan-Porphyrin Films for NLO Applications and Optical Devices 1736
Celeste A. Roney (Rosalie A. Richards, Subhash C. Bhatia, Albert N. Thompson, Jr., and Beatriz H. Cardelino)

Biochemical Characterization of Amino Acid Uptake in Potential Vacuolar Mutants of Neurospora crassa 1741
Zeljka Basic and Jonathan Z. Tayco (Kelly Kennan)

BEST COPY AVAILABLE

Preparation of Co(PYAN)$^{-3}$ and Progress Toward the Separation of its Optical Isomers 1745
Lori Bigler (Susan C. Jackels)

Attempted Synthesis of a Precursor of an Anti-tumor Marine Alkaloid: Shermilamine B 1750
William Buitrago (Yvette Jackson and Michael Lyon)

Determination of the Vanadate-Mediated NAD(P)H or NADH Oxidation Mechanism in Biological Systems 1755
Carlos J. Olivo-Delgado (Ileana Nieves-Martinez and Ronald P. Mason)

Mobius Kekulenes: Semiempirical and ab initio Hartree-Fock Calculations of Their Structures and Properties 1760
Patricia L. Frisch (Robert W. Zoellner)

Synthesis of (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d Diisopropyl 4b,8b,8c,8d-tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate: A Project on Absolute Asymmetric Induction 1765
Kimberly Johnson and Jacob E. Simpson, Jr. (Moses Lee)

The Polymerization of Dicyclopentadiene for use in the Undergraduate Organic Laboratory Utilizing Computational Methods 1769
Jason Logan (James W. Hershberger)

Examination of the Decarboxylation of Ketoisovalerate Using Pyruvate Decarboxylase from Saccharomyces cerevisiae 1773
Michael B. Meek (Betty H. Stewart)

Synthesis, Purification, and Activity of Glutaryl-CoA Analogs 1777
Shannon L. McKinney, Carrie L. Donley, Gregory K. Sewall, Patricia L. Kultgen (Colleen M. Byron)

The Synthesis of Rigidin -- A Tetrasubstituted Pyrrole 1782
R. Jordan Shuford (Keith Krumpe and John Gupton)

Molecular Modeling of Vanadium-Oxo Complexes 1787
Laura L. Sisterhen (Thomas R. Cundari)

Characterization of Liquid Crystalline Thermoset Networks 1792
Jeffrey M. Valentine (Christopher K. Ober)

Faraday Rotation of a Photogenerated Organic Triplet Molecule in Polyvinyl Alcohol Films 1797
Paul Trotto (David Hall and David Dwyer)

HPLC Analysis of Eicosanoids in Response to Valproic Acid (VPA), Endotoxins (LPS) and Tumor Necrosis Factor (TNF) 1802
Matthew Thomas McKevitt (J.R. Stephens)

Preparation of an Iron Complex of $Pyo_2[18]dieneN_6$ 1807
Shane O'Mahony (Susan C. Jackels)

The Plasma Etching of Metals and Metal Compounds 1811
Gordon Shaw (Judity Halstead)

ENVIRONMENTAL SCIENCES

Pipelines and Potential Disaster: An Introduction to Cathodic Protection 1816
Joy J. Burwell (Brian Hale and Verne Lehmberg)

Twin City Water Quality Initiative Program 1821
Valerie Kuntz (Kenneth Brooks)

Lead Contamination of Canned Food Products from Argentina 1825
Margaret M. Ryan (Richard P. Maas)

Don't Die with TDI: Dynamic Calibration of MDA Isologgers for Toluene Diisocyanate 1830
Clare E. Smith (Herschel A. Elliott and V. Dharmarajan)

The Effect of Carbon Content on the Redox Potential and Fermentation Products of Wetland Soils 1835
Wendy Rash and David Cahan (Kevin K. Moorhead and Keith E. Krumpe)

The Invasion of Carrotwood (Cupaniopsis anacardioides): A Study Comparing the Impact of an Exotic Species on two Islands in Sarasota, Florida 1840
Lisa Downey (Sandra Gilchrist, John B. Morrill and Terry Palls)

Urban Forests and Wildlife: A Web Document 1845
Katrina M. Simon (John Bishop)

Effects of Stratification on Germination of Two Oak Species in Southeastern Arizona 1849
Kimberly Suedkamp (Guy R. McPherson)

Seasonal Fluctuations in Central Greenland Ice Sheet Radar Altimeter Return Characteristics 1853
Philip Dennison (Richard Alley)

Results of a Microseismic Survey of the Front Range of Colorado 1857
Noah Daniel Hughes (Anne Sheehan)

Atmospheric Teleconnections and United States Regional Climates 1862
Dana M. McCracken (Anthony J. Vega)

Extracellular Acid Phosphatase(s) Activity of the Protozoan Parasite Perkinsus Marinus 1866
Christine M. Forsythe (Aswini K. Volety, and Fu-Lin E. Chu)

Microhabitat use by Fish Populations within the Little Miami River 1871
Daniel J. McGarvey (Horton H. Hobbs III and John B. Ritter)

Water Chemistry Habitat Assessment in Eastern Tiger Salamander Ponds 1876
Sara E. Wirtz (Daniel M. Downey)

The Derivation of United States Temperature and Precipitation Regions 1881
Donna M. Fiscus (Anthony J. Vega)

Cloud Masing of Normalized Difference Vegetation Index (NDVI) Images 1885
Heidi Zeleznik (Barry Lesht)

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COLLABORATIVE ART A MOVEMENT IN THE TWENTIETH CENTURY

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Collaborate means "to work together, especially in a joint intellectual or artistic effort." People have collaborated on artistic endeavors since prehistoric times. The Neolithic artwork, Stonehenge, in England could only have been a collaborative act, and the same is true of the ancient Egyptian pyramids. In fact, almost every monumental, artistic effort in our past must have included more than one person's strengths and abilities. Whether the actions were manual or intellectual, creative or mechanical, the workings of more than one individual had to have been involved to create such lasting beautiful, monumental works.

In the second half of the twentieth century, some people began to promote the idea that working together could be beneficial for both the artist, and the artistic work. While certain social forces made collaboration easier, more importantly, this artistic movement created social change. Collaborative art became an expression of political activism for the feminist movement, as well as allowing individuals the opportunity to give back to the community education, respect for society, and awareness for environmental changes. This account will begin with the "Happenings" in the late 1950's and move through the second half of the twentieth century. Included will be some of the main collaborative artistic endeavors which were either influenced by society or brought about some identifiable social change.

Regarding collaboration in artistic endeavors, a major turning point occurs in the late 1950's with the "Happenings." Many artists during this decade felt the need to go beyond gesture painting and junk sculpture (which was popular at the time) and because they wanted to "say" more. The first "Happening" was by composer John Cage. His 1952 "event" at Black Mountain College stimulated several other artists to collaborate and arrange other "Happenings." Allan Kaprow, Robert Whitman, Red Grooms, Claes Oldenburg, and Jim Dine were among many who became determined to present an artistic environment for the viewer.

Allan Kaprow, one of the leaders of this movement who "moved from the juxtaposition of found objects to the juxtaposition of found events," spoke about Jackson Pollock (known as "Jack the Dripper") in an article of 1958, "Pollock, as I see him, left us at the point where we must become preoccupied with and even dazzled by the space and objects of our everyday life . . . Not satisfied with the suggestion through paint of our other senses, we shall utilize the specific substances of sight, sound, movements, people, odors and touch. Objects of every sort are materials for the new art: paint, chairs, food, electric and neon lights, smoke, water, old socks, a dog, movies, and a thousand other things . . . " (Fineberg, p. 189)

Because the Happenings involved sounds, music, lighting, smells, time durations, found objects, and as Kaprow said, "a thousand other things," people had to work together. Art became an event, it was no longer "this" painting or "that" sculpture, but individuals contributing their particular expertise for the benefit of an overall outcome, a Happening. "Happenings were definitely the 'in' thing for a period. Everyone sensed the excitement and vitality of a genuine revolution in the definition of art. Yet because they did not leave museum objects and their lifespan was short, they may seem less important in retrospect than they actually were." (Fineberg, p. 189)

Even though collaboration became acceptable in the art world, in the 1950's, collaborative efforts that made important social statements, and became sources of social change did not occur until later in the twentieth century. Several collaborations including the works by Christo and Jeanne-Claude, "Womanhouse" by Miriam Schapiro and Judy

Chicago, "The Dinner Party" by Judy Chicago, and works by Russian artists Komar and Melamid are all endeavors that joined the works of individuals and facilitated them in becoming voices of social change. Each of these groups combined their talents to present ideas to the world, through artistic visual media, that made statements and stimulated change.

Christo, and his artistic partner, Jeanne-Claude (his wife), have created an overwhelming number of works that have a sophisticated understanding of the subtle political insight necessary to engage the public in critical debates on values. The 1960's centered on the realization that those with wealth and power could control democracy by shaping what people saw on television and read in the newspaper. Christo and Jeanne-Claude could compete with big business in shaping the public's perception of events. From "Running Fence" and "Surrounded Islands" to "Pont Neuf Wrapped" and "Umbrellas", the irrationality, startling scale, and presence of the work in the real world prompt us to look with a new understanding of ourselves and the world around us. Christo explained, "The project is teasing society, and society responds, in a way, as it responds in a very normal situation like building bridges, or roads, or highways. What we know is different is that all this energy is put to a fantastic irrational purpose, and that is the essence of the work." (Fineberg, p. 350)

While collaboration is taking place between a group of artists, there is a much larger, identifiable collaborative action going on with certain outside individuals during the course of the work. To make a work happen, Christo and Jeanne-Claude must include dialog with various people and show drawings to help them visualize the event. They further reinforce this with technical data including maps, photographs of the sites, engineering diagrams, and specifications. Then, the involvement of certain political and social forces are delicately interwoven into the artists' process. This interaction requires speaking with several different individuals at every point. In the end, the realization of each project depends directly on the outcome of that interaction. "Without winning the cooperation of the public, Christo could neither obtain the construction permits nor the commitment of the collectors, whose purchase of drawings, collages, prints, and small sculptures ultimately finances the work. He insists that people talk about his idea and as they do their involvement deepens." (Fineberg, p. 350)

Social statements are made in the process of the works. Collaboration is a vital part of that process. The artwork itself creates a need for passers-by to move out of their habitual ways of looking and thinking. "Everyone finds themselves doing their usual job, but now in relation to something that has no practical purpose - a work of art." (Fineberg, 350) Christo and Jeanne-Claude have created many monumental scale, site-specific, temporary artworks that are not a boastful attempt to shake up society, but rather a subtle nudge to enlighten the viewer.

While some artists worked collaboratively out of a need for change within the art community, and others worked to create a gentle social statement, some people were prepared to do what ever it took to make people listen! During the 1970's the feminist movement was at it's highest point of "waking up" society. Women were organizing, writing, speaking, protesting, marching, and involving the public in their fight for equality. Several artists during this decade worked diligently for change. Miriam Schapiro and Judy Chicago both taught at the California Institute of the Arts, and in 1972 set up the West Coast Women Artists Conference. Their most controversial project, "Womanhouse," was launched from Cal Arts with a number of their students and women artists from Los Angeles. It was the first all-female, collaborative art project.

Schapiro said, "Judy and I wanted to find a way beyond just talking. We consulted Paula Harper, a historian, and she suggested we put together a literal House that would embody all our ideas. We felt we were embarking on an adventure. We wanted to find out everything we could about this new race, this new culture: women. We wanted to understand their art, their fantasies, their limitations, their powers. . . It was like building the Parthenon: we were working out every step anew as we went." (Munro, p. 278)

The collaborative work "Womanhouse" helped wake up society and created an artistic voice, but perhaps the largest collaborative artistic impact on society occurred through the work of Judy Chicago's "The Dinner Party." For the first time a monumental artwork documented women's efforts (both artistically and historically) and stressed a need for equal historical representation for women. Before her efforts, there was little or

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no information in the history books about women's accomplishments. Chicago stated, "When I started my investigation, there were no women's studies courses . . . While an undergraduate at UCLA, I took a course titled the Intellectual History of Europe. The professor, a respected historian, promised that at the last class he would discuss women's contributions to Western thought. I waited eagerly all semester and at the final meeting, the instructor announced 'Women's contributions to European intellectual history? They made none.' " (Chicago, p. 3)

"The Dinner Party" completed in 1979, is a monumental sculpture, that involved numerous media, including ceramics, china-painting, and needlework, to honor women's achievements. These art forms were chosen because they should have been recognized as more than women's crafts (historically created and displayed inside the home), they are artistic, creative endeavors previously ignored by the institutionalized art world. "The Dinner Party" is a three sided, triangular table with an open center, each side containing thirteen place settings, (thirty-nine total). Each commemorates a goddess, or historically important woman. On the white, ceramic, tile floor around the place settings, the names of other important, historic women are glazed in gold. Each place setting contains imagery that relates to the women or their accomplishments and the names on the floor are arranged around the settings according to place in history, or the type of historical achievement. While Chicago began this endeavor alone, she says, "I was struggling to formulate what was to become an overwhelming task and one that I could never have completed alone: I intended to create a work of art that could symbolize the immense amount of material about women's history that I was discovering." (Chicago, p 4)

As her concept for "The Dinner Party" developed, dozens of people came forward to help, some for a few days and others for several years. Slowly, teams evolved and women and men worked in groups on ceramics, needlework, research, graphics, photography, fabrication and fundraising. Each group had a supervisor chosen on the basis of skill and willingness to devote time and leadership. The grand artistic endeavor became a true collaborative effort that would create a major social change by pushing historians to include information about women. Of course the entire feminist movement in the 1970's created changes for women, but this particular piece of artwork was a drastic step for historical records and women gaining the recognition they deserved.

Another group of artists in the 1970's and 80's that fought social restrictions was the Russian collaborative group, Komar and Melamid. Prior to the breakdown of the Eastern Bloc in 1990, the repressive climate made it impossible for Russian artists to exhibit anything that varied from the official formulas. Komar and Melamid became close friends in art school, and in 1972, they decided to work collaboratively and make what they called "Sots" art. The term referred to "socialist realism (which was the old fashioned academic vocabulary in which they were trained) but it also alluded to American pop art by lifting socialist realism out of its ideological context just as pop art took the clichés of consumer goods and popular media out of their commercial context in order to manipulate them as icons of the culture." (Fineberg, p. 420) Later, in 1978, to gain freedom in artistic endeavors, the two emigrated to New York via Israel.

For the Moscow artists, socialist realism and many of the subjects it depicted had certain nostalgia that evoked the last years of the Stalin period. In their work "Stalin and the Muses" there exists a likeness to the bad lighting and poorly conserved old master paintings that hung in gloomy Russian museums. On the one hand, this realistic series of work creates a political satire, glorifying Soviet history, but it also embarks on a nostalgic quality. There is also a unique displacement of time seen in their works because of the lack of formal training beyond a realistic, classic, link to the old masters. However, because they created in a certain political, satirical style, they were overstepping the boundaries of Russian artists at the time and therefore, attempting to create change within society.

After covering the Happenings, which were created out of a need to change the art modes of the 1950's, and the various collaborative works that created social change, the final category of collaborative art covered in this account include those works that are public in nature and "give back" something to the community. While there are a number of examples for this group, Judith Baca's "Great Wall of Los Angeles" and "The Aids Quilt" were chosen because they are undeniably collaborative in nature and have stimulated contemplation, education, interaction, and awareness.

In 1976, Judith Baca began the "Great Wall of Los Angeles" with a mission to preserve a largely unwritten history. The "Great Wall" is an ongoing project of the Social and Public Art Resource Center (SPARC) founded by Baca, which declares in the mission statement, "public art is a vital part of everyone's culture because it exists where people work and live -- in schools, on public transportation, and in our visibility of work which reflects the lives and concerns of America's diverse ethnic populations, women, working people, youth, and the elderly." (Senie, p. 28)

The "Great Wall of Los Angeles" is a 2,435 feet mural which depicts a historical period from the dinosaurs to the start of the civil rights movements of the 1960's. "It depicts local history form the point of view of groups and events that have been traditionally ignored by the mainstream." (Senie, p. 28) The wall includes images of the Spanish arrival in 1769, the Gold Rush of 1848, waves of Chinese and Mexican immigrants in the later nineteenth century, World War I (emphasizing the role of women), Thomas Alva Edison (a native of Mexico), social conditions in Hollywood in the 1920's, the 1929 crash and depression, the Dust Bowl refugees, World War II, Jewish refugees, the 1950's (which includes the Red Scare, the division of the Chicano community, rock 'n' roll, the origins of the gay rights movement, and the Beats), Indian and Asian assimilation, and Olympic champions from 1948 to 1964.

The "Great Wall of Los Angeles" (its actual title is "The History of California") is the longest mural in the world, and evolved through research and labor. Each section of the wall (around 100 feet) takes a year to research, organize and execute. Baca supervised different artists and teams made up of mainly locally recruited adolescents. Teenagers from the area were chosen for various reasons, mainly, young people get involved and begin to feel ownership and respect for their neighborhood. Through the process of creation, rather than defacing their environment, they become attached and proud of their community, hopefully their actions will convince other young people into positive creation and interaction. Perhaps the message of the wall may be expressed more by the young people involved than those passing the monument itself. Sixteen-year-old Sergio Moreno, after his first summer on the project hoped "that when people see this mural they forget all their prejudices and try to live with all people, no matter what race, in peace." (Senie, p. 29)

In June of 1987, a small group of strangers gathered in a San Francisco storefront to document the lives they feared history would neglect. Their goal was to create a memorial for those who had died of AIDS, and to thereby help people understand the devastating impact of the disease. This meeting served as the foundation of the NAMES Project AIDS Memorial Quilt.

Cleves Jones officially started The NAMES Project AIDS Memorial Quilt after the gathering in San Francisco in 1987. Today, ten years later, over 41,000 individual 3-by-6-foot memorial panels have been sewn together by friends, lovers, and family members, and the Quilt represents only 12% of all U.S. AIDS deaths. There are 44 NAMES Project chapters in the U.S. and 39 independent Quilt affiliates from around the world. Since 1987, over 9 million people have visited the Quilt in thousands of displays worldwide. Through these displays, the NAMES Project Foundation has raised over $1.7 million for AIDS service organizations throughout North America.

The Quilt is the largest example of a community art project in the world, 24 football fields with a walkway between sections (15 without walkway), 26 acres with walkway (17 without). It was nominated for a Nobel Peace Prize in 1989. "Common Threads: Stories From The Quilt" won the Academy Award as the best feature-length documentary film of 1989. Jane Alexander, Chairman for the National Endowment for the Arts said, "The NAMES Project gives important and impressive testimony to a tragic blight. What more poignant demonstration of the power of art can there be?"

The NAMES Project AIDS Memorial Quilt not only calls for an immediate awareness, and education of AIDS, it allows individuals to collectively remember and pay tribute to those special people who have died of AIDS. The Quilt reinforces the fact that those who have been lost to the disease are family members, friends, lovers, coworkers, teachers, old, rich, poor, gay, straight, and bisexual - diverse - and richly unique, as is each panel.

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> "Powerful and impressive, the AIDS Memorial Quilt has educated millions about HIV and AIDS. It is both a lasting memorial to those who have died and a compassionate cry for humanity to pay attention to the AIDS crisis." California Senator Dianne Feinstein. (America On Line)

The collaborative artistic endeavors covered in this account are a mere glimpse of the countless works that have been created by individuals working together. The commonalties within the groups chosen include a constant need for artistic endeavors to reach the public by stimulating thought processes and hopefully creating an active response, not just a quiet observance. While some individual works of art throughout history have also achieved this goal, perhaps utilizing information and creativity from others enhances the chances for success. Especially when the obstacle of social restraint is in effect, the completion of the work may call for a grouping of individuals to conquer that barrier. While collaboration has existed for thousands of years, it has only become an acceptable movement in art within the second half of the twentieth our century. The collaborative movement certainly has allowed for great artistic endeavors to create active social change within the framework of situations that are not easily addressed or defined. The work of Miriam Schapiro and Judy Chicago "woke up" both women and men about understanding the need for equality and the recording of women's achievements. Komar and Melamid challenged Russian classic artistic standards, Christo and Jeanne-Claude subtly nudged public opinion and encouraged viewers to become involved with the process of the event. Judy Baca's work incorporated young individuals in the intrinsic need for "giving back" historical information and raising public consciousness and, of course, the NAMES Project for the AIDS Memorial Quilt has created a dramatic artistic work that encourages individuals to pay tribute to their loved ones and at the same time educates and creates changes within society.

Bibliography

1. The Reader's Digest Association, Inc. Reader's Digest Illustrated Encyclopedic Dictionary (Boston, Houghton Mifflin Company, 1987).

2. Jonathan Fineberg Art Since 1940 - Strategies of Being (New York, Harry N. Abrams, Incorporated, 1995).

3. Eleanor Munro Originals: American Women Artists (New York, Simon and Schuster, 1979).

4. Judy Chicago The Dinner Party (New York, The Penguin Group, 1996).

5. Harriet F. Senie Contemporary Public Sculpture (New York, Oxford University Press, 1992).

6. America On Line, Web Site, The NAMES Project AIDS Memorial Quilt, URL http://ecosys.drdr.virginia.edu/namesproj.html

Nature and the Natural in the Paintings and Prints of Helen Frankenthaler

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Helen Frankenthaler is a highly respected Abstract Expressionist artist born in New York in 1928. Her work is usually discussed in terms of the formal qualities of line, color, form, and composition due to her abstract compositions. Like most abstract art, discussion of subject matter is generally avoided. However, Helen Frankenthaler consciously titled her work in reference to landscape terminology, which indicates an awareness of her physical environment. Through abstraction and non-objective art, Helen Frankenthaler's oeuvre conveys a sense of natural or landscape-like subject matter through the Abstract Expressionist belief of the artist as creator and component of nature. According to Arts Magazine contributor Jerry Bowles, "No matter how abstract Frankenthaler's paintings get, they never quite lose their hereditary connection with the world of nature and its manifestations." (22) Her work is a reflection of her environment translated through an emotional lens into abstract compositions. As a non-objective artist, she denies this presence of subject matter in her work, but at many points in her life, subject matter, style, and medium have all changed according to and reflecting her physical environment. Following her beliefs, as well as those of the Abstract Expressionists, she sees herself as creating nature through art. In an interview with Mademoiselle magazine, Frankenthaler states: "...Nature covers a lot - not only geography, but your whole psychodrama." (344) Involving the human psyche incorporates her personality, emotions, and artistic creation into the concept of nature. Her concept of nature includes all life's experiences. The process of creating art, life, and beauty is included in the definition of nature as well as one's tangible surroundings.

To install a natural framework in her work, Frankenthaler emphasizes the qualities of order and beauty when creating a painting or print. Frankenthaler said in a discussion with museum curator Michael Carmean, "Anything that has beauty and provides order (rather than chaos or shock alone), anything resolved in a picture (as in nature) gives pleasure - a sense of rightness, as in being one with nature." (8) She refers to nature as an abstract state of mind that one can attain through formal manipulation of non-objective imagery.

As an inspiration for compositions of beauty, Frankenthaler often spent summers in the country away from her home and studio in industrial New York City. In the tradition of landscape painting, she often executes studies and sketches of the summer countryside, a practice not normally adopted by abstract artists. Many of her most highly regarded pieces come out of these times spent close to physical nature. (Elderfield 66) For example, Great Meadows (1951, watercolor on paper, 22" X 30") was inspired by and executed at a farm she visited in rural New Jersey during the summer of 1951.

Although Great Meadows is an abstract painting and an exercise in the formal qualities of line and color, art critic Ronny Cohen remarks that "Frankenthaler's paintings have the kind of presence that triggers associations." (115) Whereas many abstract paintings are appreciated for their formal properties, Frankenthaler's work causes the viewer to look for meaning. Meaning is sometimes found in the combination of the number of landscape references in her titles and their relevance to her physical location at the time of painting, encouraging a reading of her oeuvre in terms of landscape imagery.

The formal qualities of line, color, and composition help promote a sense of nature. Throughout the piece exposed paper and bleeding forms are created by the addition of excess water. These clean, white, exposed areas and the thin, pale colors encourage a summer sentiment. Occupying the center of the composition is a melange of golden yellow, ochre, brown, and orange denoting an abstract grassy field. Vertical blue and purple forms, surrounded by a band of red and diagonal green and black lines in the top left of the

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composition, are reminiscent of trees or stick-like images. A circular area of ochre paint occupies the upper right corner, resembling a sun. Along the bottom, streaking up and towards the right are brown washed areas enclosed by a jagged black outline suggestive of a mountain range.

In 1952, Frankenthaler painted her best-known piece, an oil painting titled Mountains and Sea (7'3 5/8" X 9'9 1/4"). The watercolor principles of exposed paper and loose forms are now expressed in oil, which is unusual because traditional oil painting styles emphasize covering the entire canvas. She poured diluted oil paint on isolated areas of large unprimed canvas, manipulating the paint with sponges, sticks, or brushes to soak into and stain the raw canvas, a method titled the "soak-stain technique." Thinned paint creates the "halo" spreading from the paint onto the unprimed canvas and the luminescent, translucent colors found in Mountains and Sea. After a trip with prominent art critic Clement Greenberg to Nova Scotia in 1952, where she executed a number of landscape sketches, she returned to her New York studio to paint Mountains and Sea. The juxtaposition of mountain ranges in close proximity to the seashore was a striking image for her, the effect of which she reproduced in this piece. She wanted this piece to reflect not only a landscape but the whole experience of painting and creating a landscape. (Elderfield 110)

In the center of the composition, amorphous pale purple and blue shapes form abstract figures resembling rising mountain ridges or a bouquet of flowers. In the upper left, loose red lines spiral and stretch towards the corner like growing heather. Along either side of the composition stretches the suggestion of a blue horizon line. The bottom is occupied by blue, green, and pink areas bleeding into each other, creating a sunlit prism of color.

In the 1960s, Frankenthaler continued exploring the soak-stain technique and her personal expression of nature and beauty. Frankenthaler painted Seascape with Dunes (1962, oil on canvas, 5'10" X 11'8") while visiting Cape Cod in Massachusetts. The title reflects her awareness of her surroundings while the color juxtapositions and composition emulate properties of nature. The center of the piece contains two brown-green horizontal elements resembling sand dunes sandwiched between a stack of three red circular forms. Spiky, open green, blue, and brown streaks grow into the upper left forming irregular plant-like shapes. On the right, a flowery outline of purple surrounds blue and red vertical elements. The halo created by diffused paint, her choice of browns, greens, blues, yellows, and reds, and the raw exposed off-white cotton canvas promote a sense of sand and ocean.

Use of the new, plastic-based water-soluble acrylic paints of the 1960s in compositions such as The Bay (1963, acrylic on canvas, 6'8 3/4" X 6'9 3/4"), created special problems for Frankenthaler's painting style. This was one of Frankenthaler's early experiments with acrylic paint. Thinned oil paint has a tendency to bleed, blurring edges and creating new composite colors or forms. As a result of her use of acrylics, the forms in her work of the 1960s have more separate color areas. She pours excess water on the canvas to create irregular, crisp edges of color such as those found in The Bay. A luminescent flood of blue paint flows from the top of the composition to puddle in its center. Surrounded by the blue, a dab of orange provides a striking contrast and focal point. In the middleground, a horizontal band of green is painted around the blue. The last component added to the composition is a light gray wash along the bottom, providing a stable base and evoking a shoreline. On very rare occasions Frankenthaler titled her work before the piece was entirely complete. Usually she finished a composition and examined the piece to determine its title. However, The Bay was titled after pouring the flooding blue section which creates a sparkling blue lagoon-like puddle of paint. Her studio by the bay in Provincetown, Massachusetts, where she created this work, would have allowed her to see a number of views like this.

In 1964, Frankenthaler developed a more rectilinear format such as that in Interior Landscape (1964, acrylic on canvas, 8'8 7/8" X 7'8 5/8"). This rectilinear format became a regular motif of her mid-1960s paintings. A series of rectangular shapes radiates from an irregular tree-shaped central abstract form enclosed by a square blue field. Surrounding the blue field is a window-like jagged yellow frame, whose clearly defined edges are a result of acrylic paints. This is trapped by a dark area extending to the limits of the canvas. Of the title Frankenthaler said, "It's called Interior Landscape because that's what it is--an interior landscape--an abstract picture." (Carmean 42) Since "landscape" implies an exterior view, adding the word "interior" to the title brings the painting out of recognizable external influences and into the world of her imagination.

When expanding her experiments into printmaking and other media, she relied on the same principles of biomorphism and free-formed shapes found in her paintings. Printmaking allows her to experiment with other forms of nature; using vegetable and synthetic dyes on many different wood grains in combination with various types of paper brings out unusual but naturally occurring effects. East and Beyond with Orange (1973-74, 8-color woodcut, 31 1/2" X 21 1/2") incorporates natural wood texture and the abilities of different natural and fabricated dyes to enhance the composition.

In East and Beyond with Orange, the principal element is a broad panel of orange in the center of the composition. The placement of darker forms on the bottom right and left sides resemble canyon walls, creating a sunset effect when combined with the central glowing orange wash. Two darker vertical bands of orange on either side of the composition provide a frame, containing the scene. Tranquillity, calmness, and stability are inspired by this work.

Frankenthaler went to San Francisco in August of 1982 and worked with artist Garner Tullis in his experimental printmaking workshop. Tullis was a prominent figure in experimental printmaking techniques and provided Frankenthaler with technical assistance on her prints. She made several monotypes a day for four days, each set marked by an essential color. The weather during this week ranged from cloudy to stormy; the dominant color for each day reflects a mood inspired by the weather. On Tuesday the color was red and the weather was stormy, as seen in Bay Area Monotype: Tuesday I (1982, monotype, 21" X 31"). Although this monotype has no external references to landscape, the mood conveys an emotional translation of dark and tumultuous skies.

The central irregular circular forms are created by various hand-cut rubber blocks with soft, biomorphic edges, providing the same free-formed organic shapes found in her paintings, here evoking darkened clouds or turbulent seas. This series of monotypes has deeply embossed or debossed areas, depending on the placement of the rubber blocks on top of or under the paper. Although these embossed areas should be bare because the rubber blocks should prevent the murky black and red inks from touching the paper during printing, Frankenthaler often incorporates evidence of her presence as an indication of nature by way of her psyche through excessive ink that occasionally seeps into the paper covered by the blocks during printing. Frankenthaler commented that she and Tullis watched the printing press as rivers of ink poured out the sides when her plates went through. (Fine 28) The left side of Bay Area Monotype: Tuesday I displays a thick application of ink spilling over the edge of the work, evoking natural spontaneity and accident through deliberate application of materials. Throughout the piece an uneven distribution of ink causes the distinctive irregularities. The irregularities in dispersion of the red, black, and brown inks provide the emotional expression of the inclement weather during her stay in San Francisco.

By incorporating emotional translations of her physical environment into her work, Helen Frankenthaler creates non-objective art that resonates with a natural order. As an artist she is a part of nature; she is the creator of the natural properties of beauty and order. Her landscape titles indicate an awareness of external inspirations filtered through an internal, imaginative screen resulting in abstract color compositions. In abstract art there is an inclination to look for possible meanings, which is especially true in Frankenthaler's oeuvre. Frankenthaler says, "My work is not a matter of direct translations, but something is bound to creep into your heart or your head." (Carmean 36) The "something" that creeps into interpretations of Helen Frankenthaler's work is reinforced by examining the effect of her environment on the changes in her work. She took in the world around her, producing personal, imaginative, and natural abstract paintings and prints.

REFERENCES

Bowles, Jerry. "Helen Frankenthaler at the Whitney." Arts Magazine 43 (March 1969): 20, 22.

Carmean, E.A. Helen Frankenthaler: A Paintings Retrospective. Harry N. Abrams, Inc., New York: 1989.

Cohen, Ronny H. "Andre Emmerich Gallery, New York; exhibit." Artforum 25 (January 1987): 115.

Elderfield, John. Frankenthaler. Harry N. Abrams, Inc., New York: 1989.

Fine, Ruth E. Helen Frankenthaler: Prints. Harry N. Abrams, Inc., New York: 1993.

Mademoiselle. "We Talk To..." (August 1969): 343-344.

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A Comparison of Frank Lloyd Wright and Michael Graves: Furniture Influenced by Architecture

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Frank Lloyd Wright and Michael Graves are two American architects whose influence on our culture has been tremendous. These artist's are well known for their individual accomplishments, however many similarities as well as differences exist among their works. Both artist's utilize strong horizontal and vertical lines in their designs complemented by vivid colors. In contrasting two styles, some of Wright's architecture is referred to as organic in such works as the "Solomon Guggenheim Museum" while his "Falling Water" is referred to as geometric, relating to the cantilevered porches. The geometric works of Graves bring a historical reference of the Neoclassical form to modern architecture relating to colored motifs and pilaster capitals in "The Portland Building" and the various homes designed. Other than architectural structures, both artist's are designers of carpeting, fabric, wallpaper, kitchenware, dinnerware, and furniture.

BACKGROUND

Frank Lloyd Wright was born in 1867 in Wisconsin to William and Anna Wright. Wright attended the University of Wisconsin in 1884 studying civil engineering for two years. He also gained experience working part time on a construction project at this University . In 1887, Wright moved to Chicago and became a draftsman for Joseph Lyman Silsbee, a Midwestern architect. While working with Mr. Silsbee, Wright designed his first home. In the later part of 1887, Wright became a designer for the firm Addler and Sullivan, under the supervision of Louis Sullivan (Encarta, F.L.Wright), whose ideas of incorporating nature and its function influenced many of Wright's work. Frank Lloyd Wright invented many things that were economically beneficial to the builder and to the consumer. Precast concrete blocks reinforced by steel rods allowed cheaper and faster methods of construction because of the use of concrete. Air filtration systems, indirect lighting , panel heating and an internal vacuum system convinced the consumer because now these systems were inside the home. (Encarta, F.L.Wright) Mr. Wright was known as an extraordinary and serious architect, but was criticized for his "unpredictable leaky ceilings." (Heinz, p.26) Frank Lloyd Wright created the principle of organic architecture which he stated was defined in six major design principals. "Simplicity and repose in detail and decoration, to design as many different styles of homes which emphasized the individuality of people, combining nature, topography and architecture, taking the colors of building from nature and adapting them to fit harmoniously with the materials of building, using the nature of materials and having spiritually integrity in the structures designed." (Riley, p.33) Wright's production of "geometrically intricate fabrics and wallpapers, lighting fixtures, glass window motifs, custom carpet designs,"(Flanagan, p.30) and furniture range from simple to complex.

Michael Graves was born in 1934 in Indianapolis, Indiana. Graves received his undergraduate degree at the University of Cincinnati and his masters at Harvard University. After Graves earned his masters degree in architecture he was awarded a two-year fellowship at the American Academy in Rome. Graves' drawing, painting skills and the use of Cubistic techniques influenced his ideas and designs as in the "The Portland Building". In 1962 Graves returned to the United States as a lecturer in architecture at Princeton University. Later he was promoted from assistant professor to associate professor, then to full professor in 1972. During that same year, Graves along with four other architects curated the book, "Five Architects."(Encarta, M. Graves) Graves' works range from hotels such as Disney World Epcot Center in Florida to small detailed jewelry and kitchenware owned by the average consumer. Examples from some of the masters such as Marcel Breuer with his "tubular steel", Josef Hoffmann with his "square forms and Rococo undertones", and LeCorbusier with his "inspired grid" allowed Graves' style triumphant success. (Collins and Papadakis, pp.124&127) Nevertheless, Graves as well as Frank Lloyd Wright was criticized for his personal and financial problems, but for his creativity. The worst insult from his critics, who were rival architects was that " Graves makes fun of objects and makes light of things." (Hirst, p.111) Others have been quoted as calling Graves work "designer garbage and "that he strictly does outlandish things for money." A sample of this would be the outlandish commercial ads for shoe companies. In his defense Graves feels that "household items designed by architects give the average person the chance to own affordable art."(Hirst, p.112) Michael Graves plans for the future include everything for the home and office. Many compliment his work stating that "Graves' witty historical style may be the key to his product success." (Hirst, p.112) I feel his creativity, carefree attitude, and architectural skill leave many others wondering what is left or next for Michael Graves.

STYLES AND TECHNIQUE

Frank Lloyd Wright, an unlicensed engineer, designed with space in mind. Wright not only designed the living area, but also styles of furniture that should be placed in the environment. Carpeting, dinnerware, kitchenware, lighting, wallpaper, fabrics, and furniture were many of Wrights famous talents. Michael Graves' creations and structures contain historically architectural elements such as columns, pillars, arches, and towers such as in the Dolphin Hotel in Orlando.(Craven, p.527) However, the oversizing and vivid colors used to express his uniqueness and creativity in his designs illustrate his Post Modern style. The works of

Graves, which include dinnerware, jewelry, kitchenware, lighting, carpeting, and furniture show the variety and skill of in using these technology of color and scale.

Frank Lloyd Wright's teapots, salt and pepper shakers, sugar and creamers set were elegantly designed for the Imperial Hotel in Japan, using geometrical forms and precious metals. (Lind, p.215) Whereas, Graves' tea kettle, sugar bowl, creamer, and pepper mill and press coffee maker are a representation of his humor, because of the use of red and blue icons to suggest hot and cold temperature. This thought process was also used in the creation of the "Big Dripper," where the red stand is used to suggest heat and the wavy lines to suggest liquid. (Collins and Papadakis, pp.129&153) Frank Lloyd Wright's dinnerware line was composed for the Imperial Hotel as well. The gold and white pattern was produced for a more formal dinning setting and the multicolored geometric pattern for a more informal setting for the cabaret room. (Lind, p.215) The place settings designed by Graves, which are Corinth and Delos are Greek names that show his influence of the Classical elements. Delos is the star covered pattern and Corninith the red and green fleur-de-lis pattern. (Collins and Papadakis, p.126) The wall paper, fabric and, carpeting lighting fixtures of Frank Lloyd Wright are also illustrations of his architectural expression. Wrights wallpaper contains banding around the circles and the rectangles, a graduation and repetition of circles and he used a fret pattern which is the pattern that consists of small straight bars. The fabric patterns designed by Wright incorporate various sizes of squares and triangles to illustrate texture and pattern. (Lind, pp.208-209) Wrights lighting fixtures contained vertical slats which create rhythm between the spaces, the opaque class contrast with the negative space being that it is a rectangle as well. (Heinz, p.157) This wall lighting fixture from Wright contains strong banding which pull out the varying sizes of rectangles. (Lind, p.210) The glass motifs of Wright are actually the window panels used in several of the residential designs. His use of colors and geometric style allow the panels to be used architecturally in buildings, as a wall display, or as a suspended ceiling ornament. (Lind, p.213) The carpet patterns of Michael Graves were greatly influenced by the Frank Lloyd Wright with the repletion of vertical motifs but incorporated floral patterns. The abstract carpet pattern of Graves contain irregular and unidentifiable shapes such as the dash dot patterns, s-curve shapes and , the use of diagonal lines. (Collins and Papadakis, pp.154-155) The lighting patterns created by Graves express his love for Cubism and The Art Deco style as well. The use of keystone shapes, banding and negative space and sphere, expressed the Cubism influence which was the most influential movement in modern art during the early 1900's, because it introduced new approaches in using forms and shapes. (Duncan, p.11-19) The Art Deco Style became popular in during the 1920's that was mainly used in items that could be mass produced such as jewelry, pottery, textiles and furniture. (Museum of Modern Art, pp.11&12) The Art Deco Style is characterized with geometric shapes, smooth lines, and streamlined forms. In the production of jewelry for Cleo Munari, the question was asked "What ancient jewelry do you most prefer?" Graves answered Etruscan and Roman. Graves [illegible] produced "non archaeological" jewelry that is not very elaborate and ar [illegible] entified with different art styles. (Collins and Papakadis, p.128)

FURNITURE

For many architects being a total designer has allowed them to create with the entire site in mind. However, with the invention of machine technology and pre/post war industrialization, forced the architects to realize the importance of not only catering to those of the upper class but to the average consumer as well. The architects, Frank Lloyd Wright and Michael Graves, both were impressed with machinery and the ability of mass production in furniture. Both Wright and Graves used Abstract and Cubistic designs in there production of furniture. (Emery, pp.5-10)

Frank Lloyd Wright's furniture was known as both traditional and modern. The materials for his furniture consisted of various woods such as mahogany, ebony, and oak, plus other materials such as leather upholstery, fabric and steel. Wright's furniture is very recognizable because of his repeated use of high verticals and cantilevered slats. Chairs from the Robie House, the Dana-Thomas House, and the Prairie House all display Wrights unique style. (Lind, p.196) The Reader's Table also shows a series of long vertical forms with narrow spaces and lights to assist in reading. He is well know for his dining tables and chairs, but also for his armchairs, sofas, office and bedroom furniture. The armchairs and sofas were all made from various types of woods, leathers and or fabrics, they still display his use of bold horizontal and vertical slats. The office furniture is very a very identifiable piece of work from Wright's. The secretarial desk and its matching chairs are made up of metal which depict a feeling of new tech and a moving forward. The top of the desk have a resemblance of small buildings and the bottom drawers resemble the top portion of the Guggenheim Museum. (Heinz, pp.186&187)

Michael Graves, a Post Modern furniture designer has redefined the classical and modern style though his creations. The architectural experience and the use of color were not just for decoration but copies the Roman Classical style using warm tans, earth reds and violets. Many of the creations from Graves used various woods such as oak and ebony but Graves also utilized various leathers, fabrics and upholstery. The Conference Table designed by Graves for the showroom of Sunar, was made form blond wood and contained fluted pilaster legs with thin patterns. The chairs have large areas of blond wood with ebony sections and wedge shaped legs. The Circular table for the Sunar Showroom in London has square and ebony wood base, with circular designs on the top, illustrate his use of geometry in his forms.(Collins and Papadakis, p.146) The Upholstered Lounge Chair, in very identifiable of Graves because of the coral color. The chair is very organic because of the curves and the ionic column back of the chair.(Collins and Papadakis, p.148 The Plaza Dressing Table again contains spheres, rectangles and triangles all geometric form which make this a very geometric piece. The spheres support the triangle which is supported by rectangles which are repeated through out the entire dressing table and ties it all in with the circular stool. The Stanhope Bed contains negative space at the head board and the repeating of vertical lines through out the bed. The bed also contains wedge shapes and again the use of small spheres to make this a definite Graves piece. (Collins and Papadakis, p.149)

CONCLUSION

Frank Lloyd Wright and Michael Graves are the most prominent and visible designers of their time. Although they have faced numerous criticisms from there willing to try anything methods and carefree attitudes, have allowed success throughout their lifetime. Their architectural structures and various pieces designed have proven their skill and craftsmanship. Items ranging from dinnerware to carpet designs have place these designers in a category all of their own. Frank Lloyd Wright and Michael Graves are truly men who design with the consumer in mind.

REFERENCES

Bayer, Patricia,. Art Deco Interiors. Thames and Hudson, London.

Collins, M. and Papadakis, A., Post-Modern Designs. Rizzoli International Publication Inc, New York.

Craven, Wayne,. American Art History and Culture. Brown and Benchmark Publishers, Madison.

Danto, Arthur,. 397 Chairs. Harry N. Abrams, Inc., Publishers, New York.

Duncan, Alastair,. Art Deco. Thames and Hudson, London.

Emery, Marc,. Furniture By Architects. Harry N. Abrams, Inc., Publishers, New York.

Encarta Encyclopedia by Microsoft,. Michael Graves. Funk and Wagnalls.

Encarta Encyclopedia by Microsoft,. Frank Lloyd Wright. Funk and Wagnalls.

Flanagan, Barbara,.Reproducing Wright. "House Beautiful," June 92.

Heinz, Thomas A., Frank Lloyd Wright Interiors and Furniture. Ernst and Sohn, Berlin.

Hirst, Arlene., Tempest in a Teapot. "Metropolitan Home," April 88.

Lind, Carl,. The Wright Style. Simon and Schuster, New York.

Museum of Modern Art, The,. Cubism and Abstract Art. Arno Press, New York.

Riley, T. and Reed P., Frank Lloyd Wright: Architect. The Museum of Modern Art, New York.

Storrer, William Allin,. The Architecture of Frank Lloyd Wright. The MIT Press, Cambridge, Massachusetts.

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ART EDUCATION
ART IS UNDERRATED AS AN INSTRUMENT FOR TEACHING ESSENTIAL LEARNING AND COGNITION SKILLS

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Frequently articles appear in the newspaper concerning the need for educational reform and the "21st Century Classroom. It is true that our society is becoming fast-paced and information-driven. In businesses and schools across our country, computers are becoming as necessary as the telephone. While there are advantages to new technologies, we are possibly over looking the disadvantages. In this rapid growth we are losing a personal aspect, namely the ability to acknowledge and interact with other human beings. A tool to aide school reform already exists within the schools. A closer look at the underrated art room can reveal possible answers.

What learning skills can art provide? Desire, innovation, and problem solving skills are among the first of possible answers. Most curriculum can be related to art and enhanced through an art project. Art has the potential to make a significant difference in the knowledge gained and retained by the students. This can be accomplished in our school system without years of studies and huge budget changes. This paper will examine possible methods in which art can be applied to school curriculum. This application of art can provide students with opportunities in individual and group projects, thereby, enhancing individual problem solving as well as group cooperation.

BACKGROUND

From the book *Foundations of Education*, by Ornstein and Levine, a chart can be found summarizing the educational theories of eleven pioneers in education, dating as far back as the sixteenth century. Suggestions for modern day educational reform still mirror these revolutionary theories. Many of these pioneers included in their recommendations for curricula, the use of high activity levels in learning. As noted, Comenius felt that education should relate to "children's natural growth and development."[1] Froebel's educational theories have been used in Great Britain since 1854 in kindergartens. Froebel's applications, or methods of instruction, were based on the premise that self-activity, play, and imitation would facilitate children's growth and learning. He felt that children were eager to be active learners. Piaget's educational theory extends that of Comenius by suggesting that education should be organized to the growth and development patterns of children. Children need to see objects, to touch and feel them, and to be able to manipulate objects in order for learning to take place. As a means for intellectual development, the children should be encouraged to verbalize their finding, discoveries, what they have learned from each lesson. In early childhood children lack the ability to think abstractly. Children need a concrete form of learning, until adolescence when the ability to think abstractly develops. However, as abstract thought develops, the need is not eliminated for children to test their ideas in concrete media. Art can provide the concrete key to learning in many subject areas.

TEXT

The concern for effective education extends from the beginning of organized education to current. The need for reform or restructure with the educational system is a common topic across America. In the broadcast, *School That Work*, hosted by Rodger Mudd, several schools

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were highlighted that explored and instituted pioneering solutions in restructuring their school programs. In each school the primary goal was to assure all of their children achieved academically. Solutions incorporated collaborative learning environments. There is a closeness existing between the teachers and students that is not commonly found in other schools. Teachers looked to each other for new ideas as well as for problem solving. In each school, the Principals felt free to enter classrooms and participate in instruction. These Principals were not seen in strictly an authority role, and it was evident that the children felt comfortable with the interaction from all school staff members. Each of the schools had unique and effective applications in interactive education and creative lesson techniques. They proved among other points, that curricula can be effectively interrelated.

One of the elementary schools highlighted proved that money is not a key to educational success. Their success stems from the school's acting independently from the school district, the strong camaraderie among its teachers, and their stronger dedication to the children's success. The teachers do not teach in isolation, and display support for one another's projects. Teachers readily enter each others classroom as they implement interrelated lessons.

Examples of collaborative lessons were numerous and extend from the kindergarten and up. Twice the fourth graders and kindergartners worked on an assignment together in pairs. One upper grade encompassed many subjects through one project. The students worked in pairs on a geography assignment. English class involved the students developing a report on their geography assignment. Through the research required to complete the assignment, the students were exposed to Library Sciences. Art provided the visual aspect as the student created mop-up map illustrations of their geography assignment. All of these classes focused the student's attention into one single lesson. This exemplifies how curricula can be related, if collaboration between teachers and lesson plans is an element in lesson planning.

Numerous articles or abstracts are available through Infotrac that demonstrate successful use of art in classes and successful integration of art with other curricula. One article explains the approach used by Philadelphia, PA's Lea School, known as *Creative Connection*. Their approach unifies or consolidates art, math, technology, and architecture. The project links school to the community and challenges students to explore themselves as well as their community. Mathematics are involved into each activity to "strengthen the link between imagination, design, and real world visibility. The goal is to develop higher order thinking skills and broaden our students' views beyond the classroom and their neighborhood, into their entire world."[2]

In her research article, Who Ever Said Studying Art Would Be Easy?, Judith Smith Koroscik writes, "Increasingly, our teachers are being asked to link art to other parts of the K - 12 curricula, often between art and social studies or between the visual arts and other art forms, such as dance or theater."[3] Arthur Applebee notes in his book, "the curriculum is a vehicle that shapes the kinds of knowledge-in-action that students develop."[4] Education should be more than the act of inputting information into students. Education should include the opportunity to apply learned information.

Alan Block and Sheri Klein look to answer the question "How can we devise the educational experience as a journey without dictating its pathways and boundaries?"[5] Their article describes their experiment in the use of postcards to mirror a travel in education. Most of us when taking a trip either take pictures or buy postcards to remember our travels, "They are a symbol of movement."[6] The students produced postcards to also represent an experience and movement. More importantly, the student-produced postcards are in fact - Art, that is Mail Art. Block and Stein note "If we understand the walk as the metaphor for curriculum, then the postcards are curricular tools for connecting with the learner along his or her journey."[7] Mary Ann Stankiewicz explains in her editorial that "Metaphor is considered to be an essential process and product of thought."[8] She continues with a quote from Richard Schiff as describing metaphor as a bridge between art and life linked to the contextual approaches to art. Through classroom observation in different schools, I am seeing teachers incorporate an art project to convey understanding of a lesson to students. Art is more than drawing and coloring, it is a connector to enhance student's learning. At my local junior high school, Mr. Greene recently interrelated many techniques in his lesson on Japan. He taught the student's the art of Origami, prepared several Japanese dishes of typical foods along with teaching about geography, language, customs, and religion. One of his students commented that his class is interesting no matter what he teaches about. The students feel they learn much more since

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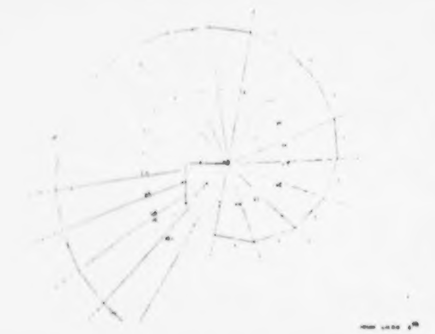
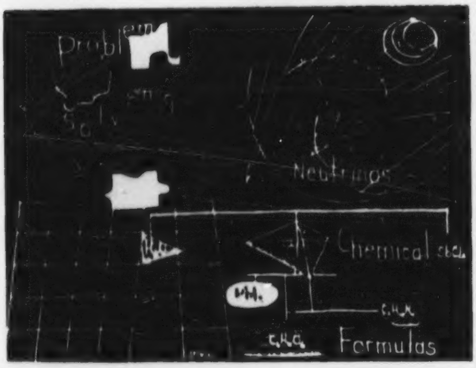
they do not go strictly by the book. The example to the left, was a clever way in which the high school geometry teacher persuaded students to calculate the square root of numbers. Each square root calculation directly relates to the length of its line. The result is a unique art form that has introduced geometry, given students experience using a calculator, and built confidence for doing math computations.



I feel these teachers have to a limited extent, correlated art to coursework and allowed the students the opportunity to apply learned information.

The example below is how a chemistry teacher begins coursework. The students were to research and develop an art project in their choice of media that related to chemistry. This example demonstrates a few aspects that would be covered during the semester.



The cover of Art Education displayed the concept of using a recognized work of art and reinventing or redefining it. This is an excellent example of how art can begin interrelated curricula. The cover illustrates the Mona Lisa, painted by Leonardo da Vinci and a student's representation of the Mona Lisa. Interrelated curricula could include geography lessons of Italy, history through events in Italy's history or events in the life of da Vinci. English could relate through the development of an essay to relate with other research or through the study of literary works for that time period. Science and math classes could explore any of the various invention and theories of Leonardo da Vinci. The possibilities of this one topic are far reaching, as the suggestions above are just a sampling.

The book *Schooling in the Light of Popular Culture*, identifies the most frequently reported problems, causes, solutions, and praises that appeared in the Times during the 1950's and 1980's. Note should be taken that many of the listed problems and causes are also the solution. In five of six categories, curriculum is listed. Consideration should be given to curricula changes from successfully restructured schools, such as those in the program *Schools that Work*. It is very possible that adding art to interrelated curricula may have a greater effect in overall education as much or more than changes in the content.

In, conclusion, we should consider the statement made by Larry Martz in his book, *Making Schools Better*, "Education is done with children, not to them. Learning is an active process of questioning, exploring, and understanding, a child is not a receptacle to be filled up with lectures and memorized facts."[9] In our search for improvement in the educational system, educators should consider an interrelated curricula that includes art. Educators working together through interrelated curricula gain expanded problem solving and creative thinking skills. At the same time, educators as role models, are setting important examples to students. Namely, examples of ability to acknowledge and interact with other human beings, of being part of the solution, and of successfully working as part of a group. Most art projects can involve interaction of working in a group, creative thinking, and problem-solving. And according to the junior high school students, keep class fun. The end result for those students, they have increased their knowledge and applied the knowledge to action while enjoying themselves.

[1] Ornstein and Levine, Foundations of Education, (New York Houghton Mifflin Company, 1977), p 104-105

[2] Lavalais, Diane, School Arts, May-June 1995, Vol 94, No 9, p17

[3] Koroscik, Judith Smith, "Who Ever Said Studying Art Would Be Easy?", Studies in Art Education, Fall 1996, Vol. 38, Issue 1, p 5

[4] Applebee, Arthur N., Curriculum as Conversation. Transforming Traditions of Teaching and Learning, (Chicago University of Chicago Press, 1996), p 60

[5] Alan A. Block and Sheri R. Stein, "This is Where I Am Right Now", Art Education, May 1996, Vol 49, No. 3, p 20

[6] Alan A. Block and Sheri R. Stein, "This is Where I Am Right Now", Art Education, May 1996, Vol 49, No 3, p 20

[7] Alan A. Block and Sheri R. Stein, "This is Where I Am Right Now", Art Education, May 1996, Vol 49, No 3, p 20

[8] Stankiewicz, Mary Ann, "Editorial Metaphor and Meaning," Art Education, May 1996, Vol 49, No 3, p 20

[9] Martz, Larry, Making Schools Better, (New York Random House, Inc., 1992), p 18

Toontown: The Disney Tradition Continues

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Toontown is the newest "land" at Disneyland and perpetuates many of the phenomena for which the theme park has been well known and even criticized in the past. This analysis shows that Toontown is a physical microcosm of Disneyland, beginning with the entryway which leads one under a train station to emerge in a different world on the other side. Here, Baudrillard's concept of simulacra is taken to the extreme, as "real" and "fake" become entangled in a three dimensional simulation of a two dimensional (cartoon) representation of the world. The result is a landscape more perfect for visual consumption than even that of Disneyland proper. Compulsive heterosexuality is set up as the norm in a highly gendered system so blatantly stereotypical one wonders how it passed from the planning stage to completion

Toontown is the newest land at Disneyland in over twenty years. Inspired by the movie "Who Framed Roger Rabbit?" it is billed as "the land that Toons built" just for kids. It is a cartoon world come to life, the place where all the cartoon characters at Disneyland are supposed to live. Like the finale in "Who Framed Roger Rabbit" the Toons have broken their corporate bonds and mixed together, representing the merger of Disney and Warner Brothers.

Toontown is a physical microcosm of Disneyland itself. Just as one enters Disneyland, in Toontown, one also "[passes] through a gate suspending normal temporal and spatial arrangements" (Mills 1990, 70). From this gate, the pathway leads under a train station to emerge into a different world on the other side. In both Disneyland and Toontown this functions as a form of ritualistic rebirth (Stilgoe 1983, 218). While in both cases this passage under the train station leads back to the good old days, to childhood, and to adventure, the Toontown entrance does not lead to optimism and the promise of progress. Disney parks have always have problems with the concept of progress and tomorrow, for the projections do not come true. At EuroDisney, Tommorowland was replaced with Adventureland, a land of nostalgia for the "Wild West." In Toontown, the aspiration to progress is replaced by the aspiration to regression. It really is the place in which one can become a blathering child again. Toontown is built on a modified hub design, and the Jolly Trolley runs on tracks through the busiest section, just as a trolley runs down the busiest parts Main Street, U.S.A.

In many ways Toontown outdoes the rest of Disneyland at its own game, amplifying phenomena for which Disney has become infamous. Two of the most famous subjects of critique of Disneyland proper exemplified in Toontown are simulacra and gender.

Jean Baudrillard (1983) considers Disneyland to be the ultimate example of simulacra, a copy of an original which does not exist. Simulacra, says Baudrillard, is like a map which precedes the territory. Simulacra becomes more real than the real thing it simulates. In so doing, simulacra obliterates its referent, leaving itself as a copy without an original. In this way, Main Street U.S.A. becomes more real to us than Kansas Street, the main drag in Marceline Missouri on which it was based, ever was. When we become nostalgic for turn of the century life, we think of the sparkling Main Street at Disneyland rather than the dirty, muddy and theft ridden main street of Walt Disney's childhood or any of the other thousands like it (Marling 1991, 194). The simulacra at Disneyland confuses our understanding of reality. As Umberto Eco (1986, 44) writes:

> When, in the space of twenty-four hours, you go (as I deliberately did) from the fake . . . wild river of Adventureland to a real trip on the Mississippi, where the captain of the paddle-wheel steamer says it is possible to see alligators on the banks of the river,

> and then you don't see any, you risk feeling homesick for Disneyland, where wild animals don't have to be coaxed. Disneyland tells us that technology can give us more reality than nature can.

Baudrillard's concept of simulacra is not subtle enough to describe the actual phenomenon of real and fake at Disneyland. Stephen Fjellman (1992, 255-56) defines four categories of real and fake: the real real, real fake, the fake fake, and the fake real. The real real at Disneyland are elements of nature to be controlled: hunger, thirst, lines. The real fakes are turn of the century facades on Main Street, or the moving spaceship cabin in the Star Tours ride, or a cartoon Mouse named Mickey in his debut short "Steamboat Willie". The fake fake are human beings in Disney character costume. As children can attest, the fake fake is more real than the real fake. "Look its *really* Mickey!" Even otherwise sane adults do the same thing. A friend of the author who had never been to Disneyland before saw Mickey Mouse, spontaneously yelled *"Mickey!"* ran up to him and hugged him. To this day she doesn't know what overcame her. Even Fjellman's concept of the fake fake is not subtle enough to cover the permutations of reality in this exchange overheard at Disneyland:

> Child: I saw Mickey . . . 'n Goofy . . . 'n Dumbo . . .'n the Little Pigs . . .
> and . . . and . . .
> Adult (helpfully): Didn't you see Snow White?
> Child: Oh, yes. I saw *her* . . . but she wasn't real.

As Anthony Haden-Guest (1973, 270) quips, "A mouse with a fiberglass head was real. A girl with a wig was not." The fake fake, it seems, has an internal hierarchy all it's own.

The fake real, what Baudrillard called simulacra—a copy without an original, is achieved by transformation of the real fake through continuous bombardment which results in a blurring of boundaries. In this way the turn of the century facades (real fakes) on Main Street become the phenomenon and mythos of Main Street U.S.A. (fake real) itself.

Toontown is simulacra taken to the extreme. It is, after all, a life size cartoon. "Where," an advertisement in the *Los Angeles Times*, February 7 1993, tells us, "a Toon can be a Toon. And you can too!" A place where "real" and "fake" become entangled in a three dimensional life sized simulation of a two dimensional drawn caricature representation of the world. Even Richard Fjellman's distinctions of the real and the fake cannot capture the subtitles of the gyrations of reality here. It is no accident that the author's friend who went crazy over Mickey Mouse did so in Toontown. Or, that the rest of the night she kept repeating excitedly, "I met Mickey! I *really* met Mickey!" In Toontown it is *not* the real fake which turns into the fake real, the simulacra which is more real than it's referent. Here, it is the fake fake which becomes the fake real—the simulacra—more real than the tawdry, boring lives and homes lacking wonder to which the visitors must return at the end of the day. One can always aspire to the lifestyle presented in Tommorowland, even if it will not come to pass. But one cannot aspire to owning dishes which swim around inside a dishwasher. Just as a fiberglass headed character seems more real than a girl in a wig, so too the Toontown dishwasher seems more real and exciting than the one presented in Tomorrowland's Carousel of Progress, or the ones in our homes.

Fish swim around in the gas pumps at Goofy's Gas. The fact that it seems *so real*, realer than real, can suddenly crash into that sinking feeling that absolutely nothing at all is real. This phenomenon, labeled "creeping surrealism" by Joel Achenbach (1987, 18), exemplifies Baudrillard's idea that as simulacra is more real than what it copies, it renders nothing real. After all, what can one do with a plate full of hologram chocolate chip cookies?

One thing we *can* do with hologram cookies (which are found in Minnie Mouse's kitchen) is consume them visually. Just as the cookies pull the viewer in to be visually captivated, so does Toontown itself. It is a landscape even more perfect for visual consumption than that of Disneyland proper. It is candy for the eye. Not only in the figurative sense, but literally too. One feels as if one could run over to a hill or tree and start licking. The construction is reminiscent of the latest trend in new housing developments where houses appear artificial: oversized for their lots, with wasted space, out of proportion windows, and stucco which has been too perfectly applied and painted neutral pastel or sickly blues and greens. But here in Toontown it works, for here, *artificial appears more real than real ever could.* The buildings' proportions are all off, the colors pop, and the shapes jump out at the viewer. Toontown draws the viewer in, and the viewer devours Toontown.

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The most troubled and troublesome area in Toontown is that of gender. Toontown was built on a highly gendered system so stereotypical, one wonders how, in the 1990's, it passed from the planning stage to completion. The legacy of gender trouble at Disneyland goes back before Disneyland to Walt Disney's animation days. The women he employed were "ink and paint girls," not animators, who had to work in a separate building and were paid the lowest wages at the studio (Holly and Denning 1993, 93). The fictional women Disney animated, such as Sleeping Beauty, Snow White, and Cinderella, are bland passive heroines. In a scathing criticism of Walt Disney, Kay Stone (1975, 44-45) writes: the Disney heroes "succeed because they act, not because they are," while the heroines are "cute little beings existing among pretty animals and singing flowers." The villains of these films, such as wicked stepmothers and Cruella DeVille are also female. Walt Disney's animations offered women only the dichotomy of nice passive girl versus wicked witch. At Disneyland the gender troubles continued. These troubles are best exemplified in the ride Pirates of the Caribbean, where a "group of pirates loots a town and rapes its women, who enjoy the process because, it is explained, they're all old maids" (Schickel, 1968, 336).

The symbols of male and female in Toontown are Roger and Jessica Rabbit of "Who Framed Roger Rabbit." They grace each bathroom entrance, and we must identify with one of the two in order to know which bathroom to use. Roger is the presented as the norm: a regular, decent guy. Jessica is the (highly) sexualized Other. Their relationship is a realization of the stereotype of the nerd teenage boy's ultimate fantasy. Roger is a gangly, plain looking guy—well rabbit—who managed to win the oversexualized object of his desire. Why is his object of desire so much the exoticized Other—a sultry over idealization of a human female? Judith Butler (1990, 22-23) maintains that when gender is regulated as "a binary relation in which the masculine term is differentiated from a feminine term and this differentiation is accomplished through the practices of heterosexual desire" the system is an "institution of a compulsory and naturalized heterosexuality."

In the forms of Roger and Jessica Rabbit, Toontown has tapped into what Jane Kuenz (1993, 78) calls Disneyland's chief fetish: compulsive and unchanging heterosexuality in the service of reproduction. These paradigms of male and female are based not simply in gender roles, but in heterosexual gender roles, played up to the nth degree. When the author walked up to a bathroom in Toontown she had, for the first time in her life, the alienating sensation "this bathroom is not for me." The role she was supposed to identify with was so extreme that she could not identify with it. This is a concern, not because the author's identity as a woman is threatened, but because Toontown is advertised as a land for children. What kind of influence will this have on young girls and boys?

Mickey and Minnie Mouse do not seem to function together on the level of desire described by Butler. In fact, they don't seem to function on any level of desire at all (or, as will become apparent, even on any level of friendship). Nevertheless, their relationship is based on gender as "'a ritual social drama' that produces heterosexuality as a prediscursive or natural category" (Kuenz, 1993, 79). The only thing which seems to hold their relationship together is stereotypical gender roles.

Minnie is passive, her life is centered on the home and on Mickey. According to the phone messages and notes in her house, Mickey is her only friend. She puts his wishes and needs as number one on her list of things to do, and is constantly assisting him, such as making his breakfast, lunch and dinner, and giving him presents. At the back of Minnie's house is the Wishing Well. It is the only apparent indicator of active agency in Minnie's life. However, it is only a false indicator, as wishing is only the unfulfilled, passive version of doing or creating.

Mickey is active. He has many friends and is totally dedicated to his work at his movie studio, the Movie Barn. His lives his life in the world, as shown by the tiles of some of his movies: "Mickey's Winning Team," "Mickey's Service Station," "Mickey's Mellerdrama." Notes and messages from Goofy, Donald and Roger Rabbit, all of which pertain to their work together, grace his bulletin board and answering machine. Mickey even has Pluto, his trusty dog. Minnie does not rate high on Mickey's list. Calling her ranks sixth, even after watering his lawn. In the message he leaves on Minnie's Phone, Mickey says "I'll be late for our date. I have to meet someone at the Movie Barn, you know how it is. Gee, thanks for understanding, bye." Minnie comes second to Mickey's outside world with regularity. Both parties seem oblivious to Mickey's lack of appreciation and respect for Minnie.

Mickey and Minnie's houses, which stand next to each other, exemplify the trappings of their respective highly defined genders. Minnie's house is quaint: it is pink and lavender, has wood shingles, flower boxes, heart shaped windows and a heart shaped weathervane. Mickey's house is solidly "masculine" with wood siding, a brick roof, and no ornamentation.

Inside Minnie's house there are three rooms: a sitting room, make-up room, and kitchen. The furniture in the sitting and make-up rooms is all cartoonishly oversized and angular, and mostly pastel. The kitchen is white and closer to normal life-size. The sitting room couch and chair are upholstered in a leafy green print. Sitting in the magazine rack is *Cosmousepolitan*, and lying over the arm of the chair is *Jessica's Secret*, a takeoff on the *Victoria's Secret* lingerie catalog. Minnie's list of things to do reads:

1. Call Mickey
2. Mousercise
3. Make box lunch for Mickey
4. Cook a nutritious breakfast for Mickey
5. …the garden
6. …for Mickey
7. …center

The make-up room has a large dressing table with enormous cosmetics and bottles of perfume sitting on top. There is a chaise lounge, a wardrobe, and a few books. In the kitchen the focus is on cheese. The shopping list on the refrigerator not only lists myriad cheeses, but cheese puffs, cheese crackers, cheese cake, cheese pizza, etc. Also on the refrigerator is a recipe for "Mickey's Favorite Cheddar Cheese Chip Cookies."

Mickey's house is paneled in dark wood and has a solid feel. There are six rooms to Minnie's three rooms, representing Mickey's more full life. There is an entrance followed by a front room, with the requisite ship in a bottle and model car on the table, and an abstract print couch and fireplace. The phone nook holds books and messages. Mickey's to do list reads:

1. Wake up at 5 A.M.
2. Mousercise
3. Play with Pluto
4. Eat a balanced breakfast
5. Water Lawn
6. Call Minnie
7. Be in Movie Barn by 6:30 A.M.
8. Open Barn to greet guests

The trophy / music room includes the compulsory sports trophies and stuffed fish. A piano and globe round out Mickey's creative and intellectual sides. In the smoking room is a second fireplace, books, television, dart board, more trophies, and Pluto's bed and bowl. Mickey also has a laundry room. This is the one non-stereotypical room in Mickey's house, proving he is at least somewhat more rounded than Minnie. But he doesn't actually wash his own laundry, as the note for the housekeeper attests. Next is the greenhouse, and then the backyard, which leads to Mickey's Movie Barn.

From Mickey's house we learn he is a well rounded gentleman. His life is dedicated to his friends and work at the Movie Barn. Minnie's house shows that her life revolves around Mickey. He is her only friend, and the first priority in her life. Minnie is a stereotypical Stepford Mouse. She only exists to support her boyfriend, whether he treats her well or not; clothing and makeup are of utmost importance; and she cooks. She also knows her role in sex, as evidenced by her *Jessica's Secret* catalog. Mickey conversely has barely any time to spend with Minnie; he takes her for granted and takes advantage of her. He too is a stereotype—a man of agency out in the world who makes no attempt at equality with his partner. Mickey does not seem to be friends with Minnie. Likewise, Minnie does not seem to be friends with Mickey. There is no exchange on the level of friendship. They both appear to simply be following roles they have been ordered to play. There is absolutely no reason for them to be together except for the gender / sex roles which make a heterosexual relationship a necessary requirement.

The blatantly biased depictions of gender in Toontown as evidenced in both Jessica and Roger Rabbit, and Mickey and Minnie Mouse are highly disturbing in an environment supposedly built for children who, by their very nature, are still working out their own gender roles.

This analysis of Toontown has shown Toontown to be a physical microcosm of Disneyland proper, a land which displays characteristics for which Disneyland has been infamously criticized in the past. Toontown, the ultimate example of Disney simulacra, encourages visual consumption which borders on the imperative to literally consume one's surroundings. Toontown's gender roles are based on compulsive heterosexuality, leaving little room for friendship or mutual exchange.

REFERENCES

Achenbach, Joel. "Reality To Be Canceled?" *Tropic Magazine, Miami Herald*, December 13 1987: 18. Quoted in Stephen M. Fjellman *Vinyl Leaves: Walt Disney World and America* (Boulder: Westview Press, 1992), 254.

Allen, Holly and Michael Denning. "The Cartoonists' Front." *South Atlantic Quarterly* 92, no. 1 (1993): 89-117.

Baudrillard, Jean. *Simulations*, trans. Paul Foss and Paul Patton. New York: Semiotext(e), 1983.

Butler, Judith. *Gender Trouble: Feminism and the Subversion of Identity*. New York: Routledge, 1990.

Eco, Umberto. "Travels in Hyperreality." In *Travels in Hyperreality: Essays*, trans. William Weaver. New York: Harcourt Brace Jovanovich, 1986.

Fjellman, Stephen M. *Vinyl Leaves: Walt Disney World and America*. Boulder: Westview Press, 1992.

Haden-Guest, Anthony. *The Paradise Program: Travels through Muzak, Hilton, Coca-Cola, Texaco, Walt Disney and other World Empires*. New York: William Morrow, 1973.

Kuenz, June. "It's a Small World After All: Disney and the Pleasures of Identification." *South Atlantic Quarterly* 92, no.1 (1993): 63-88.

Los Angeles Times, February 7 1993, Cartoon section.

Marling, Karal Ann. "Disneyland 1955: Just take the Santa Ana Freeway to the American Dream." *American Art* 5, nos. 1-2 (1991): 169-207.

Mills, Stephen F. "Disney and the Promotion of Synthetic Worlds." *American Studies International* 28, no.2 (1990): 66-80.

Schickel, Richard. *The Disney Version: The Life, Times, Art and Commerce of Walt Disney*. New York: Simon and Schuster, 1968.

Stone, Kay. "Things Walt Disney Never Told Us." *Journal of American Folklore* 88 (1975): 44-45. Quoted in Stephen M. Fjellman *Vinyl Leaves: Walt Disney World and America* (Boulder: Westview Press, 1992), 264.

Stilgoe, John R. *Metropolitan Corridor: Railroads and the American Scene*, 218. New Haven: Yale University Press, 1983. Quoted in Karal Ann Marling "Disneyland 1955: Just take the Santa Ana Freeway to the American Dream." *American Art* 5, nos. 1-2 (1991): 194.

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Political Ideologies of Harlaxton Gardens, Harlaxton, Lincolnshire, England

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As we approach the end of the twentieth century, the English countryside is still dominated by the large mansions and parks that belonged to the aristocratic landed gentry of the annals of British history. The land serves as a vehicle of ideas, of personal and political commitment which has been cultivated by a society very conscious of history in the midst of the dynamic changes of the nineteenth century. In response to industrialization, urbanization, and the rising middle class, rural landowners turned to the past in search of security. Large 'Jacobethan' style mansions invoking the reign of James I were constructed in the midst of vast and consciously altered landscapes across the English countryside. These mansions and gardens embody traditional political and land-inspired English values of wealthy, moral, and well-educated men. Harlaxton manor in the English Midlands at Lincolnshire, although not as famous as Belvoir Castle, has never been studied. My intent in this paper is to demonstrate that its owner, Gregory Gregory, had a political and ideological motivation for his creation of the vast and theatrical panorama that Harlaxton manor displays.

Gregory's position as prominent country squire in the nineteenth century and as the owner of Harlaxton can be attributed to his noble lineage. The Harlaxton property first came into the hands of Flemish immigrants, the de Lignes, in 1619. In 1620, Daniel de Ligne, was knighted by James I and ten years later was named high sheriff of Lincolnshire county. Gregory's family, from Nottingham, married into the de Ligne family in 1738. Through a succession of inheritances, Gregory acquired the Harlaxton estate in 1822 in addition to properties in nearby Nottingham and Denton. Thus, it appears Gregory quickly acquainted himself with the role of a landed gentry.

With his new societal position, Gregory sought out a hillside on the Harlaxton property ideal for the creation of his grandiose scheme for a manor. Gregory searched for an ample area where he could display his wealth of books, fine art, and statuary accumulated on the Grand Tour. He envisioned the construction of a traditionally influenced manor on a hillside with dramatic terraces and landscape trailing down from it that would display Gregory's social and political status. This new estate would be comparable to the precedents set by the landed gentry who Gregory would have known at neighboring Belvoir Castle and Hatfield House. The grandeur of these estates conveyed a message of an owner who welcomed royalty into his domain. "The temple of honor must be built on an eminence rather like a spurious church in a landscape park."[1] In summary, Gregory's estate would embody all of the supposed moral qualities and political ambitions associated with an old English secular 'faith', a belief in unswerving British tradition.

In 1831, Gregory razed the old de Ligne homestead, Hungerton Hall, and briefly employed Anthony Salvin, a well-known designer and architect, until 1838. At this time he then hired another prominent designer, William Burn, who remained at Harlaxton until its completion in 1855. These two designers, Salvin and Burn, would combine Gregory's romantic and youthful energy with his landed and powerful display of tradition. To do this, they chose to fashion the manor in an overall 'Jacobethan' style.

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The 'Jacobethan' style is characterized by dramatic skylines and undulating facades reminiscent of Baroque dynamism. The 'Jacobethan' is actually a revival combination of the seventeenth century English Jacobean and Elizabethan styles. So named for the king and queen of England, respectively, these styles symbolized strong and independent periods in English history and nationalism.

This period, the beginning of the nineteenth century was insecure in its sense of tradition, history, and nationalism. When the popular Queen Victoria succeeded the throne in the midst of dynamic and changing times, it is understandable that such times inspired the revival of Jacobean and Elizabethan conservatism.

Thus, this combined 'Jacobethan' style became acceptable as the national style and it was often employed in the rebuilding of country houses of revivalist Tory landowners of the 'Young England' faction.[2] The 'Young England' faction represented an early nineteenth century collaboration of young, energized Tory politicians responding to industrialization, urbanization, and a new middle class.

Due to Gregory's prominent social status, he was very cognizant of these contemporary political activities, if not directly involved in them himself. Under the influence of 'Young England', Gregory was offered an escape from the disagreeable present to an agreeable, but imaginary, reconstruction of the past, in which lords of the manor would once again dispense the paternal justice of a feudal society.[3]

In the fashion of Elizabethan fondness for high ground, as Gregory saw displayed by the placement of the nearby Duke of Rutland's property, Belvoir Castle and the Avon eminence, Stoke Park, Gregory chose to build Harlaxton on a hill. Wishing to model his mansion after Belvoir, Gregory was also attracted to its arrangement of gardens and grounds. The harmonious transition from house and gardens to terraces to natural woodlands and fields surrounding Belvoir paralleled Gregory's proposals at Harlaxton.

Gregory sought to articulate a 'picturesque' display of a mansion on a hill closely surrounded by formal flower gardens which united with the natural countryside at Harlaxton. The concept of the 'picturesque'[4] in landscape design originated with Humphrey Repton, a well-known contemporary garden designer who is famous for his numerous landscape 'improvements'. Repton could take a sketch of the existing property and visualize the required improvements to create a picturesque environment. Repton's 'picturesque' style was captured by the Quarterly Review, "(Repton) extracted real English style gardening to be typified by mature parks, dignified mansions, and gentlemen benevolently overlooking flourishing landscapes."[5]

While Repton never had direct contact with Harlaxton, the new and younger landscape gardener, J. C. Loudon, visited the site years after its completion to find some of his own practice put into use. Loudon's theories focused primarily on what were thought as the liberal qualities of nature. The liberal view also implied a political position which Loudon sought to manifest in his landscape creations, fostering the term 'gardenesque'. This 'gardenesque' liberality pronounced itself most strongly with the vast array of vegetation used throughout the gardens as well as the manner in which this vegetation was planted. "Its (the 'gardenesque') principle function was to display the skill of the gardener, particularly where the gardener was also the owner."[6]

The theories of Repton and Loudon, the 'picturesque' and the 'gardenesque', respectively, were not far from each other in basic principles. The former tended to be founded in the more conservative designs reminiscent of his predecessors. The latter, on the other hand, greeted a new society with innovative designs. Loudon and the new society incorporated theories and practice of Repton's 'picturesque' methods and elaborated to extremes. This resulted in a more articulate formation of geometric and formal gardens immediately surrounding the house of the estate. Loudon's 'gardenesque' also developed 'picturesque' landscapes into more densely and irregularly planted parks.[7] Two or more trees were planted in a single hole to create a dense and irregular outline. Clumps of land and vegetation scattered freely across the landscape surrounded the owner with a sense of variety and luxuriance.

Carefully considering the placement of plants ease the harmonious flow of the overall contrast, from the natural to the unnatural. A mix of evergreen cedars, yew, holly, and holm oak trees are planted in 'gardenesque' fashion around terraces and unite areas of formal atmosphere with the encompassing woodland and countryside. This mixture of trees provides a variety of height, texture, and color. Common laurel, Portugal laurel, Irish yew, and holly frame selected garden walks and cascade down terraces exaggerating the topography. The sensation of such deliberate creations enhances the theatrical and dramatic illusions.

In our exploring this particular use of vegetation and dramatic display, standing at the front entrance gates, one sees a mile ahead the magnificent 'Jacobethan' manor. this view is embraced by the woodland which rises behind and to the side of the house. From this imposing introduction, one explores the great expanse of the countryside. Drawing from indenture contracts, it is likely that the cultivated fields which now stretch across the expansive grounds also lined the same drive that Gregory traveled in the nineteenth century.

The descent down the drive leads one into a 'picturesque' interplay of water and woodland. Midway along the mile-long entry, the smooth continuity of the natural land encounters a small lake enclosed within irregular and serpentine edges. This irregularity reflects Repton's 'picturesque' influence and is enhanced by the encompassing thin woodland of willow and birch tees. Leafed, deciduous trees add delicacy to the lake and protect it from the disparate cultivated fields. This delicacy also contrast with the dark and brooding qualities of the conifers and Lebanese cedars which frame one's view of the manor.

Next, passing through the entrance lodge gate, the hedge row lining the approach guides one's eye along the ascent to the manor. The dense hedge serves as a natural guide as well as a natural screen to outlying property. Nearing the house, the hedge serves again to separate the cultivated fields from the more formal and majestic stages lying ahead. Clumps of deciduous trees located at the end of the hedge row deliberately screen a full view of the manor. The grand 'Jacobethan' decor and skyline of the bell tower are all that is visible at this stage on the approach.

Their dense foliage also affects the lighting of the approach. Nearing the manor, the approach appears to narrow and darken as the natural shading of the trees overhand. However, exiting from the shadow, the stage opens to a flood of natural light so that every detail and shadow of the intricate Baroque-style manor is exposed.

The moment one steps through the courtyard gates at Harlaxton one becomes a character on Gregory's stage. One is immediately struck by the unmistakable Baroque character of the architecture manifested in the manor which is also reflected in the exterior and gardens. The next three of these stages, French, Italian, and Dutch, are among the elaborate and formal gardens immediately surrounding the manor.

The grounds adjacent to the manor were conspicuously designed to delight as pleasure-gardens and embody a more personal and dramatic aura. These pleasure-grounds reflect his most articulate manipulation of the land. A more utilitarian section of the estate is to the north, thus the pleasure-grounds are situated asymmetrically, in accordance with Baroque principles.

At the inception of the formal gardens is a somewhat compact and dramatic series of terraces resembling the terraces Gregory derived from designs at Hatfield House and Belvoir Castle. Salvin had advocated such terracing. These terraces along with the French, Italian, and Dutch gardens affiliate Gregory with the 'Young England' factions residing at Hatfield and Belvoir. Overall, the terraces cascade down the hillside aesthetically blending with the more natural and untamed landscape and at the same time divide the French, Italian, and Dutch gardens.

Although today they are largely grass lawns, the grounds were once elaborate gardens dotted with classical monuments similar to those Gregory encountered on his Grand Tour, and conveyed in his words, "...an ideal means of imparting taste and knowledge...."[8] The Grand tour afforded him the opportunity to collect pillaged items allowing Gregory to return with artifacts exemplary of his cultural awareness as well as his personal tastes, acting at the same time as a mark of his social position. Classical sculpture once dispersed amidst the 'worldliness' of the formal gardens would have delighted and intellectually entertained Gregory's relatives and friends.

Little French influence is visible today. What remains is a long gravel walk in the south gardens with flowers bedded in parterre-fashion (partitioned) and this suggests the existence of a Parisian scene. A survey of the grounds from 1885[9] delineates the outlines of apparent parterre gardens on several terraces.

It is my theory that boxed beds of various plantings, depending on the season, would simulate those seen in the colorful and elaborate beds at nearby Hatfield which are certain to have influenced Gregory's design at Harlaxton. The use of colors and more specifically, color contrasts, heightened the theatrical and fantasy effects created. A landscape archaeological study currently being conducted will undoubtedly prove my theory.

On another terrace the stage is an Italian scene with remnants of a summerhouse and colonnades, which may have sheltered a vinery during Gregory's lifetime. Theatrically, the area opens to full sun, suggestive of the Mediterranean climate. The architecture and lay-out initially appears very formal and Renaissance like. However, the offset entrances and exits onto this stage, as well as the irregular placement of the summerhouse is recognized as an Italian Baroque arrangement.

Strolling further, the woodland wraps around the south side of pleasure-grounds opening to the next stage: an irregularly and naturally framed artificial Dutch canal. The very geometric quality of the canal seems to embody some of the most artificial and formal manipulations of Gregory's land. However, the naturally shaded environment soften its formality and provides seclusion from all other scenes of the estate.

Climbing to the highest terrace, one can imagine Gregory sitting here on an old stone bench next to a tree stump surveying his vast and romantic terraces. I imagine it may have been his favorite spot throughout the entire estate. Here the benevolent man could sit and overlook the stages of his land and life. The terraces gently step down into rolling fields outlining each of Gregory's political and personal ambitions. 'Picturesque' contrasts of the natural versus the architectural, the wild vis-à-vis the serene, and intimacy versus vast vistas culminated in one overall ambitious display of wealth, power, land, political ideology, and old English tradition at Harlaxton manor.

ENDNOTES

[1] Nigel Everett, The Tory View of Landscape. London, 1994, 99.

[2] William Vaughn, Romantic Art. London, 1991, 125.

[3] B.H. Abbott, Gladstone and Disraeli. London, 1972, 27.

[4] Everett, 184.

[5] His theory of the 'picturesque' appears in his Observations on the Theory and Practice of Landscape Gardening which was published in 1803 and was followed by a succession of texts published in 1806 and 1816.

[6] Alan Gore and Laurence Fleming, The English Garden. London, 1929, 171.

[7] Tom Williamson, Polite Landscapes: Gardens and Society in 18th Century England. Gloucestershire, 1995, 153.

[8] Christopher Hibbert, The Grand Tour. London, 1974, 15.

[9] Ordinance Map 1887, Harlaxton Library Archives, Harlaxton College, Grantham, England.

REFERENCES

Abbott, B. H., 1972, Gladstone and Disraeli, (London: Collins Clear Type Press).
Everett, Nigel, 1994, The Tory View of Landscape, (London: Yale University Press).
Gore, Alan, and Fleming, Laurence, 1929, The English Garden, (London: Michael Joseph Ltd.).
Hibbert, Christopherm 1974, The Grand Tour, (London: Hamlyn Publishing Group,Ltd.).
Ordinance Map, 1887, Harlaxton Library Archives.
Vaughn, William, 1991, Romantic Art, (London: Thames and Hudson Ltd.).
Williamson, Tom, 1995, Polite Landscapes: Gardens and Society in 18th Century England.
(Gloucestershire: Alan Sutton Publishing Ltd.)

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Reminders of Death and Lessons For Life:
Vanitas and *Memento Mori* Paintings of the Spanish Golden Age (1556-1700)

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"I saw all the deeds that are done under the sun; and see, all is vanity and a chasing after wind." (Ecclesiastes 1:14)

This vision comes from the book of Ecclesiastes in the Old Testament of the Bible. The author's statement was a reaction to his own revelation that toil and life are impermanent. He realizes that generations of individuals such as himself come and go, and only the earth remains truly eternal. This legacy recognized the transience of human existence and is paramount in Catholic doctrine. It forms a framework of ideas concerning mortality in the nations that adhere to the message. Spain, the most Catholic of countries during its Golden Age (1556-1700), built upon this doctrinal legacy and added to it a unique commercial and ideological experience that considered human mortality as well, and depicted it in unique genres of painting called *Vanitas* and *Memento Mori*.

Spain began its ascent to world power status in the early 16th century as a result of New World exploration and commerce. Cities such as Seville in southern Spain became solitary depots for various trades with the newly "discovered" West Indies. Wealth became abundant, and official administrative systems were developed to deal with the new influx of income. Customs houses, Chambers of Commerce, and mints were instituted to take full advantage of a rising standard of living. Initially, life was bustling with excitement for the Spaniards who benefited in the rush to the New World.

The city of Seville came to epitomize the effects of rapid newfound wealth. A "supermarket to the world," Seville acquired vast riches from commercial trade. Everyone was affected by the growing desire for social status. Citizens built larger and more decorative homes to keep pace with their neighbors. They also threw huge public festivals and engaged in elaborate religious ceremonies. The Church also shared in the decadence and wealth, and commissioned many new artistic endeavors. Sevillan society in general became more influential economically because of the amount of money pouring onto its shores.

Not all effects of Spain's rapid advancement to financial prosperity were beneficial, however. Besides a luxurious lifestyle, newfound wealth also brought with it greed and corruption. The citizens became numb to the adverse effects because of an immersion in wealth without any apparent consequences. Silver was widely available and people spent it loosely in an effort to increase their social status. City life suffered with crime and exploitation as a result of the all-consuming drive to acquire great wealth and prestige. As awareness of this situation grew, more and more individuals began to issue warnings against the situation. Spain was quickly becoming a society steeped in material and spiritual corruption that could seriously affect its status as a worldwide spiritual leader and in fact, conflicted with their purported spiritual values.

This growing sense of disillusionment continued to spread throughout Spanish society well into the latter part of the 16th century. Beginning in the 1580s, economic decline was added to the list of growing concerns, and during the next thirty years, Spain gradually lost its seat as the world's greatest colonial power. In addition to destroying hard-earned advancements, economic decline escalated because of epidemics, constant warfare at home and abroad, and immigration to the New World colonies. Such a state of affairs left Spain with a shrunken population and declining opportunities at home and abroad.

Disillusionment also spread into the activities of the Church. During the early years of New World colonization, the Spanish clergy increased in numbers in order to Christianize native peoples and accomplish other missionary goals. However, as contact with the New World lessened because of the declining economic situations at home, the clergy was forced to direct its attention to domestic concerns. Once home, the displaced clergy returned to a scene of severe economic, social, and moral decline. Despite these pressing spiritual concerns, the clergy became embroiled in rivalries amongst each other, and disputes arose concerning land claims, customs, and religious ceremonies. Issues such as growing crime, prostitution, and violence did not receive the attention they deserved. Spanish society suffered because of the lack of strong spiritual leadership.

Other religious groups took a more militant approach to the moral decline of the times. Within these groups, a morbid strain developed in the interpretation of Catholic doctrine. A "cult of death" emerged which put greater stress on the role of purgatory and penance after death. In addition, a "popular mission" movement developed within the

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Jesuit and Franciscan monastic orders. This new strain preached graphic images of hellfire and damnation to small groups situated in evangelical villages. Leaders used vivid paintings and sketches to illustrate images of judgment and punishment in an effort to reform what they saw as an immoral society.

Spain thus became a land divided. Society was torn between the repercussions of maintaining the rapidly acquired wealth of the past, and the desire to reform the societal immorality that resulted from economic decline. The imbalance took a turn for the worst in 1649 when Spain fell victim to the Black Death of Europe: the Bubonic Plague. Rats and fleas spread the disease rapidly amongst a Spanish society already suffering from economic decline and poverty. Within three months, Spain lost one third of its entire population. It was a devastating blow to a society that prided itself on being spiritually rewarded and a messianic people. Mass death was not part of being a divinely chosen nation!

The plague and its aftermath caused Spanish society to react in two very different ways. Some citizens considered themselves lucky to be alive and they searched for immediate gratification to celebrate their survival. Decadent behavior escalated within this group. In their pursuit of gains and possessions, disputes arose concerning the abandoned estates of the recently deceased. Mass death cleared the way for new groups of people to take what they could in the ruins and keep it for themselves.

Other surviving middle class citizens desired to pursue a more religious approach to living. These groups devoted themselves to leading a more pious and penitential existence. This group viewed the calamities of the plague as divine retribution for the previous years of worldliness and sin. Repentance was their goal because they believed that life was short and death was certain at the hands of an angry God. As a result of this mentality, there was an increase in the number of citizens leading an eremitic lifestyle. Meditation pertaining to Christ's own death would help to eliminate the fear surrounding the lingering situation in Spain following its own battle with the Bubonic Plague.

In addition to these responses, the plague also ushered in a new mentality concerning the nature of death itself. It became an extremely familiar and personal experience as well as a practical situation. Amid the confusion of mass death, land and possessions were left behind. Spain was in a state of constant upheaval concerning a solution to the problem. The situation forced Spanish society to seriously consider the process and preparation needed for a good Christian death.

Spain did have a vast history of organized demise to build upon which originated in the Renaissance. Practical devotional literature called Ars Moriendi, the Art of Dying, was widely read in the public sphere during this time. These works detailed divine grace and forgiveness rather than judgment and damnation at the time of death. According to the literature, this state could be achieved by deliberate preparation prior to the actual time of death in the form of questions, catechetical quizzes, and specific prayers. Alejo de Venegas states in his book *The Agony of Crossing Over at Death* (1537), "the greatest folly any man could commit…is to live in a state in which he does not want to die; and the remedy for such madness is none other than a good constant preparation for death." Spanish Catholics prepared for death their whole lives in order to do what was appropriate when the time came, but also as a guide to living a good life in the meantime.

The Black Death of 1649 called this legacy to mind. The historical art of dying took on practical considerations by placing more importance on the necessity of a prepared final will. Wills became so important during these years of mass death, that no citizen was allowed a Christian burial without one. Personal wills contained two types of clauses. First was a pious clause which dealt with the spiritual estate of the individual. Citizens were responsible for leaving some sort of bequest to the church after death. The second type of clause was a distributive clause which dealt with the material possessions of the individual. Both types of clauses were needed to have a completely good death.

The act of writing a will was also very beneficial for the person before death. It was considered a penitential act that would help an individual to accept the inevitability of death and detach from their worldly possessions by cataloguing their distribution. In addition, this act would help to increase an individual's generosity thereby benefiting them in the afterlife. Personal wills also took on a confessional quality through necessary reflection on the past and its accomplishments. These aspects were particularly important during the years of the plague, as testified by the deathbed presence of a notary.

In addition to being a documented phenomenon, death in Spain was also considered a social process. Moments before death, a priest, neighbors, or members of a local confraternity were summoned to the bedside of the dying individual to join the notary. These observers had a social and religious duty to help the victim fend off any last-minute temptations. This was a highly esteemed act of charity on the part of the observers. Prayers would be read and the priest would administer confession, final communion, and extreme unction by anointing the individual's five senses. These last rites were issued to prepare the individual for the separation of the body and soul. The priest and observers would continue to remain with the victim until they passed into the afterlife. This was of the utmost importance because of the believed presence of demons at the bedside of the dying individual. It was at the precise moment of the soul gradually moving upward toward the spiritual realm that the devil would attack the still present sense of reason at the last minute of life. It was a bitter contest between the demonic presence and the

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reassuring power of the bystanders. The demonic presence would also try to tempt the victim with vain sentiments such as: the desire for longer life, impatience with suffering, attachment to family, riches, honors, merits, fear of hell and punishment, denial of faith, or anger and blame at God for death. The bystanders at the scene provided the remedies and encouragement needed to overcome these temptations, thereby providing a good death and the possibility of eternal salvation for the individual.

Not only did society attempt to aid an individual at death through prayer and encouragement, but also through preparatory artistic endeavors called *Vanitas* paintings. These works, often in the form of still life, contained hidden allegories which pertained to the ephemeral nature of earthly existence and human life. *Vanitas* paintings often carried a distinctly moral warning about contemplating death before being faced with the unknowable circumstances of temptation that could impede salvation.

Vanitas paintings would also provide the necessary example for the renunciation of earthly vanities needed at the last moments of life. They achieved this in three types of grouped objects. One group contained symbols of wealth and power, as well as knowledge and worldly pleasures. Objects within this group include jewelry, coins, armor, weapons, books, and instruments. Viewers were reminded that there was no protection against death which would take away the powers and possessions of earthly existence. A second group of symbols reflected the transience of human life. These objects included clocks, hourglasses, candles, and flowers which alluded to the passing of time and decay. Included in this group were skulls and bones which acted as *Memento Mori* objects by reminding the viewer of their impending human demise. *Memento Mori* objects added to the power of *Vanitas* paintings by bringing these ideas down to earth for the viewer to contemplate. A third group of symbols was concerned with references to an afterlife or resurrection. Objects within this group included corn, walnuts, glasses of wine, and other religious items.

In addition to the objects depicted, the power of *Vanitas* paintings also resided in their symbolic display and arrangement. The various objects were generally found in untidy piles amid mass disarray. The intentional negligence gave viewers a sense of worthlessness and abandon concerning the objects. By portraying the objects as meaningless and empty, the fleeting earthly pleasures they represent are depicted as trivial and subservient to eternal spiritual life. *Vanitas* paintings were intentionally mysterious in the comprehension of their arrangements in order that the viewer should be forced to contemplate the images on a more detailed basis. Good examples of these paintings include Antonio Pereda's *Vanitas* (1634), and Juan de Valdes Leal's *Allegory of Vanity* (1660). Both works contain earthly vanities and *Memento Mori* skulls, which work together to warn the viewer about attachments to worldly manifestations in the face of certain death.

Not only were *Memento Mori* objects found in Spanish *Vanitas* paintings, but also in painted images of penitential saints such as Mary Magdalen and St. Jerome who began to be depicted as a witness to the Last Judgment in the 16th century. Closer in humanity to the viewer, the image of St. Jerome was that of a humble and penitential man who meditated over skulls about the inevitability of death and the subsequent vanity of earthly objects. *Memento Mori* works of penitential saints brought reflection about death, heaven, hell, and last judgment more down to earth in order to provide Spanish Catholics with a contemplative and penitential example of behavior.

The most complete example of Spanish *Vanitas* and *Memento Mori* paintings can be found in the 17th century works of Juan de Valdes Leal. Leal was extremely interested in themes such as death, suffering, and judgment and he depicted them in his paintings. In fact, he aimed at shocking the viewer into repentance by providing a startlingly realistic arrangement of images and symbols that portrayed the inevitability of death. Many of Leal's works were commissioned by the Jesuit Order in Spain, which contributed to their dark and sinister moods. Ignatius Loyola, the founder of the Jesuit Order, advised his followers to avoid any thoughts or feelings of happiness because they obstructed the sorrow needed to better contemplate death and final judgment.

In 1672, Leal was commissioned to decorate the Church of the Hermandad de la Caridad in Seville by the leader of their Brotherhood of Charity, Miguel Manara. Manara adhered to the teachings of the Jesuit Order and based his commission on his book, *Discurso de la Verdad* (1671), which begins, "Memento homo quia pulius est, et in pulverem rebertis" (the first truth that must reign in our hearts is: dust and ashes, corruption and worms, the tomb and forgetfulness). The hieroglyphs produced by Leal were particularly fitting for this location. Their stark depiction of death reflected the work of the Brotherhood of Charity, whose main duty was burying the dead. This act of mercy was particularly important after the outbreak of the Bubonic Plague in 1649, and the subsequent famines in 1651 and 1677, which killed a significant portion of the Spanish population.

Leal produced two masterpieces for the Church of la Caridad in Seville. The first was titled *Finis Gloriae Mundi* (The End of Worldly Glory). A literal *Memento Mori* painting, Leal showed the viewer a stark and realistic account of the interior of a crypt. Skulls and bones lie in scattered piles to remind the viewer of the fragility of human life and the inevitability of death. A stigmatized hand holds a scale in perfect balance above the remains. One side reads "Nimas," "neither more," and holds animal representations of the

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Seven Deadly Sins: pride, anger, avarice, lust, gluttony, laziness, and envy. The other side reads "Nimenos," "nor less," and contains objects of penitence and mortification: the heart-symbol of the Jesuits, a nail studded cross, scourges, a rosary, and a hairshirt.

Beneath the scales of salvation, rich in somber tonalities, three decaying figures lie in perpetual stillness. One figure is a skeleton, one a bishop in white holding his crosier, and the other a knight of the Order of the Calatrava. Each figure represents a position based upon the pursuit of earthly vanities. The figures as a whole represent the legend of the Three Living and the Three Dead (1200), in which one of the dead says to the living, "What you are, we were; what we are, you will become." This image emphasizes the premise that all of humanity is equally subject to mortality.

Leal's second hieroglyph *In Ictu Occuli* (In the Twinkling of an Eye), is a literal *Vanitas* work. The viewer sees books, weapons, crowns, a globe, and a snuffed out candle. Above the piles of vanities, a skeleton carries a scythe and a coffin and points to the title of the work while extinguishing the light of earthly existence. The work illustrates a verse from I Corinthians, "And the last enemy to be destroyed will be death, for he has put all things under his feet." For the viewer, this representation brings the Biblical down to the level of Spanish society.

The conditions in Spain during its Golden Age (1556-1700), including social attitudes, economic fluctuations, and great tragedy, were particularly conducive to the creation of *Vanitas* and *Memento Mori* paintings. They were meant to remind the Spanish people of how fragile life was, and to warn them that focusing on possessions was futile. Death was inevitable, and the only thing that one could take with them was spiritual preparation. These paintings tell the contemporary viewer about the unique experiences that altered the way that Spanish society saw this world and the next. They are also a reminder, even today, of our own temporary existence.

WORKS CITED

1.Defourneaux ch.4. 2.ibid. 3.Payne 54. 4.Payne 59. 5.Payne 57. 6.Meiss 67.
7.Meiss 73. 8.Eire 25. 9.ibid. 10.Eire 26. 11.Eire 21. 12.Eire 23. 13.Eire 29.
14.Eire 32. 15.ibid. 16.ibid. 17.Hall 291. 18.Martin 424. 19.ibid. 20.Hall 291.
21.Groseclose 52. 22.ibid. 23.ibid. 24.Rice 163. 25.Rice 165. 26.Trapier 54.
27.ibid. 28.ibid. 29.Trapier 55. 30.Trapier 57. 31.Trapier 58.

REFERENCES

Aries, Philipe. Western Attitudes Toward Death From the Middle Ages to the Present. Baltimore: The Johns Hopkins University Press, 1974.
Brown, Jonathon. Images and Ideas in 17th Century Spanish Painting. Princeton: Princeton University Press, 1978.
Eire, Carlos. The Art and Craft of Dying in 16th Century Spain. New York: Cambridge University Press, 1995.
Gomez-Moreno, Carmen. Spanish Painting, the Golden Century. New York: McGraw-Hall Book Company, 1965.
Groseclose, Barbara. "Vanity and the Artist" The American Art Journal 1987:51-59.
Hall, James. Dictionary of Subjects and Symbols in Art. New York:Harper&Row, 1974.
Mallory, Nina Ayala. El Greco to Murillo. New York:Harper Collins Publishers, 1990.
Martin, Fred. "Art and History-Vanitas" Artweek Dec. 7, 1985:2.
Meiss, Millard. Painting in Florence and Sienna After the Black Death. Princeton: Princeton University Press, 1951.
Payne, Stanley. Spanish Catholicism. Madison, Univ. Of Wisconsin Press, 1984.
Rice, Eugene F. Saint Jerome in the Renaissance. Baltimore:Johns Hopkins Univ, 1985.
Scott, Barbara. "The Theme of Vanitas in 17th c. Painting" Apollo Dec. 1990:423-24.
Trapier, Elizabeth Du Gue. Valdes Leal. New York: Hispanic Society of America, 1960.

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VISUALIZING THE HUMAN FORM: ART AND ANATOMY IN EIGHTEENTH-CENTURY ENGLAND

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The dualism of art and science in Eighteenth-century England was reflected in the anatomical illustrations of the time. This relationship, revolutionary for contemporary medical thought, resulted from the intellectual and aesthetic partnership formed between anatomists and artists. Although artistic and medical anatomy both convey knowledge of the inner workings of the human body, their visual motives are diverse. Medical anatomy divides the human body into its mechanical components while artistic anatomy attempts to conceptually visualize the whole based upon its parts. This research has focused on the artistic influences placed on Enlightenment period anatomical illustration. Whether the artist's brush or the anatomist's scalpel played a greater role in the study of anatomy during this time is evaluated.

As long as brushes have sculpted the graceful curve of muscles and scalpels have opened windows into the inner body, anatomy has been intertwined with art. Twentieth-century artist Burne Hogarth contended that medicine and art can enhance and refine one another when anatomy provides a connection. Medical anatomy dissects and partitions the human system into finer, more microscopic details. Artistic anatomy visualizes and fuses the whole from these parts (Hogarth, 9). During the Eighteenth century, the art of medical illustration flourished and joined artists and anatomists in a common aspiration: visualizing the human form.

In England, artists and anatomists did not cooperate in the study of anatomy before 1720. Instrumental to their developing collaboration was the establishment of a series of artistic and educational academies in England from 1711 onward. Additionally, dissections began to be performed by anatomists including William Cheselden and William Hunter with an artist's motives in mind (Bignamini and Postle, 84). The real source of inspiration for the reform of human anatomy came from the imagination of the artist (Chewning, 22). Although the surgeon was experienced in dissecting techniques, he was rarely skilled in recording minute observations. However, the artist who wanted to understand the inner body in order to depict it more accurately needed an experienced hand to expose and isolate the part or system being observed. This mutual need made artists and anatomists appropriate partners.

As can be seen in the most noteworthy of period anatomical works, the anatomist typically had developed a well-established relationship with a competent artist. William Cheselden was the first anatomist to instruct artists in England, and he believed that an anatomist must be skilled in drawing. He began teaching anatomy classes in 1711 and published an illustrated handbook for his course. This book, *The Anatomy of the Human Body*, established Cheselden as the foremost teacher of anatomy in England (Garrison, 198). His masterpiece is a skeletal atlas entitled *Osteographia*, which resulted from his collaboration with artists Gerard Vandergucht and Jacob Schijnvoet. The extent to which Cheselden contributed artistically to the atlas remains unknown. The title page of *Osteographia* shows the camera obscura, which was constructed of a mirror set at an angle to a lens, which reflected an image onto paper (Gernsheim, 16). This was possibly the first time this tool was used for drawing medical subjects (Thornton and Reeves, 82). The late Eighteenth-century obstetrical atlases of William Smellie, Charles Nicholas Jenty, and

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William Hunter are landmarks in medical illustration. Jan van Rymsdyk was the artist for most of the illustrations in these works. He also produced drawings that John Hunter incorporated in his 1771 *The natural history of the human teeth* (Thornton and Reeves, 85). It appears that Rymsdyk's first drawings were executed for William Hunter's monumental *work, the Gravid Uterus*. This was the first atlas to depict the pregnant uterus and the fetus throughout gestation. Rymsdyk worked on this project for twenty-two years because of Hunter's wish for perfection. When he had completed Hunter's atlas, Rymsdyk began working on his own publication, the *Museum Brittanicum*. The book expresses his frustrations as a portrait painter forced to earn a living as a medical artist (Thornton, 65). Although Rymsdyk's name appears consistently in Hunter's atlas as the artist responsible for the drawings, he claimed that Hunter neglected giving him the praise he was due. Rymsdyk contended that he would no longer illustrate medically. However, in 1787, in need of money, he returned to the subject of the gravid uterus when he illustrated the male-midwife, Thomas Denman's *Collection of engravings*.

William Hunter was significantly involved in the artistic community for social and professional reasons. He accepted his responsibilities as Professor at the Royal Academy very seriously, arguing in his lectures that anatomy was the foundation of art (Jordanova, 386). Hunter envisioned anatomy and art co-flourishing amongst Renaissance geniuses such as Leonardo da Vinci and Andreas Vesalius and viewed himself continuing in this tradition (Kemp, 144-8). His work, the *Gravid Uterus*, is essentially a product of the Vesalian tradition. The thirty-four illustrations represent the pregnant uterus in life-size, anatomically exact and artistically perfect, according to historian Ludwig Choulant. There were, according to Hunter, two traditions of anatomical illustration. The first was one in which nature was imaginatively reconstructed in the minds of anatomists and artists. Hunter contrasted the first tradition with his own, simple portraits of nature showing the objects as they were seen (Jordanova, 399). Illustrations "that represented what was actually seen" carried "the mark of truth." Hunter stated, "What imitates Nature most is most striking (Kemp, 39)."

Despite such assertions, Hunter's works did not reflect nature. Instead, they fabricated it because of the lifelike quality he added to the cadaver illustrations. This was a technique common in Eighteenth-century anatomical pictures. Parts of the body were shown realistically, often giving great attention to features other than those that were the explicit subject of the picture. Elsewhere, some bodily parts were completely cut off, such as the thighs of a pregnant subject. This view gave the impression that the body was realistically whole, but the amputation showed human flesh caught between the vitality of life and the decay of death. The plates strive to give an impression of life, as in the way the umbilical cord seems wet. This startling effect of combining realism with butchery was very common. Hunter was concerned with body topography, spatial relationships, surface features and particularly textures. For Hunter, these technical details were very important because they combined descriptive clarity with beauty. However, some of his plates are more diagrammatic, showing large parts in detail only (Jordanova, 386).

In the traditional approach to displaying anatomized bodies, only male bodies were depicted (Chewning, 20). The only reason for showing female forms was to highlight reproductive differences. Therefore, the vast majority of illustrated female bodies were pregnant. In the 1700s, pregnant woman imagery provided new visual insights into fetal development. Previously, the fetus was portrayed as a tiny adult body floating in the womb enclosed by a vast amount of open space. The illustrative plates in Hunter's *Gravid Uterus* and Jenty's *The demonstrations of the pregnant uterus* show the full-term child nearly bursting out of the womb. The mother's body frames and molds the fetus. The two lives are portrayed as a single interconnected system (Brock, 47-8). Both Hunter's and Jenty's works are illustrated by Rymsdyk. The plates of pregnancy made for Jenty are examples of mezzotint, a form of engraving that was seldom used in medical illustration of the time (Garrison, 335). Jenty favored mezzotint because the illustrations could be hand colored afterwards, they evoked a three-dimensional appearance, and they were "capable of exhibiting a nearer imitation of nature (Thornton, 55)." In Jenty's work, soft contours are emphasized, and the subjects' thighs are not sectioned as seen in Hunter's atlas. Furthermore, the torso is surrounded by soft, folding drapery. Rymsdyk also illustrated plates in Smellie's *A sett of anatomical tables*. William Smellie, the foremost English midwifery professor, first described the correct passage of the fetal head through the pelvis (Garrison, 214).

In a few cases, as with Peter Camper, the anatomist was his own artist. Camper attended Smellie's midwifery lectures and eventually illustrated his *Tables*. His diagrammatic drawings were further embellished by the engraver in order to enhance their beauty (Thornton, 17). Camper was instrumental in the shift of anatomic portrayal of subjects. He believed that anatomic subjects should be represented architecturally, as da Vinci had done. Following the Vesalian school was Camper's rival, German artist and anatomist, Bernhard Siegfried Albinus. Albinus maintained that anatomic subjects should be presented in perspective, meaning that they should not be drawn as seen from one point of view. Camper and Albinus frequently criticized one another's works, provoking a bitter controversy between them (Choulant, 285).

In a dual role as a painter and anatomist, George Stubbs was unique in English art. His drawings exemplify his extraordinary knowledge of anatomy from which his work is based. Stubbs studied human anatomy under surgeon Charles Atkinson, who also encouraged him to lecture in anatomy to medical students. John Burton asked him to illustrate his book, *An essay towards a complete new system of midwifery*. The book contains eighteen, technically-poor illustrations. The quality of these drawings reflect Stubbs self-taught art of engraving and inability to base them on original observation. The engravings do not bear Stubbs' name because he was not proud of his endeavors into a subject with which he was unfamiliar (Thornton and Reeves, 83). Stubbs based these plates on Albinus' *Tables of the Gravid Uterus*. His style, apart from the obvious delineating of fully rounded forms, shows little deviation from that in contemporary anatomical books (Doherty, 3). Around 1759, Stubbs began work on his *Anatomy of the Horse*. He gained a profound knowledge of the creature through the dissections he performed himself. Thirty years later, Stubbs' interest turned to drawings based on dissection of the human body. This interest in anatomy went far beyond that of any European artist of the period. Stubbs relied on empirical research methods and appreciated anatomy for its own sake. He was not alone, however, in believing that a true knowledge of anatomy could only be gained by first-hand experience (Bignamini and Postle, 22).

While anatomy seeks to explain, art seeks to reveal. When medical illustrations are examined from an artistic point of view, the true beauty of the human form is observed. Early Twentieth-century scientist and philosopher Jacob Bronowski stated in his book, *Science and Human Values*, "It is wrong to think of science as a mechanical record of facts, and it is wrong to think of the arts as remote and private fancies. What makes each human, what makes them universal is the stamp of the creative mind (Chewning, 4)." Whether through the mind of science or the eyes of art, the same creative force has led anatomists and artists to their common goal: an increased knowledge of our inner selves.

64

The American Canon:
Great Male Playwrights and Their Female Characters

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The Great American Canon of playwrights is a select group of writers who are considered by critics and educators to be worthy of admiration and study. These writers tend to be white males who have been successful on Broadway. The works of these playwrights also tend to exclude women characters "from the subject position [subordinating] her as an object to be attained, an obstacle to be removed or a space to be conquered by the active male subject" (Yarbro-Bejarano 138). These tendencies make it very difficult for a post modern, Chicano playwright who has failed on Broadway to join the canon. Luis Valdez is an influential playwright in Chicano theater but he has been overlooked by the canon despite the similarities between his work and those of such playwrights as Arthur Miller and Sam Shepard.

Valdez's plays are comparable to the greats in the canon in several ways: he has proven to be a financially successful writer (in L.A. instead of on Broadway), he writes plays for a specific audience, his plays are about the state of society, and he focuses his work on men instead of women, who have been relegated to the background. Valdez fulfills these canonical characteristics like Miller and Shepard, yet he is rarely considered to be a "great American playwright." Valdez's work also shares the same flaw as Miller and Shepard: a lack of fully developed female characters.

VALDEZ'S WORKS

Luis Valdez focuses his creative energies on educating and improving the lives of his primarily Chicano audiences. He started El Teatro Campesino in 1965 as a way of bringing plays to migrant farm workers. With those plays came the knowledge that they were not alone in their struggle to gain a better life for themselves and their families. As his play group expanded and began having professional actors and not just workers performing the *actos*, Valdez started focusing on longer, more complex stories.

Valdez's Zoot Suit tells the tale of a man sent to prison for a crime that he did not commit. In Zoot Suit, as in all his plays, Valdez uses stereotypes to make his point. All the characters are defined by these stereotypes: the white do-good supporters, women, and even the Hispanic pachucos. The audience identifies the stereotypes and can rally against the ones it perceives as negative. The obvious stereotypes make the message easier to be identified by the audience and they leave feeling that the problem is not too great to solve.

Each one of Valdez's plays, and its subsequent message, reflects an issue in American society. While Valdez has been doing this for over thirty years, and his technique is effective, using plays to get a social message across to an audience is certainly nothing new to Hispanic theater. In his book Mexican American Theater, one of several that he has written on Hispanic and Chicano theater, Nicolas Kanellas writes that this tactic has been used throughout the history of Mexican theater:

> Mexican/Hispanic theater, besides serving esthetic and entertainment needs, also served the social and political purposes of the community, which conceived of itself at different times as a conquered people whose culture was threatened, later as a colony in exile ('Mexico de afuera'), and today as a minority oppressed by a larger, monolithic culture. (Mexican American Theater 117)

COMMON THEMES

Zoot Suit shows how the press persecutes minorities and has a great deal of control over how the American public thinks, feels, and acts. The use of newspapers for everything from sheets to the judge's bench drives this fact home for the audience. The characters are surrounded by the press and under its influence even while in jail.

Arthur Miller has also written a play about the dangers of letting a handful of people control the way the majority behaves. The Crucible uses the Salem witch hunts as an allegory to the 1950's McCarthyism. One thing that is repeated throughout the play is that an accused person can be set free with no further repercussions if he/she simply admits to being a witch and then implicates a few other people.

A striking similarity between the two plays is the fact that the only way for a character to escape the current situation is to join the accusers and forfeit his/her identity. John Proctor chooses martyrdom rather than lose himself to his accusers. In Zoot Suit, Hank Reyna tries to escape from himself: first by attempting to join the Navy and then by becoming involved with a white liberal woman. In both attempts, he is forced to look at who he really is: a man sent to prison for being Chicano and a man sent, by his white girlfriend, back to his Chicana girlfriend.

Despite the parallel themes in their work, Miller has received more acclaim for his works due to his success on Broadway. Valdez is not viewed as highly as a social critic because of the difference in audiences. Miller's audience is white, upper middle class men and women and Valdez writes for working class Chicanos. Most regular Broadway audiences probably do not know about writers like Valdez simply because these writers are not brought to Broadway. They also are not accustomed to a writer who makes his stereotypes, and his disdain for them, as obviously as Valdez does.

MAKING THE TRADE

Of all the stereotypes in Zoot Suit, the one that Valdez does not seem to be against is that of women. Alice Bloomfield is a Jewish woman who befriends Reyna after he is incarcerated. Alice plays the stereotypical liberal white woman who is determined to fix all the world's problems (presumably because she has none of her own). She is Hank's only contact with the world outside of prison. They are intrigued by the foreignness of each other - there's an appeal to the newness of the relationship and of having a relationship with someone so different from oneself. The audience watches this relationship grow until it culminates in a kiss in prison. She is nothing more than a toy that cheers him up in prison and is later discarded when no longer needed.

Della Barrios is "the girlfriend." She is a paradox because she is a character with no real character. She acts as a narrator to the Sleepy Lagoon incident but that is all the audience sees or hears of her; she conveniently disappears and is not seen with Reyna for half of the play. At the end of the play, she reappears and Alice is traded for Della. This is startling because most of the audience has forgotten her. At the end of the play, Alice sees that she has successfully solved Reyna's problem and volunteers to leave, claiming she is "out of place" (90). But she waits for Hank to choose before she begins to leave, thus completing the trade.

Valdez is not the first playwright to use women as tradable objects in his plays. Arthur Miller and many other playwrights in the canon display women as "exchangeable, perhaps symbolic, property for the primary purpose of cementing the bonds with men" (Austin 47). Gayle Austin's theory of male homosocial desire claims that women are the only thing that come between men and "between men and their fathers" (50). An example of this can be seen in Miller's Death of a Salesman when Happy and Biff trade dates and when Biff finds out that Willy is cheating on his wife with a character who is known only as "The Woman." Willy trades one woman for another depending on what town he is in at the time.

This theory of exchange is also apparent in Sam Shepard's Buried Child. In this play, it is not the father who is caught cheating on his wife. The wife has an affair with their son. There is no explanation as to what went wrong in the marriage or why Halie and Dodge became so estranged; the audience only knows that for some reason, Halie was exchanged or, in this particular play, just given to the son. Halie literally comes between a father and his son. Dodge admits to killing his own grandchild to prevent anyone from knowing its parentage.

> It lived, see. It lived. It wanted to grow up in this family. It wanted to be just like us. It wanted to be a part of us [...] We couldn't let a thing like that continue. We couldn't allow that to grow up right in the middle of our lives. It made everything we'd accomplished look like it was nothin'. Everything was canceled out by this one mistake. This one weakness.

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> [...] I killed it. I drowned it. Just like the runt of a litter. Just drowned it. (124)

Despite Dodge's confession of murdering an innocent child, it is Halie who is the ultimate villain. After being rejected by her husband for six years, she begins an affair with her son, Tilden. This serves to separate Tilden and Dodge, Dodge from Bradley (another son), and it continues until every male-male relationship is irrevocably destroyed. Halie is the obstacle to be removed.

Although she is the source of the family's problems, Halie doesn't have a coherent conversation with anybody in the play; she rambles on about her third son, Ansel, and the weather whenever she is in a situation that she cannot handle. When faced with a topic of conversation that she does not like, she claims that nothing would have happened if Ansel were alive because he was so much smarter than Tilden, although not as handsome. It is also implied that Halie had an affair with Ansel as well as Tilden when she claims that "Ansel would've stopped [Dodge] from telling these lies! He was a hero! A man! A whole man! What's happened to the men in this family! Where are the men!" (124). She is incapable of defending herself and complains that nobody else will. She is completely unaware of the world around her and is ignored by every other character in the play because she is not viewed as having anything important to say.

THE MISSING WOMEN

Shepard also falls prey to Austin's "missing daughter" theory. Or in this case, the missing daughter-in-law. Austin believes that in most canonized plays, the only significant female role is the wife/mother role and the sons are the only dominate children (48). This is apparent in the casting of Buried Child because there are no daughters and the only female character besides Halie is there for the sole purpose of giving Dodge someone to tell his story to. One character that is blatantly missing is the daughter-in-law. Tilden, in between having an affair with his mother and serving time in prison, also had another son. Vince shows up out of nowhere after a long period of time and nobody recognizes him or even acknowledges his presence. But there is no mention of a mother for him. Shepard has apparently forgotten the basic biological rule that a child needs two parents. The audience is left to wonder what part, if any, this unmentioned character played in the dysfunctional family, why she joined it, and why she left.

Valdez's Bandido is different from Shepard's Buried Child in that there is an abundance of women. All these women are either traded by men or they trade themselves to men. With the exception of Rosario and Rita, all the women in this play are prostitutes that are commonly referred to as "whores" in the stage notes (102). Rita's only role is to chase after a man and insult Rosario because she is jealous of Rosario's "status." She disappears after two scenes and returns for one scene later in the play where, despite the fact that she is married, she continues to chase Tiburcio and tries to replace Rosario. There is very little depth or growth to the character and she does not add much to the play.

Rosario is married but is having an affair with the Tiburcio. After being told "she's only a woman," Rosario, according to the stage notes, "stops and takes control of her own destiny" (134). While that sounds like Valdez is giving women credit, taking control over her own destiny only means that she allowed herself to be traded to the more dominant man. At the end of the play, Rosario is traded again, this time to the Impresario. She, like the other women in Valdez's plays, is "excluded from the decision-making process" and she, of all the women in Bandido, is the most dependent on men for her emotional and financial needs (Yarbro-Bejarano 132).

Kate is the most independent because she earns a living for herself. Unfortunately, her livelihood comes from owning a brothel and her only friend is a man. This shows the audience that she depends on men for everything. Valdez displays women as being completely incapable of independence or survival without someone else to dictate every aspect of their lives. The only control they appear to have is choosing which male shall determine their destiny, and that control is not absolute. While some may argue that the play has a right to treat women in this fashion because it is set in the 1800's, Valdez should remember that not all women in that period were unfaithful to their husbands, whores, and totally dependent on men. An interesting way to change the production of this play would be to give Kate some other occupation (such as being a nurse or a seamstress) or have Rosario choose independence rather than a new husband. These changes would necessitate changing some lines and the direction of these characters.

ADVERSARY WITH THE MALE DOMINANT

The role of the women in Bandido are examples of Kanellas' theory of relationships in Chicano theater; "Adversary with the male dominant" relationships. While most women are not shown as being prostitutes or unfaithful wives in Hispanic theater, they are, unfortunately, commonly portrayed in the roles "of the wife who is not in the limelight herself, makes very few, if any, decisions and contents herself with helping her husband and taking care of the children without making many demands on them for herself" (Hispanic Theater 73,74). This is the role of Dolores Reyna in Zoot Suit and the white Linda Loman in Miller's Death of a Salesman.

Bandido should not be considered a paradigm for all Hispanic plays; Valdez uses sweeping stereotypes to describe all people, but his stereotypes of women seem unnecessarily harsh because they do not appear to be stereotypes he is trying to change. Dolores Reyna has a slightly smaller role in Zoot Suit than Della Barrios. She is of no significance to the play other than being a wife and mother. When her daughter, Lupe, comes in wearing a skirt that is far too short, Dolores tells her to change. When Lupe is caught by the father, Enrique, Dolores tries to use the popular terms and explain to Enrique that she is trying to be "like a puta... I mean, a pachuca" (35). Although she fumbles on the terms, she tries valiantly to be a friend to her children but seems to have no other purpose. In some ways, Dolores Reyna is the ideal mother for most playwrights, she puts food on the table, fusses over her children, and then disappears until the next meal. She does not even react to her son's arrest.

To see Linda Loman in a male dominant relationship, one needs only to look at the stage directions in Miller's play. Linda's actions say more than the dialogue ever could. In Act One, before the dialogue even starts, Linda is described as a woman who is

> most often jovial, she has developed an iron repression of her exceptions to Willy's behavior-- she more than loves him, she admires him, as though his mercurial nature, his temper, his massive dreams and little cruelties, served her only as sharp reminders of the turbulent longings within him, longings which she shares but lacks the temperament to utter and follow to their end. (Miller 6)

Obviously, the audience cannot read Miller's description of Linda's character, so another way to display her weakness is used. The actress who plays Linda must use her tone of voice and her body language to show Linda's attitudes. When the Loman's are first seen together, Linda calls to Willy "with some trepidation" (6). During the course of the conversation, the stage directions show that Linda speaks "very carefully, delicately," "helpfully," and "resigned" (7). Linda is unable to stand up for herself or give an opinion that is truly her own. As the play progresses, Linda is shown "taking his shoes off," "filling his cup when she can," "holding his jacket for him," following him, and finally, "getting him into the jacket" (7,64-65). Her every word and every action revolves around a man who is verbally abusive and spends half the play yelling at her. Despite her apparent love for this man, she cannot even act to save his life when she knows that he is planning to commit suicide.

Linda is more of an extension of Willy, something that is there to serve but will never pose any kind of threat to him, than a character with a mind of her own. It would be interesting to see the play if it were performed without regard to the stage directions; having Willy get into his own jacket, pour himself a cup of coffee, or taking off his own shoes. It would change the play entirely, to see Linda actually employed or at least looking for a job to help out the family. Doing this would result in the focus of the play shifting to Linda Loman and relegate Willy to the background.

CONCLUSION

Through his plays, Valdez has always tried to "inspire the audience to social action. Illustrate specific points about social problems. Satirize the opposition. Show or hint at a solution. Express what people are feeling" (qtd in Yarbro-Bejarano 134). He has also begun to question the theatrical apparatus. This is something that Jill Dolan said more feminists and other resisting readers need to do when she pointed out that

> the theatrical mirror is really an empty frame. By questioning the entire apparatus of theater's representation of women, feminists can 'deconstruct gender categories. If we stop

> considering the stage as a mirror of reality, we can use it as a laboratory in which to reconstruct new, non-genderized identities. And in the process, we can change the nature of theater itself. (qtd. in Austin 19)

Valdez has helped deconstruct images for his audiences and also begun to point out the cracks in the mirror. Unfortunately, like Miller and Shepard who held the mirror up to their audiences to show what is wrong with society, Valdez failed to open people's eyes about the images to which women are confined. When theater is used to suppress people and then proclaimed to be the clearest mirror of life, the line between reality and the fiction portrayed as reality gets blurred and all women must pay the price. The only way to eradicate the negative images caused by the male gaze, is to have more women accepted to the canon (Austin 81). Since that appears to be in the distant future, the first steps can be taken today by allowing Valdez and writers like him to be considered a part of the canon. With the door open to minority playwrights, feminist writers will eventually get the opportunity to join the canon and be accepted as great American playwrights.

REFERENCES

Austin, Gayle. Feminist Theories for Dramatic Criticism.
Ann Arbor: The University of Michigan Press, 1990.
Kanellas, Nicolas. Hispanic Theater in the United States.
Houston: Arte Publico Press, 1984.
Kanellas, Nicolas. Mexican American Theater: Legacy and Reality.
Pittsburgh: Latin American Literary Review Press, 1978.
Clurman, Harold, ed. Arthur Miller.
New York: Viking Press, 1971.
Shepard, Sam. Sam Shepard: Seven Plays.
New York: Bantam Book, 1981.
Valdez, Luis. Zoot Suit and Other Plays.
Houston: Arte Publico Press, 1992.
Yarbro-Bejarano, Yvonne. "The Female Subject in Chicano Theater: Sexuality, 'Race,' and Class." ed. by Sue-Ellen Case. Performing Feminisms;Feminist Critical Theory and Theater. John Hopkins University Press; Baltimore, MD: 1990. 131-149.

Henry Purcell's *Dido and Aeneas:*
A 1689 Composition Endures Controversy

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During the past several years, early music scholars have debated several issues concerning the English opera *Dido and Aeneas* by Henry Purcell (1659-1695), including when it was first written and where it was first performed. Until Bruce Wood and Andrew Pinnock openly challenged established scholarship, it was widely accepted that *Dido and Aeneas* was first performed at Josias Priest's Chelsea boarding school in late spring of 1689. However, in Early Music in August of 1992, Wood and Pinnock declare this ". . . impressive edifice of modern commentary . . . [to be] founded on sand" (Wood/Pinnock 'Unscarr'd' 373). Since their article's publication, leading Purcell scholars have addressed Wood and Pinnock's suggestion of 1684 as the date and a court function as the work's première venue. However, despite these new arguments which concern style, political allegory, and similarities of the piece to *Venus and Adonis* by John Blow (1649-1708), I, along with Martin Adams, Curtis Price, and Andrew Walkling, agree that the date first set forth by W. Barclay Squire in 1918 is correct and Henry Purcell's work was indeed commissioned by Josias Priest and first performed at his boarding school for young women in 1689. In this paper, I will: 1) present the historical background of this controversy; 2) explore several sides of the *Dido and Aeneas* issue, and 3) demonstrate both that Purcell's opera was written when scholars had originally dated it and that the contradictory modern evidence is erroneous and not convincing enough to make one think otherwise.

Dido and Aeneas has always been a source of controversy. When W. Barclay Squire first indicated a première date of 1689, it was a fairly radical suggestion. Until that time, scholars generally believed that this opera had been written in 1677 during Henry Purcell's youth; however, Squire viewed this belief as incorrect. In his article in The Musical Times, he found particular fault with the assertion of Sir John Hawkins who stated that:

> "One Mr. Josias Priest . . . kept a boarding school for young gentlewomen in Leicester-fields; . . . he got Tate to write, and Purcell to set to music, a little drama called "Dido and Aeneas"; Purcell was then of the age of nineteen." (qtd in Squire 253)

Squire concluded that this statement must have been incorrect because a copy of the libretto containing the following heading: "An Opera Perform'd at Mr. Josias Priest's Boarding-School at *Chelsey* [sic]" was later discovered (253). Priest did once have his boarding school located at Leicester-fields; however, he moved to Chelsea in 1680. Therefore, if the heading on the copy of the libretto were correct, *Dido and Aeneas* could not have been performed before 1680 because Priest's boarding school at Chelsea did not exist before that time (Squire 253). By relying principally on D'Urfey's Epilogue to the opera for evidence, Squire also presented an extremely sound argument that *Dido and Aeneas* was first composed and then premiered in 1689. This epilogue was first published in a 1690 book entitled *New Poems*, however, the publisher of *New Poems* had already released a similar work entitled *A New Collection of Songs and Poems* in 1683. Squire's conclusion was that the Epilogue was written sometime between the publications (1683-1690). Squire then narrowed this seven year span for Purcell's premiere to two years (1688-1690) by focusing on the religious upheaval in England at the time to which he believed D'Urfey alluded in the Epilogue:

> Rome may allow strange tricks to please her sons,
> But we are Protestants and English nuns,
> Like nimble fawns, and birds that bless the Spring
> Unscar'd by turning times we dance and sing. (qtd. in Buttrey 52)

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The political allusions in the Epilogue were later explained by John Buttrey in his essay "Dating Purcell's *Dido and Aeneas*" published in the Proceedings of the Royal Musical Association in 1967. Here he describes how England's political and religious climate at the time of Purcell's opera could be termed "treacherous" at best. James II, a known Catholic, succeeded King Charles II in 1685 and foolishly made a habit of flaunting his religious affiliation, something that, at the time, was safe to do because the English people were frightened by the turmoil and Protestant genocide occurring in France. However, the English Protestants took comfort in the fact that James II had a daughter, Mary, who not only was a child from his first wife and raised in the English Church but also was in line to inherit the throne. This false sense of security turned into England's greatest "fear come true" when James II and his second wife bore a son who replaced Mary as heir to the throne. At this time, believing the birth to be a fraud and that Mary had been cheated out of her rightful inheritance, several important Englishmen appealed to William of Orange for help. In the end, James II and his family fled to France and William and Mary ascended the throne as joint rulers (Buttrey 53).

From this historical background, Buttrey draws strong parallels to D'Urfey's Epilogue:

> The remark, 'Rome may allow strange tricks,' refers to the supposedly fraudulent birth of a son to James and his Catholic queen. Such a comment could only have been made *after* William and Mary had ascended the English throne. It has therefore been conceded that the opera must have been performed sometime after February 1689 but before the Autumn of that year when D'Urfey's Epilogue appeared in print. (53-54, italics added)

Thus, Squire's became the prevailing argument to support Purcell's work as having premièred in 1689 at the Chelsea boarding school. The aforementioned argument first introduced by W. Barclay Squire in 1918 had been the driving force in Purcell scholarship until August of 1992 when Bruce Wood and Andrew Pinnock published their article "Unscarr'd by turning times?" in Early Music. In it they proposed that Purcell's opera debuted in 1684 and the performance at Priest's school in 1689 was merely a revival. They cited many examples of style in this music that they believe were inconsistent with his later works, e.g., doubling of the string parts, tessitura of the vocal parts, the use of ground bass, his declamatory writing, and its similarities to John Blow's *Venus and Adonis*. In addition to these questions of musical style, Wood and Pinnock also conclude that the Prologue is not a political commentary on the Glorious Revolution as other scholars had suggested, but rather alludes to the harsh winter and cold spring in England in 1684.

First let us examine Wood and Pinnock's principal arguments concerning musical style. They have difficulty believing that an opera composed in 1689 still displays musical traits characteristic of Purcell's earlier works. Concerning the composer's treatment of stringed instruments, Wood and Pinnock assert that because he only doubles the voices in unison, the opera must be an earlier work. They claim that after the mid-1680s, "Purcell's mature concerted music derives much of its thrilling sonority from using the strings either to add at least one independent part . . . or consistently to double voices at the octave" (Wood/Pinnock 'Unscarr'd' 377). While they concede that Purcell does use unison doubling after 1685, they maintain that this practice is confined to the anthems he composed for the Chapel Royal.

Another feature of *Dido and Aeneas* that bears striking resemblance to Purcell's early works is the use of ground bass. Wood and Pinnock suggest that the scalic bass Purcell used in 'Oft she visits this lov'd mountain' is too similar to his songs *Swifter Isis, swifter flow* (1681) and *The Summer's absence unconcerned we hear* (1682) to be a coincidence (figure 1) (Wood/Pinnock 'Unscarr'd' 377).

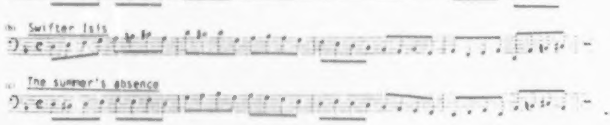

Figure 1: Three scalic basses in Purcell's works

Wood and Pinnock also cite *Dido's* declamatory writing as being characteristic of an earlier time in Purcell's development. They point out that in his later works he makes text declamation more melodic rather than relying on the direction of the vocal line and the cadential structures (Wood/Pinnock 'Unscarr'd' 378). Wood and Pinnock conclude that there is more arioso writing than would be needed in a piece intended for performance by schoolgirls. This quantity of arioso is also characteristic of his earlier works because it is built on a slow-moving harmonic bass line (Wood/Pinnock 'Unscarr'd' 381).

The wide tessitura of the voices is another musical feature of *Dido and Aeneas* that Wood and Pinnock declare as not only uncharacteristic of Purcell's early works, but also uncharacteristic of the musical period as a whole. In *Dido and Aeneas*, Purcell set the treble voice a considerable distance away from the rest of the voices; according to Wood and Pinnock, this spacing was a "striking feature" of the early Restoration period, but was "By the late 1670s . . . becoming rare . . . [although] the gap between treble and countertenor parts lingers on into the *early* 1680s" (Wood/Pinnock 'Unscarr'd' 377, italics added). Wood and Pinnock then observe that the gap was more than two octaves in some parts of *Dido and Aeneas*, yet such a large tessitura was practically nonexistent in any type of music after 1683 (Wood/Pinnock 'Unscarr'd' 377).

When analyzing musical style, Wood and Pinnock readily compared Purcell's work to one of his contemporary composers, John Blow, and his work *Venus and Adonis*. Blow and Purcell had a symbiotic musical relationship, i.e., both were consistently borrowing from one another. Furthermore, Wood and Pinnock point out that each of them borrowed from the other's more recently composed works rather than the other's older pieces. Purcell's interpretation of Blow's ideas was evident in the structure of his work as well as the specific musical ideas, e.g., qualities of texture, tonal pattern, and scoring for voices and instruments. One example of Blow's work that Wood and Pinnock compare to *Dido and Aeneas* is the following bass line (figure 2) (Wood/Pinnock 'Unscarr'd' 383).

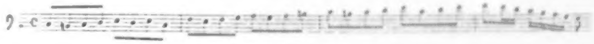

Figure 2. Bass Line by John Blow

One should also notice the similarity that this passage bears to 'Oft she visits' (figure 1). Wood and Pinnock fervently claim that "It is highly unlikely that Purcell in 1689 would have been borrowing wholesale from Blow's *Venus and Adonis*, written six or seven years earlier. Yet borrow he did . . ." (Wood/Pinnock 'Unscarr'd' 381).

Purcell was as clever with his technique of borrowing material as he was with his allusion to the harsh winter of 1683-1684 and the cold spring that followed it. Wood and Pinnock compared the observations of two people whom they declared weather experts, John Evelyn, an English gardener, and Nahum Tate, the librettist of *Dido and Aeneas*. Late 1683 and early 1684 were characterized by strange weather conditions including both an extremely harsh winter and cold spring. Wood and Pinnock first suggested that several places in Tate's libretto conform rather nicely--too nicely to be a coincidence--to Evelyn's diary of the actual weather conditions of that time and then through that comparison concluded that "they provide the key to Tate's seasonal allegory in the *Dido* prologue, and help incidentally to date it" (Wood/Pinnock 'Unscarr'd' 389). However, despite his allusion to the cold spring of 1684, Wood and Pinnock dismissed any chances of allusions to the political climate of the time in the Prologue, even though they do admit that political allegory in the Epilogue is not only possible, but probable. They refuted several examples in Tate's libretto of what other scholars had examined as possible political allegory including the phrase ". . . To the new rising star of the ocean." Whereas Buttrey claimed that this verse was a clear welcoming of William from Holland, Wood and Pinnock maintain that the 'new rising star' is simply Venus physically rising out of the ocean, not William crossing the Channel (Wood/Pinnock 'Unscarr'd' 374-375).

Having summarized the main points of Wood and Pinnock's argument, I will now examine a few refutations beginning with a short letter written to Early Music in August 1993 by Martin Adams of Trinity College in Dublin. While Adams appreciates Wood and Pinnock's efforts and acknowledges that they do make some good points (e.g. *Dido and Aeneas*' similarities to John Blow's work) he nevertheless states that "their stylistic evidence is less solid, for to make their case they have chosen just about the least reliable indicators" (510). Adams declares that:

> In such a style-conscious composer as Purcell, conclusions based on comparisons between genres are hazardous when confined to generalized, essentially surface features such as melodic versus declamatory methods of word setting, and the relationship between choral parts and accompanying instruments. (510)

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More specifically, Adams challenges their scholarship by citing the 'God save the King' chorus in the *Welcome Vicegerent* ode, written in 1680, as an instance where the strings are nearly completely independent of the voices. This challenge is furthered when Adams claims that their analysis of the ground basses is just plain wrong because they are not ground basses at all, but are instead rhythmic ostinatos. He also contends that the declamation of text:

> . . . is not unusual for the late 1680s, either in quantity or style. Granted that it is different from that in the odes; but it is similar to dialogues and recitative songs . . . from the mid-1680s or later. . . . (510)

Adams is not the only scholar who remains unconvinced by their conclusion; Curtis Price and Andrew Walkling also criticize their arguments. Price disapproves of both their comparison to Blow's work and their analysis of Purcell's musical style; Walkling takes issue with their interpretation of allegory in the libretto. First, I will delineate Price's refutations and then Walkling's arguments. In February 1994, Price attacks Wood and Pinnock's close comparison of *Dido and Aeneas* with Blow's *Venus and Adonis*. Price claims that even though *Venus and Adonis* can be a major source for understanding Purcell's work, one cannot simply conclude that the latter of the two works follows in the exact footsteps of the earlier since "[al]though Blow's opera was revived at Priest's school in April 1684, its actual date of composition is *unknown*" (Price 116, italics added); Price later warns his audience against compounding assumptions. Also in his article, Price challenges Wood and Pinnock's interpretation of Purcell's musical style. First and foremost, Price asserts that:

> While Purcell's style obviously changed between 1684 and 1689, I would maintain that the change is not as pronounced as that which happened about 1689-1691, during which time Purcell reached maturity as a composer and fully synthesized the latest French and Italian styles. (117)

Therefore, Price concludes that it would not be unusual if, in 1689, *Dido and Aeneas* was more like his earlier works than his later ones. He also accuses Wood and Pinnock of only citing musical examples that support their argument and ignoring those that refute it. Furthermore, Price points out a characteristic of style which he believes is interpreted wrongly by Wood and Pinnock, i.e., Purcell's declamatory writing. Price asserts that the declamatory writing in *Dido*'s 'Whence could so much virtue spring?' is quite different from Purcell's earlier works such as 'Ah had we, Sir, the pow'r' from *The Summer's absence unconcerned we bear*. Notice that in 'Whence could so much virtue spring?,':

> . . . both melody and accompaniment work together to reflect the text: in the latter the voice and continuo are much less integrated. Notice especially the elaborate melisma on the insignificant word 'of' in the phrase 'One entire piece of harmony.' (Price 120)

After Price refutes Wood and Pinnock's claims regarding musical style, Walkling becomes a part of the *Dido and Aeneas* controversy with the first of his two articles analyzing the opera. The two subjects on which he disagrees with Wood and Pinnock are the issues of musical style and the use of allegory. On the question of style, Walkling asserts that:

> Wood and Pinnock seek to demonstrate that a change took place in Purcell's compositional style at some point between the early 1680s and 1689 or later. Yet . . . the date on which the change actually came about is not firmly established, and is sometimes left to fall anywhere within a space of up to seven years . . . . (Walkling 'Dating' 471)

This assertion makes a comparison of compositions a bit more challenging. Walkling also studies the use of allegory in *Dido and Aeneas* and concludes that it is unusual for Tate, in the libretto, to concentrate so heavily on the reference to spring when the harsh winter of 1683-1684 is, as Wood and Pinnock claim, really the most memorable. Walkling also sees it as unlikely:

> . . . for Tate to employ an obscure allegory in order to make reference to something as straightforward as the weather, particularly if, as Wood and Pinnock suggest elsewhere, that allegory had no other more significant motive, such as praising a king and queen. (Walkling 'Dating' 470)

In an article written more than a year later, Walkling again asserts that Wood and Pinnock's disregard of political allegory is incorrect. He feels that it is erroneous to think of Purcell not utilizing allegory in his composition because "political allegory was central to the functioning of high culture in seventeenth-century England" (Walkling 'Political Allegory' 541).

A consideration of all of the arguments and counter-arguments surrounding this issue is more than a little challenging. However, after much reflection, I am still unconvinced by Wood and Pinnock's argument that *Dido and Aeneas* was written in 1684 instead of 1689 and that its premiere was at a court function rather than Priest's boarding school in Chelsea. First, I am skeptical about their study of musical style. For example, perhaps Purcell's doubling of voices by the strings was necessary to support the young voices in the Chelsea school. If Purcell was commissioned to write the opera for school children, he would have taken great pains to assure that this work could have been performed by young musicians. With regard to *Dido and Aeneas*' ground bass, Purcell could have, in 1689, borrowed some of his earlier material just as easily as he could have in 1684, thus making Wood and Pinnock's argument moot. I also agree with Price's opinion regarding Purcell's declamatory writing. 'Whence could so much virtue spring?' appears to be more similar to *Now does the glorious day appear* than it is to 'Ah had we, Sir, the pow'r' if one takes into consideration the uses of melismas. Therefore, I suggest that the exact opposite of Wood and Pinnock's argument is true and that Purcell's declamation of text in *Dido and Aeneas* is much closer to that which he used in later, not earlier, works.

I also suggest that Wood and Pinnock are too hasty in their judgment of the allegory in Tate's libretto. Why would he include a complex allegory on the subject of weather and completely leave out any mention of the political turmoil in England? Fine art has always reflected the time in which it was produced and the society in which it was born. Therefore, since England at this time was in the middle of internal turmoil, that turmoil *has* to have been reflected in at least some of the fine art produced at the time. I also support Walkling who states that any reference to the tumultuous weather of 1683-1684 would have probably focused more on the harsh winter than the spring that followed (Walkling 'Dating' 470). Nevertheless, even if Tate does utilize some sort of reference to the weather, I must still agree with Buttrey that the true allegory is in Tate's references to the Glorious Revolution (52-54). To ignore Tate's allusions to the scandal surrounding James II's supposed heir and the welcoming of William and Mary as rulers would be, I feel, a complete oversight.

Finally, I cannot be convinced by Wood and Pinnock's arguments because a good portion of them are based on a major assumption, i.e., the compositional date of John Blow's *Venus and Adonis*. How can one date *Dido and Aeneas* by comparing it to another work with an equally uncertain date of composition? In this instance, I must again agree with Price and his warning to audiences regarding arguments that are based on pure conjecture and assumptions (116).

In conclusion, the reader has both been made aware of the findings of the major scholars on the various sides of the *Dido and Aeneas* issue and has been informed as to what my personal conclusions are in reference to the available scholarship. I believe that in the past hundred years, W. Barclay Squire has given the academic world the most probable hypothesis regarding the composition date of Purcell's opera and that his hypothesis has been adequately supported by other, later Purcell scholars including John Buttrey, Curtis Price, and Andrew Walkling. However, despite any of these scholars' convincing arguments and academically and musically logical proposals, until a diary or newspaper article or other definitive document is found, the *Dido and Aeneas* controversy will probably continue to rage.

REFERENCES

Adams, Martin. "More on Dating *Dido*." Early Music 21 (1993): 510.

Buttrey, John. "Dating Purcell's *Dido & Aeneas*." Proceedings of the Royal Musical Association 94 (1967-1968): 51-62.

Goldie, Mark. "The Earliest Notice of Purcell's *Dido and Aeneas*." Early Music 20 (1992): 393-400.

Luckett, Richard. "A New Source for *Venus and Adonis*." The Musical Times 130 (1989): 76-79.

Price, Curtis. "*Dido and Aeneas*: Questions of Style and Evidence." Early Music 22 (1994): 115-125.

Purcell, Henry. Dido and Aeneas.

Squire, W. Barclay. "Purcell's *Dido and Aeneas*." The Musical Times (1918): 252-254.

Walkling, Andrew R. "The Dating of Purcell's *Dido and Aeneas*: A Reply to Bruce Wood and Andrew Pinnock." Early Music 22 (1994): 469-481.

___. "Political Allegory in Purcell's *Dido and Aeneas*." Music and Letters 76 (1995): 540-571.

Wood, Bruce, and Andrew Pinnock. "'Singin' in the Rain': Yet More on Dating *Dido*." Early Music 22 (1994): 365-367.

___. "'Unscarr'd by Turning Times'?: The Dating of Purcell's *Dido and Aeneas*." Early Music 20 (1992): 373-390.

Determining the Authorship of the Toccata and Fugue in D Minor, BWV 565

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One of the most famous organ works of Johann Sebastian Bach (1685-1750) is the *Toccata and Fugue in D Minor*, BWV 565. Traditionally this piece was thought to have been written by the prolific composer sometime between 1705 and 1710. There has been some controversy surrounding this hypothesis, however; some scholars, Peter F. Williams and David Humphreys, in particular, now contend that the piece was not even written by Bach, because it is too inconsistent with his other compositions to be a work of the Baroque master. They propose several alternative hypotheses; in them, neither attributes the piece to Bach. Despite their claims, I believe that Bach was, in fact, the true composer of this popular organ work. In this paper, I will: 1) describe the context in which the piece was composed, according to the traditional hypothesis; 2) give a brief analysis of the work; 3) consider the arguments presented by these musicologists and further investigate their claims; 4) refute these claims and show that their evidence is not sufficient to warrant the questioning of the authorship of this work.

To gain a greater understanding of the piece, it is helpful to consider the traditionally accepted conditions under which it was composed. The *Toccata and Fugue in D Minor* has been classified with the works composed during the second portion of Bach's Arnstadt period (1705-1707). Many of his compositions from this period display the influence of other early eighteenth century German composers. For example, the young Bach had just made a trip to Lübeck where he observed the great Dietrich Buxtehude (c.1637-1707). He returned from this trip with confidence in his growing abilities as an organist and composer. He began to realize that he would have to leave his position at Arnstadt if he wanted to further develop these abilities (Keller 73). The pieces he wrote during this period were works that would catch the attention of future employers. The flashy *Toccata and Fugue in D Minor* with its dazzling effects is no exception, as can be clearly seen by analyzing the piece.

A detailed analysis of the work reveals that this haunting piece is actually quite simple in construction and compositional technique. It can be divided into five major sections: 1) an introductory toccata (m. 1-30); 2) the fugue (m. 30-59); 3) a cadenza-like section (m. 59-86); 4) a return of the fugue (m. 86-127); 5) a second cadenza which closes the work (m. 127-143).

The opening toccata consists of a series of rapid keyboard figures used for dramatic effect, unified by reliance on a C# fully diminished seventh chord. Included in the first two measures are a pair of descending scale passages in octaves, followed by an arpeggiated C# fully diminished seventh chord and its resolution to the tonic. In measures 4 through 10, there is a sequenced three note ascending scalar figure doubled at the octave and its reiteration an octave higher, followed by arpeggios that are sequenced downward until they again reach the C# fully diminished seventh chord. The highest Bb of the chord continues to be held after the chord is released and is used as the beginning note for a descending scale passage followed by an arpeggiated dominant seventh chord, which resolves to a held tonic chord. Measures 12 through 15 consist of a sixteenth note melody in the right hand, while the left hand interjects an A between each two notes of the melody. This idea of returning to the dominant pitch between each note of a melody plays an important role in the subject of the fugue, which will be discussed in detail later. Measure 16 is a simple arpeggio sequenced three times, followed by a VI-v-i-V progression. Measure 17 is an exact repetition of measure 16; however, this time an A is held over after the rest of the chord is released to begin a solo passage. The passage is followed by a second VI-v-i-V chord progression, then a third repetition of measure 16, this time an octave higher than the original, and another short solo passage which ends with the now familiar C# fully diminished seventh chord. This chord serves as a transition to the next five measures that contain a sequenced triplet figure based on the arpeggiation of that chord. The sequencing ends just before the third inversion dominant seventh chord in measure 27, which resolves to a first inversion tonic chord. Then the pedal plays descending thirds in sixteenth notes, followed by a pair of dominant-tonic progressions to end the toccata section.

The second section is the exposition of a four-part fugue. The subject of the fugue was alluded to in measures 12-15, where the melody was broken up by a reiteration of the dominant pitch between each note. In this case, the melody line starts on the subdominant, descends the minor scale to C# and ascends to F before dropping to A and ascending in a melodic minor scale pattern. The countersubject is very simple--an eighth note pattern that mainly moves in parallel sixths (or occasionally thirds) with the melody of the subject. The subject is presented first in the tonic key by the tenor voice, then answered by the alto voice in the subdominant key, which is not the usual key for an answer. A short episode returns the piece to tonic for the soprano's presentation of the subject in measure 39, followed by ten measures of sequencing and modulation before the bass presents its answer in the pedals. Then a rising bass line supports the sequenced sixteenth notes in the right hand for three measures, after which the subject is again present in the tenor voice, this time in F major, the relative major of the tonic.

The third section begins abruptly after the F major statement of the subject. Instead of a section developing previously presented material, which would normally be expected at this point, the piece moves into a soloistic section that commences with a sequenced descending scale pattern that eventually changes to a sequenced arpeggio in measure 66. Then, as if to reassure the listener that this is just an interlude and that the fugue is not over yet, the subject is stated in the soprano voice in measure 70. The statement is immediately followed by more sequencing of arpeggios until measure 83, where scale patterns begin to lead into the next section.

The fourth section is the continuation and conclusion of the fugue with the development of subject and countersubject material. It begins in measure 86 with a statement of the subject in C minor in the pedal. This statement is immediately followed by a statement of the subject in the alto voice, also in C minor. Measures 91 and 92 modulate through the use of sequencing in the soprano voice to reach the dominant key in measure 93, where a presentation of the subject occurs in the tenor. More sequencing and modulation take place until measure 103, where an inversion of a fragment of the subject is played in the left hand, followed by the appearance of the subject in the alto voice in the tonic key. A few measures later, the pedals also play the subject in the tonic key, this time unaccompanied. This presentation of the subject is followed by a sequenced bass figure supporting melodic fragments in the upper voices. In measure 115, there is a brief reappearance of the arpeggiated material from section three; however, this time the pedals play a D on beats one and three of each measure, giving it a sense of purpose and forward motion. Then in measure 120, the bass line begins to play sequenced fragments of the subject, building intensity, as the manuals play rapid chord progressions over it. This leads to the final statement of the subject in the same voice in which it was originally presented over a tonic pedal tone in the bass. The fugue concludes after a chord progression in eighth notes with a deceptive cadence over the bar line from measure 126 to 127.

The deceptive cadence sets up the final section of the piece, which begins in bar 127. Rapid four note Bb major scale segments open this section, which eventually modulates to G minor in measure 129 with the introduction of F-sharps and an E-natural. Then two more modulations occur in quick succession in measures 130 and 131, both through the use of fully diminished seventh chords. Then, just when the piece appears to be cadencing in A minor in measure 132, a C major chord is held on the downbeat of measure 133, which begins another rapid passage of sequencing, this time predominantly in C major. This passage leads to measure 137, where a sequence made up of block chords and arpeggios of those chords begins. The sequencing continues until a circle progression is made from V/iv to iv in D minor on the downbeat of measure 141. This chord begins the suspension-laden chord progression that brings the piece to a close with a iv to i plagal cadence in the original key of d minor.

Now that a brief analysis of the piece has been made, we can begin to evaluate some of the aspects of the work that musicologists cite as evidence that the *Toccata and Fugue in D Minor* was the work of another composer. One of the first points made is that there is no existing autograph manuscript; the earliest extant copy of the piece was made in the mid-eighteenth century by Johannes Ringk (1717-1778), a pupil of J.P. Kellner (1705-1772), who in turn was a pupil of Bach. There is no reason to question Ringk's integrity, however. There are many extant examples of pieces he copied in Bach's name that are known to have been originally composed by Bach, for example, the *Wedding Cantata* BWV 202 (Williams, "BWV 565" 337). It is unlikely that he would have knowingly misattributed a work to Bach. This information, however, led Humphreys to propose that the piece was actually written by Kellner, and later copied by Ringk (216). This hypothesis also seems unlikely. Humphreys himself admits that any similarities that can be found between Kellner's works and this one are definitely not conclusive (216). Nothing closely resembling the dramatic devices used in the *Toccata and Fugue in D Minor* are apparent in a survey of some examples of his writing. Also, Kellner's use of the pedal differs significantly in these samples of his work. After its entry in the fugue section of each example, he continues to use the pedal almost continuously throughout the rest of the piece. In the *Toccata and Fugue in D Minor*, the pedal is used much more sparingly, a technique more characteristic of Bach's works. In addition, the structures of his pieces in no way resemble the unusual structure of the *Toccata and Fugue* in question. The hypothesis also does not explain how copies of *Toccata and Fugue in D Minor* were made in the early nineteenth century by J.A. Drobs (1784-1825), a student of J.C. Kittel (1732-1809), another student of Bach (Williams, Organ 214). It seems unlikely that two different students of Bach would have passed down the same misattributed piece.

Williams offered another explanation. His hypothesis is that it may be an organ transcription of a piece originally for solo violin by another composer ("BWV 565" 335). Many arguments can be made against this hypothesis. First, the dramatic, overpowering effect that the opening toccata has on the listener could not be replicated by a solo violin, since it is not idiomatic for the violin. Many sections would have to be significantly altered to make them

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possible to be played on that instrument. The reiteration of the dominant in the subject of the fugue would be logical for performance on the violin, because it would utilize neighboring strings, but Geiringer stated that this technique was often used by Bach in his works for keyboard (244). However, even if the piece, as Williams also suggested, had been written originally for violin in the key of A minor, transposed up a fifth, more than one-third of it would still contain notes that fall below the range of the violin. A four-part fugue would also not be idiomatic for solo violin; furthermore, it would be unlikely for a violin soloist to play one voice of a fugue, and have the rest of the voices filled in by an accompanying keyboard. Even Williams states that there is no known violin piece, by Bach or any other composer, that even resembles the *Toccata and Fugue in D Minor* (Organ 220). Taking all of these considerations into account, it would seem that this hypothesis is also unlikely.

Another criticism of the work that has been made by musicologists, particularly Williams, is that the piece is too simple and unusual to have been written by Bach, and that it does not fit stylistically with his other works. We will now consider some of the piece's unique components individually.

The opening bars of the piece are identified as unusual by Williams, who states that it is odd to begin an organ work with such a doubling ("BWV 565" 331-332). On the other hand, if the piece were a programmatic work depicting, for example, a violent storm, as Pirro suggests, the octaves create the perfect effect (35). This hypothesis would also explain another oddity, the work's unusually heavy reliance on the fully diminished seventh chord, especially in the opening toccata. This is one of the first works after the development of tonality that exhibits such frequent usage of this chord. But in this instance, it is not only effective as a programmatic device, it also unifies the series of seemingly unrelated, improvisitory subsections of the toccata.

Another oddity can be seen in the final cadence at the end of the piece. The minor plagal cadence (iv-i) is unusual. It does not give the piece a sense of closure, and, at the end of such a powerful work, it seems both anticlimactic and understated. The cadence still seems too weak even if the F in the final chord is raised to an F#, creating a Picardy third which was commonly used in Bach's time and may have been accidentally omitted by a copyist. Ending with a major chord instead of the D minor chord does provide a feeling of relief, as one would feel after enduring a storm, if Pirro's hypothesis is adopted. The major chord also fits in well with the rest of the closing section, with the section's reliance on major scale fragments in measures 127-129 and 133-136.

Williams also finds it anomalous that the pedal enters and plays a solo in measures 109-111 ("BWV 565" 333). However, examination of other pieces shows that such usage of the pedal is not unusual in Bach's organ works. For example, in *Prelude and Fugue in A Minor*, BWV 551, the pedal enters and plays a solo on two occasions, once in measure 78, and again in measure 82 (Figures 1 and 2) (Bach, Ser. 4, V. 6).

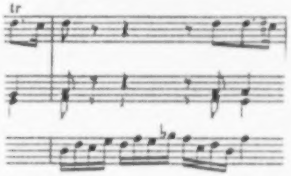

Figure 1 - BWV 551, m. 78

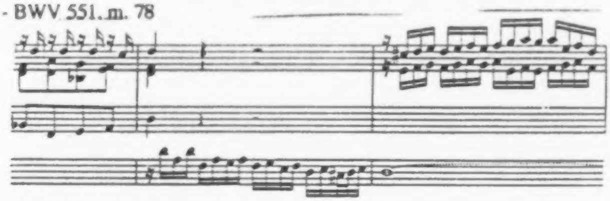

Figure 2 - BWV 551, m. 82-83

In the solo pedal example in the *Toccata and Fugue in D Minor*, the reiteration of the dominant every half beat implies harmony to the listener, a device that does not occur in BWV 551. Other examples of solo pedal passages in Bach's organ works can be found in BWV 535, BWV 536, and BWV 543. And in BWV 532, there are sixteen separate solo pedal figures of similar length to that in *Toccata and Fugue in D Minor*. So Bach's usage of the pedal in this instance is neither unjustifiable nor out of the ordinary.

Another difficulty Williams asserts when claiming that this piece should not be attributed to Bach is the extensive reliance on one harmony for sustained periods, such as the C# fully diminished seventh chord in measures 8-10 and 22-27 and the long string of arpeggios in measures 66-70 and 73-82 ("BWV 565" 333). Again, these chords, especially the fully diminished seventh, may have been used for dramatic effect or programmatic purposes. Geiringer suggests that the arpeggios in the third section served to retain the sense of improvisation created by the opening toccata (244). So these passages also fit well with the rest of the piece and its composer.

Finally, Williams argues that the piece is too simple both harmonically and contrapuntally to have been composed by J.S. Bach ("BWV 565" 333). After careful analysis of the score, the work does in fact seem simple in composition. Scalar passages and arpeggios dominate the piece. Sequences can be found abundantly. The countersubject consists of simple parallel sixths and thirds with the subject. That many of the piece's elements are simple, however, is not proof that it was not conceived by a great composer. There is often beauty in simplicity, and the enduring popularity of the *Toccata and Fugue in D Minor* shows that many listeners have found some of that beauty in this piece, regardless of whether or not the piece deserves its lofty status on technical grounds.

These individual arguments can also be refuted collectively if one considers that no one, not even the great Johann Sebastian Bach, was born a great composer. He too had to learn the principles of polyphonic writing and voice leading. If this *Toccata and Fugue* was written in approximately 1705, as has been traditionally accepted, then Bach was still in his youth at the time the piece was composed. This could help explain many of the perceived abnormalities identified by the musicologists quoted earlier. Perhaps these slightly unusual figures were the work of a young Bach, who was still struggling to find his voice as a composer. The piece does exhibit many of the characteristics cited by Keller as indicators of the work of a young composer (35-37). As J.N. Forkel once stated, young composers are commonly apt to "run riot up and down the keyboard, to play as many notes as the five fingers of each hand can manage, and to continue in this wild course until some point of rest is reached by chance" (qtd. in Keller 35). The opening and closing toccatas and the middle section are examples of such fast passages; in the opening toccata, the passages often, cleverly, come to "rest" on fully diminished seventh chords, which offer no sense of relaxation in functional harmony. Indiscriminate doublings are also regarded as the work of a young composer. The octave doublings at the opening of the *Toccata and Fugue in D Minor* are not best described as "indiscriminate," but they may help to attribute the piece to a younger Bach. The unusual pedal entry, the minor plagal final cadence, and any perceived weaknesses in contrapuntal ability could also be explained by noting that this is an early Bach work, and that he was still developing his compositional technique to the fine art form that one sees in his later masterpieces.

In conclusion, after careful consideration of all the evidence we currently have, it would be premature to discredit Bach as the composer of this famous, admirable, and enduring work. The dramatic effects and irregular structure of the piece are not uncharacteristic in organ literature, nor is it inconceivable that such a piece could have been written by a young J.S. Bach. What we see in this *Toccata and Fugue* is the work of a developing composer who shows some of the flashes of brilliance that eventually evolved into the mastery of his craft and made him and his works immortal.

REFERENCES

Bach, J.S. Neue Ausgabe Samtlicher Werke. Series 4, Vols. 5-6. Basel: Barenreiter-Verlag Kassel, 1964.

Chiapusso, Jan. Bach's World. Bloomington: Indiana UP, 1968.

Gannett, Kent. Bach's Harmonic Progressions. Oliver Ditson, 1942.

Geiringer, Karl. The Bach Family. New York: Oxford UP, 1954.

Humphreys, David. "The D Minor Toccata BWV 565." Early Music 10 (1982): 216-217.

Keller, Hermann. The Organ Works of Bach. Trans. Helen Hewitt. New York: C.F. Peters, 1967.

Kellner, Johann Peter. Ausgewählte Orgelwerke. Lippstadt, Kistner, and Siegel, 1958.

Pirro, A. Johann Sebastian Bach: The Organist and His Works for the Organ. Trans. Wallace Goodrich. New York: G. Schirmer, 1902.

Williams, Peter F. "BWV 565: A toccata in D minor for organ by J.S. Bach?" Early Music 9 (1981): 330-337.

---. The Organ Music of J.S. Bach. Vol. 1. Cambridge: Cambridge UP, 1980. 2 Vols., 1980.

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Plains Attire:
The Individual Expression of Culture, the Cultural Expression of Identity

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Apparel is simultaneously the most personal and the most public statement of one's self-identification.[1] Historically, clothing worn by North American Plains Indian cultures has been used to show individual status, wealth, and prestige. Although there are distinct differences between male and female generated art, Plains attire evinces deeply embedded statements about individual power, personal and cultural identity. Decorative patterns, colors, accouterments and clothing styles are often reflective of the preferences of the producing artists' group affiliation. Influence from outside cultures, from migration, and from technological advances, have all affected Plains attire, yet many of the considerations that date from the 1700s still apply today.

The formal clothing of the plains peoples serves as a record of their cultural, social, and world-views. Male art is in no way intended to be subtle (Allen 1996). It denotes in absolute terms an individual's history, describes power, and includes the rights to special accouterments. Men's attire can be "read" by those who know the codes. Present-day iconography has evolved from the pre-reservation period when a man's actions in battle, politics and other strategic events were often prominently displayed on his shirt, horse and home--blatant visual reminders of the personal history of a man. Scalp locks were taken from slain (or bested) enemies, knotted at one end and worn dangling, fringe-like, from a shirt. Among some groups, friends and admirers of an individual may have cut scalp locks from their own head, and donated them as tribute (Marks 1996). Pictographic symbols on men's robes provided a visual record of an individual's accomplishments. Feathers (eagle feathers in particular) were the prerogative of warriors, and were only worn by those who had earned them in a display of courage or bravery. A single eagle feather was enough to relate the ability of a man to back big words with actions.

From the beginning of the historic period, men's attire has also been effectively used as a strong statement of the influence of an individual. Government systems revolving around councils and inter-tribal occasions of state often demanded that individuals represent the nation or band. In official circumstances, the prerogatives of authority and honor were prominently displayed. The Plains Indian was so accustomed to the use of formal attire to denote status that a Blackfeet chief accompanying Prince Maximillian zu Weid on his tour of the plains the 1830s commented that he was "much surprised that the whites always appeared in their common, everyday clothes, whereas they (the chiefs) always put on their handsomest dress" (Thomas and Ronfeldt 116).

There is a clear differentiation between male and female generated art. Female generated art is typically abstract or geometric in design. Items produced by women often include images titled with reference to features of life on the plains: "mountain", "river", "tipi". Women's art conveys ideas more subtly than does male art, and is clearly the more conventionally "artistic" choice. Where men's images are conveyed so as to leave clean, concise messages, women's art can be said to leave lasting impressions (Walker and Maynard 206, see also Corbin 110).

Women's art was used to beautify and adorn the attire of all members of her family, but many garments worn by women also served to manifest family wealth. Even a child's dress might be adorned with cowrie shells and bead work. In the reservation period, cowrie shells represented a substantial investment, having been traded at great distance and expense. In the pre-reservation period, elk teeth would have been used to substantiate accumulated wealth (Furst 176, see also Karklins 101, 132-35; Furst 176).

In the 19th century, articles made by women became popular trade items, exchanged among other Indian nations for horses and goods, and with Europeans for cloth, beads, and metal objects (Penney 30-34). The skill of some artists resulted in extensive recognition of their work. Guild association may have helped to influence the bias toward distinct group preferences in style, color, and pattern. Many items were traded at great distances, so variation of design alone does not allow precise identification of origin; there is, however, a tendency toward tribal preference for certain compositional groupings. These patterns have long been debated. In the early 1900s, anthropologist Franz Boas addressed the issue of context and content in decorative applications. Boas made several generalizations, including the idea that groups incorporated designs into their repertoire, and then assigned meaning to the image in accordance with the contexts of their own cultures. According to Boas, "The idea which a design expresses at the present time is not necessarily a clew [sic] to its history. It seems probable that idea and style exist independently, and influence each other constantly"[2] (Jonaitis 16-25).

As assimilation into white culture progressed, some types of traditional clothing continued to gain cultural importance. Long after it had become the custom to wear European fashions, formal attire retained its emphasis on the older materials and styles. In an effort to hasten assimilation into white culture, government agents and missionaries tried to dis-associate native peoples from "traditional" clothing. According to Erdoes, "Schools prided themselves on pictures [of] Indian children arriving at school in blankets and moccasins and three months later the same children in collars jackets and bow ties." (67). Additionally, children were not allowed to speak their native languages, or practice non-Christian rituals; by the time they had completed their educations, most students felt alienated from their birth-culture.[3]

Some types of clothing did sucessfully cross the barriers made by white American culture. Female artists were remarkably proficient in translating perferred designs into new media. Many Plains groups originate from east of the Mississippi. The Woodland people, exposed to French embroidery techniques, had incorporated floral designs into their work. As Plains women acquired small, rounded seed beads through trade, they shifted from quill to beadwork. Artists experimented with elements of style, generally retaining earlier tendencies toward favored patterns despite the transistion from flat to round media. Penney offers an interesting view of the incorporation of exotic trade goods into native American attire:

> When European traders offered their Indian partners glass beads, silver brooches, silk ribbons, and colored cloth these materials were interpreted in terms of their symbolic implications and potential for power. ...The 'trinkets and baubles' dismissed as trivial when traded away by the Europeans were transformed into expressions of wealth and power when incorporated into Indian dress and worn on the body as an ornament. European traders looked on in astonishment as Indians suspended iron axes around their necks, used house keys for ornaments, or hung papers of pins from their hair but without comprehension of how these had been evaluated by their new owners. (Penney 36)

Various Plains groups also provided opportunity to belong to specialized organizations, each with their own distinctive uniform. Many militaristic societies cut across division by clan or band, allowing for larger group unification. The Kiowa Black Legs society was known to have existed in 1834. Historically, the Black Legs functioned as a police force during migrations. Discontinued during the early part of this century, the Black Legs society was revived in 1958 by Gus Palmer. The society was fortunate to have the guidance of elders who remembered the traditional songs, dances and ceremonies from the 1920s. Today members wear black leggings to recreate the black paint of earlier society members, and red capes symbolic of one captured from a Mexican officer by Palmer's great grandfather (Time-Life 120-128).

There are also societies to honor the accomplishments of women. The attire of the Cheyenne Quilling society is resplendent with the embellishments of plains quill and bead artistry. As plains men grew notorious for their ability as horsemen and buffalo hunters, the women became increasingly able to help support their family through finely crafted trade goods (Penney 33-34). Guilds controlled much of the art, and apprenticeship was graded by type of item. Ceremonies were conducted to celebrate the initiation of a women to the next level. Here, a woman recounted the items that she had made (just as a warrior would recount the battles he had fought). These female societies, also, cut across band and clan divisions, although a hierarchy system may have prevailed in that the participants usually came from among the families of more notable men (Walker and Maynard: 205-209).

A strong case for the association of art with the cultural self-identification of a people can be found in the area of political protest attire. The resurgence of interest in "traditional ideologies" in the 1960s and 70s resulted in the inclusion of older symbols on clothing. Worn as an expression of solidarity and acceptance of one's "Indian-ness", these elements are viewed as statements of identity by the Indian and non-Indian alike. For Indians raised in urban communities, this often meant going back to the elders on the reservations to seek cultural educations.

At the 1973 trial of AIM members Russell Means and Dennis Banks for their participation in the siege of the Wounded Knee site, elders of the Pine Ridge reservation attended in "traditional" attire. Judge Nicols called the attorneys and defendants into chambers and demanded that the elders in "costumes" be removed from the courtroom. Attorneys for the defense explained that the attire was the equivalent of "tux and tails", worn out of respect for the proceedings. The Judge remained adamant that "white" attire should be worn in the courtroom until Severt Young Bear, interpreter for the group, said "Judge, I wouldn't talk that way if I wore a black dress to work." --Nicols thought it over, grinned and relented, allowing the elders to retain their formal attire (Means 307).

Today, the most common appearance of plains formal attire is found at powwows,[4] held across the country. Powwow serves as a communal gathering for people, and may be held for celebratory, honoring, or social purposes; many include contests where dancers compete for prize money. Pow-wow attire has undergone many innovations intended to appeal to the viewing public, creating controversy from both within and outside the native community over the use of new materials and elaboration of design.[5] Attention is paid to the importance of the visual presentation of attire; even non-participants are requested to adhere to certain standards of dress. Among native peoples, ladies include a shawl when entering the dance arena; men are expected to wear a hair ornament.

The dances of men are of earlier origin than those of women, and typically recreate historic events and stories. One of the oldest styles, the men's Grass Dance, is attributed to the Kansa, Ponca and Omaha. In the 1860s, when it was taken up by the Northern plains people, most dancers belonged to functioning societies, with rights to certain prerogatives. The Grass Dance was led by men wearing belts adorned with crow feathers; other dancers attached sweet grass to their clothing (Heath 107-9, White Eagle 1996).

In the late 18th and early 19th century the development of the dance, and its accompanying regalia, split in two directions. The Straight Dance developed among the Osage, Ponca and Pawnee through inclusion of elements of Midewewin[6] society. Straight Dance includes clothing popular among the eastern immigrants of the period: cloth shirts, ribbon trimmed bandoliers, deer-hair roaches, or hats with fur "trailer" tails. The Straight Dance attire does not include the crow feather belt, and therefor allowed for the inclusion of dancers who did not belong to formal societies. (Heath 109-10)

Alternately, the western Oklahoma tribes expanded on the use of the crow feathers, developing what eventually became a double bustle. In the 1930s men's attire included a roach or feather "crest", held on the head by a head band, necessitated by the short hair typical of the period. In the 1960s feather "bobbers" were added to increase the suggestion of movement (Heath 111). Originally this effect was achieved with the hip socket of a bird attached with sinew (Fields 96); later by a "pivoting see-saw platform holding sockets for two feathers, which bounce off rubber-band springs" (Heath 111-12). Today, this is often accomplished by using fishing swivel hooks and film cannisters (Redman 1996). As bustles became more elaborate there was a shift toward the use of purchased feathers, many dyed in brilliant colors, and new importance to the selection of color was added to design considerations (Redman 1996). Many groups faced controversy over the decision to include nylon yarn. Today the use of mylar streamers is creating a similar debate.

Historically, plains women have taken a smaller part in public dance, serving primarily as supporters from outside the dance circle. Few accounts can be found of women's dances from before the turn of the century, except in religious ceremony. Ladies Dance regalia, in the sense suggested by pow-wow competition, has an even shorter history (Heath 115). The inclusion of women in competition powwow dance dates from the late post-reservation period, when many urban women were among those returning to "traditional" ways. Interestingly, women's attire continues the trend of employing abstract design and providing indications of social status.

Dancers competing the Ladies Fancy Dance category among the Northern Cheyenne generally recreate the buckskin dress worn by those groups that had longest access to buffalo and elk hides. Reminiscent of the clothing of Cheyenne Quilling society, the dress usually includes quilled or beaded geometric trim (Henry, 1996). Among Ojibwa and Northern Plains groups, Fancy Dance attire can be composed of a silk or cotton dress with appliqued decoration, ribbon banding, or embroidered techniques. The designs are, again, in geometric shapes, although curvilinear floral designs are somewhat common among the Plains Ojibwa.

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From the requisite shawl that is an essential component of all ladies regalia, the category of Ladies Fancy Shawl has developed (Schwei 9). One of the newest dances, beginning among the Kiowa only in the 1960s, Fancy Shawl is seen primarily as an elaboration of Ladies Fancy (Heath 110). The ensemble includes an appliqued or embroidered dress, along with an elaborately decorated shawl trimmed with a long, flowing fringe (J. Jones 1996).

The regalia of women may also express religious views, or healing and cosmological references. The Ladies Jingle Dress is attributed to the Ojibwa (Parfit 94), and is said to have come from the vision of a woman who had prayed for healing for her sick child. (White Eagle 1996, Red Crow 8). Based on earlier elk teeth or cowrie shell ornamented finery, Jingle dresses use cones made from tobacco tin lids to supply elements of movement and sound. (Jones 1996).

There are elaborate sets of prescriptions and proscriptions that accompany the creation of dance ensembles. For example, in designing a Jingle Dress, most dancers that I spoke with agree that there should not be more than 365 cones per dress; that each should be tied on with a prayer, that the design should preferably come to a women in a dream, and that even a child should design her own dress. Also, most agreed that the cones should not be purchased pre-formed, but should be rolled for the woman by a man in her family.[7] Several men noted that females in their family had sewn the abstract decorative elements of their garments.

This interplay of co-operation between men and women is indicative of the constructs on which Plains social structure is based. There is now, and has always been, a strong sense of division between the roles of the sexes; and yet, the division has always served to enable individuals to compete only in ways that are of ultimate benefit to the society as a whole. For each sex, there is a prescribed method of production that serves to signify individual status within the community. The contribution of the opposite sex is a method of unifying the individual with the family, the family to the community, and the community to the culture.

Pow-wow attire and dance are often the subject of debate. Many people earn their living from working the pow-wow circuit, providing opportunity for the potential misuse through commercialization. Missing from the public view are the pictographic designs found in early men's attire, while accouterments considered prerogatives of certain groups continue to be held in the control of those groups. Federally protected, and restricted to only certain individuals, Eagle feather remain symbolically important among the Plains groups. An eagle feather that has been found lying on the grounds of a powwow is to be guarded, but untouched until recovered with proper ceremony, by veteran dancers. All other powwow activity ceases until the feather is returned to the owner. In practical terms, this includes those with Federal authority to handle the feather; symbolically this is described as an "important and sacred tradition" (Red Crow, 1996).

As suggested by the story of the decision of the judge in the Wounded Knee case, certain forms of attire among the Plains people today are recognized as a message of ethnic solidarity by native and non-native alike. Clearly, the debate that centers on the appropriate use and display of accouterments, regalia, and design is an indication of the importance of the association to the historical past of the Plains culture. Artistic innovations are scrutinized, accepted, or rejected based on standards that reach deeply into the past and present mores of the group. Efforts to depart in the extreme from the cultural context of decoration and symbology are met with dispute. While fashion and innovation continue to influence the stylistic changes that typify Plains attire, it is clear that Plains formal clothing continues to remain a strong statement of individual identity and accomplishment, as well as a message of cultural unity.

Notes

[1] Throughout this paper I use the identification of nationality chosen by the source.

[2] Boas, Franz--1903 "The Decorative Art of the North American Indians", as quoted in A Wealth of Thought, Aldona Jonaitis. See Jonaitis also for an excellent summary and perspective of the writings of Boas, and their juxtaposition with other theories in Native American art.

[3] According to Erving Goffman, total institutions engage in re-socialization by altering personality through deliberate control of the environment. Employing techniques calculated to disrupt routine, and remove persons from their natural element. Such treatments may "institutionalize people entirely making them unsuitable for life outside of the institution." (14)

[4] The term "powwow" may have originated with the Algonquin term *pau wau*, and is a reference to a formal meeting (Parfait 91).

[5] For a concise summation of powwow attire among the Southern Plains peoples consult Kavanugh, Thomas W, "Southern Plains Dance: Tradition and Dynamism" in Native American Dance Cermonies and Social Traditions.

[6] The Midiwewin are a medicine society of the Great Lakes area, especially among the Ojibwa.

[7] Conclusion assembled from discussions among women including Charlene Quire, Jennifer Jones, and Georgena Jones--dancers at the Red Crow powwow; Marilyn Fields (Shawnee, Delaware), who is learning dance and a person identified only as Jean on a message board on AOL.

Works Cited

Allen, Anne Guernsey, PH D. (Assistant Preofessor of Fine Arts, Indiana University Southeast) Lecture on Plains art styles. 14 Mar, 1996.

Fields, Marilyn (Shawnee, Delaware) Director of Muscatatuck Woodland Village, North Vernon, Indiana. Personal interviews dated between Mar., 1996 and Feb., 1997.

Furst, Peter T. and Jill Leslie Furst. North American Indiana Art. New York:Artpress, Inc. 1992.

Goffman, Ervin. Asylums: Essays on the Social Situation of Menatal Patients and Other Inmates. Garden City, N.Y.: Anchor Books. 1961.

Heath, Charlotte, ed. Native American Dance: Ceremonies and Social Traditions. Washington, D.C.: Smithsonian Institute Press. 1992.

Henry, Marlis. Ladies Fancy Dancer. Personal interview, 5 Oct., 1996.

Jonaitis, Aldona. A Wealth of Thought: Franz Boas on Native American Art. Seattle: University of Washington Press. 1995.

Jones, Georgena (Ojibwa). Jingle Dancer. Personal interview, 5 Oct., 1996.

Jones, Jennifer (Ojibwa). Ladies Fancy Shawl Dancer. Personal interview, 5 Oct., 1996.

Karklins, Karlis. Trade Ornament Usage Among the Native Peoples of Canada: a Source Book. Ottawa, Canada. Communication Group. 1992.

Parfit, Michael. "POWWOW a Gathering of the Tribes." National Geographic. June 1994. (88-113)

Penny, David W. Art of the American Indian Frontier: the Chandler-Pohrt Collection. Seattle: University of Washington Press. 1992.

Redmon, A.J. Men's Grass Dancer. Personal interview, 5 Oct., 1996.

Quire, Charlotte (Lakota). Jingle Dancer. Personal interview, 5 Oct., 1996.

Schwei, Barbara. Program ed. "American Dance Theatre" New York: American Dance Theatre. 1996.

Thomas, Davis and Karin Ronnefeldt. People of the First Man: Life Among the Plains Indians in Their Final Days of Glory, the Firsthand Account of Prince Maximillian's Expedition up the Missouri River 1833-34. New York: E.P. Dutton & Co. 1995.

Time-Life Books. The Warrior's Way. Richmond, VA: Time Life Books Press. 1995.

Walker, Bryce and Jill Maynard. Through Indian Eyes: the Untold Story of Native American Peoples. Pleasantville, N.Y.: Reader's Digest Association. 1993.

White Eagle, Robert. M.C. Red Crow Indian Council Pow-wow, 1996. From an introduction to a dance, 5 Oct., 1996.

Winch, Terrence, ed. All Roads are Good: Native Voices on Life and Culture. New York: Smithsonian Institution. 1994.

Victim vs. Participant: A Comparison of Dmitri Shostakovich's *Lady MacBeth of Mtsensk* and *Katerina Ismailova*

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The premiere of the opera *Lady MacBeth of Mtsensk* in 1934 brought great fame and recognition to Russian composer Dmitri Shostakovich. The success of the opera gained the composer attention within the Soviet Union and throughout the Western world. In 1936, it was condemned and Shostakovich lost all his rights and his music briefly disappeared within the Soviet Union. In 1963, a revised version of *Lady MacBeth* premiered, titled as *Katerina Ismailova*. The new version contains some revisions in music and libretto and was given a new opus number. The exact reasons for the revisions remain unclear, but most evidence points towards Shostakovich's personal desire for improvement in the work as opposed to political pressure due to the 1936 condemnation.

Prior to his work on *Lady MacBeth*, Shostakovich had written his first opera, *The Nose* based on the story by Nikolai Gogol. The opera was written while Shostakovich worked as music director for the avant-garde theater director Vsevolod Meyerhold. "This opera, like so many other interpretations of Gogol made in this period satirizes Nicolaevan Russia as an emblem of all that the avant-garde of the day abhorred: oppressive regimes, a bureaucratic cast of mind and above all cultural philistinism" (Fitzpatrick, 228). Members of one of the feuding professional groups, the Russian Association of Proletarian Musicians (RAPM) harshly criticized the opera. This was the first time in which the accusation of "Formalism" was first associated with Shostakovich and one of his major works. Despite the criticism of *The Nose*, with the popularity of Shostakovich's First Symphony many Soviets took pride in the composer's accomplishments and his flourishing reputation in the West. He was, after all, a Soviet composer who had been trained in the Soviet era of the Petrograd conservatory and had the mutual experiences of the revolution with his generation.

Shostakovich began work on his second opera *Lady MacBeth of Mtsensk* in 1930. The libretto was based on a short story by 19th century Nikolai Leskov. The story concerns itself with life in rural 19th century Russia and a woman, Katerina, who is bored with her life and takes a lover. This results in the murdering of her father-in-law and husband. In his story, Leskov portrayed the life of the merchants in the provinces, their cruel and boorish lives. The effect Shostakovich wanted to portray was Katerina as a victim of her circumstances and that her only true crime was wanting a better life (Wilson, 96). There was speculation that Shostakovich planned a trilogy of operas portraying womanhood in Russia.

Shostakovich completed *Lady MacBeth* in December of 1932 and it premiered at the Leningrad Malyi Theater (MALEGOT) on January 22, 1934. A few days later a simultaneous production began at Moscow's Nemirovich-Danchenko Theater under the title *Katerina Ismailova* after the opera's heroine. Both productions received a great reception. "'A triumph of musical theater' was the heading in the newspaper *Sovietskoe iskusstvo* which devoted a page to the opera- and the musical press continued to publish analyses and commentaries on it for a whole year after its premiere" (Clark, 185).

Lady MacBeth was considered a success and secured Shostakovich's reputation "as a composer of dramatic genius both at home and abroad" (Wilson, 96). MALEGOT had given 50 performances and abroad, the opera had been staged in the USA, Argentina, Sweden and Czechoslovakia.

Popularity for *Lady MacBeth* increased so much within the first two years of production that the Bolshoi Theater staged a new production of the opera. It was a production by the Bolshoi Theater's Second Company that Stalin along with Vyacheslav Molotov and other party officials attended in January of 1936. Shostakovich was in Moscow at the time and was to remain present the event that the party members wanted to meet him. He was not summoned to meet with the officials, they had reportedly left after the first act; Shostakovich was not called to the official's box.
Two days later on January 28, Shostakovich received a crushing blow in the form of an editorial which appeared in the Russian journal *Pravda* which condemned the opera as "muddle instead of music."

The article in *Pravda* reportedly written by Politburo member and a close associate of Stalin, Andrei Zhdanov was not an attempt to deny the composer's talent but branded it as "formalist" and a

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"Leftist distortion" of music. "'Formalist' was the code word for a composer who strayed in the direction of the modern, wicked West" (Fitzpatrick, 213). As the article stated: "All this is not due to lack of talent , or the lack of ability to depict simple and strong emotions in music. Here is music turned deliberately inside out in order that nothing will be reminiscent of classical opera... The power of good music to infect the masses has been sacrificed to a petty-bourgeois, 'formalist' attempt to create originality through cheap clowning. It is a game of clever ingenuity that may end very badly" (translated in Seroff, 204-207). However, the staging of the opera seen by Stalin is unclear and therefore, the extent of vulgarity and offensive material displayed is unknown. With the condemnation of *Lady MacBeth*, Shostakovich's membership to the Union of Composers was revoked.

Shostakovich did serve as collaborator in all three Russian productions of *Lady MacBeth* in 1934 and 1935 including MALEGOT in Leningrad and at the Nemirovich-Danchenko Theater and Bolshoi Theater's Filial in Moscow. The composer agreeably made minor musical changes and offered alternative texts and other modifications when problems appeared during rehearsal. "This was, of course, well before specifically political motives could have preoccupied him" (Fay, 162). Although there were occasional changes made throughout the opera in the 1963 version, the scene which received the most attention is the rape/seduction scene of Katerina and the hands of Sergei in Act I, Scene 3. In the original opera, Katerina is seen more as a willing participant in the sexual act than as a victim. Although the orchestration in the instrumental interlude changed the most, the words were changed to enhance the idea of Katerina as a victim.

There are significant changes in Katerina's aria in the beginning of Act I, Scene 3. The lines omitted from *Katerina Ismailova* include, "The foal runs after the filly, the tom-cat seeks the female." In the original, Katerina's description of her loneliness are in terms of not having someone to fulfill her physical needs as she states, "No one will put his hands round my waist, no one will put his lips to mine, no one will stroke my white breast, no one will tire me out with his passionate embraces." These lines are obsolete from the revised version. There is no longer Katerina's desire to fulfill sexual frustrations but to fill the void of mere companionship in the absence of her husband. In *Katerina Ismailova*, the heroine states, "I've no one who loves me, no one to love. My days pass in a cheerless bleak procession. I'll grow old, never knowing what love was. Ah! Why, ah why, should this be my fate!"

Another significant difference in the libretto occurs after Sergei's entrance in the same scene. He has come to Katerina's room in an effort to tempt her. In the libretto for *Lady MacBeth* Katerina muses that if she only had a child, she would not be bored with her life. Sergei is encouraged by Katerina's statement and adds to it by saying, "Yes, but even a child, if you'll allow me to put it like this, comes as a result of something, not just of its own accord." In the revised version it is reading that Katerina wishes for to rid her of boredom and it is Sergei alone who alludes to Katerina taking a lover. Therefore, allowing Katerina to remain in our eyes as a dutiful wife and strengthen the idea that she is a victim.

Another major change in the libretto occurs after the musical interlude in the same scene. In *Lady MacBeth* after the sexual act has occurred Katerina asks Sergei to leave, that she is a married woman. Sergei entreats her to not think of that and Katerina states, "I have no husband, but you alone." In the revised version, Katerina as a victim is more discernible. There is no mention by Katerina that she no longer has a husband, in fact she implores Sergei to remember that she is a married woman and that she has sworn an oath to her husband to remain faithful. The scene ends with Sergei calling for, "my Katya!"

In the staging of the original, the physical violence between Katerina and Sergei occurs during the instrumental interlude in front of the audience, but in *Katerina Ismailova* the physical struggle and seduction are carried out and interpreted in the imagination of the listener. Both versions do emphasize that Katerina is dragged behind a curtain and none of the action actually occurs on the bed which is in plain view of the audience.

Of the music that was changed in the revision, the music in the interlude of Act I, Scene 3 was changed the most. The most noticeable change is the absence of the trombone glissandi which enhances the idea of seduction and the sexual act and enhances the idea of primal passion between Katerina and Sergei. In *Katerina Ismailova* the interlude has a much more subdued tone, almost as if there is an attack of conscience or because Katerina's father-in-law, Boris Timofeyevich returns.

It is the "rape" interlude which because of either prudishness or a sense of political correctness was altered drastically. In the revised version, the "rape" interlude has been reduced to an illusion which occurs only for the listener. In the revised opera even the increasing musical and dramatic tension between Katerina and Sergei comes to an abrupt halt when the father-in-law reappears in the courtyard.

Even with some of the alterations made in *Katerina Ismailova* the opera was rejected by the Party in 1956 and further revisions were made. The premiere of *Katerina Ismailova* was produced by the Stanislavsky Theater and although it eventually was sanctioned by the Minister of Culture, recent occurrences surrounding Shostakovich's controversial Thirteenth Symphony gave cause to worry and

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"for the sake of caution it was camouflaged by being billed as *The Barber of Seville*" (Wilson, 350).

Shostakovich took a very active role in productions of *Katerina Ismailova*. "The composer felt that his presence was essential to the opera's new life; for instance, he stated that he had in some measure been able to tone down exaggerations in the London and Zagreb productions, where undue emphasis had been given to the erotic element (350). He attended all the rehearsals at the Stanislavsky Theater but he took an active part in the productions in London and Riga. In Vienna, Shostakovich demanded that some proposed cuts be restored and refused to allow La Scala to use the first variant of *Lady MacBeth of Mtsensk*.

As for the comparison of the two operas, most interest in the revised version disappeared when in 1979 the original 1932 score for *Lady MacBeth* surfaced in the West. This in turn instituted as new set of productions of the "rediscovered" opera. It is assumed that the original version contains Shostakovich's first and best intentions, without any politics involved. It is the original which is now performed as opposed to *Katerina Ismailova*. "The fact that Shostakovich himself repeatedly expressed a preference for his own revised score is usually discounted; for how could the composer have been in position, even after Stalin's death, to tell the 'real' truth?" (Fay, 161). It is however the revised version which bears Shostakovich's stamp of approval.

The 1936 condemnation of *Lady MacBeth* was undoubtedly a personal blow to Shostakovich. However, the condemnation was effective in defining the stylistic policy which Soviet composers followed for the next forty years. My belief is that the revival of the opera in a revised form was not due to political pressure as much as it was a personal artistic decision by Shostakovich. The original idea that Shostakovich wished to portray was Katerina as a victim of her circumstances, not a participant in the events that would lead to her tragic end. The revised music and libretto in *Katerina Ismailova* depict Katerina more as a victim than as a participant in her seduction.

WORKS CITED

Clark, Katerina. Petersburg, Crucible of Cultural Revolution. Cambridge, Massachusetts: Harvard University Press, 1995.

Fay, Laurel E. From Lady MacBeth to Katerina Ismailova: Shostakovich's Versions and Revisions. Ed. David Fanning. Shostakovich Studies. Cambridge: Cambridge University Press, 1995.

Fitzpatrick, Sheila. The Cultural Front: Power and Culture in Revolutionary Russia. Ithaca: Cornell University Press, 1992.

Seroff, Victor Ilyich. Dmitri Shostakovich: The Life and Background of a Soviet Composer. New York: Alfred A. Knopf, 1943.

Shostakovich, Dmitri. Katerina Ismailova. Melodyia, S10 21393 004, 1984.

Shostakovich, Dmitri. Katerina Ismailova, libretto. Translations by Edward Downes. New York: Leeds Music Company Corporation, 1979.

Shostakovich, Dmitri. Lady MacBeth of Mtsensk. With Galina Vishnevskaya, Nicolai Gedda, Dimiter Petkov. Cond. Mstislav Rostropovich. London Philharmonic Orchestra and Ambrosian Opera Chorus. EMI, 7 49955 2, 1979.

Shostakovich, Dmitri. Lady MacBeth of Mtsensk, libretto. Translation by Joan Pemberton Smith, 1979.

Wilson, Elizabeth. Shostakovich: A Life Remembered. New Jersey: Princeton University Press, 1994.

New Possibilities in Composition Through Computer Technology

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Recent advances in computer music technology have provided a new and exciting set of tools for composers. This study focused on the creative manipulation of musical data using a computer-based compositional system. The greatest advantages of such a system are: 1) a great reduction in the elapsed time between artistic inspiration and auditory realization; and 2) the composer's nearly unlimited ability to manipulate musical parameters, both through the use of a graphical interface and mathematically. These processes are demonstrated through examples detailing the evolution of an original composition entitled *Samsara*.

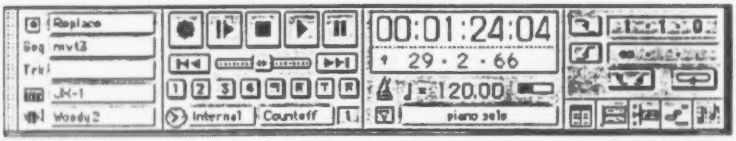
Since the introduction of the personal computer, many fields have made use of these powerful devices, and music is no exception. Perhaps the most familiar music-related task is the notation of music for publication. However, there are many other areas in which the computer has become a useful tool. Normally, composing music is a slow and arduous process. Once the music is on paper, the appropriate musicians must be assembled to perform it, and any modifications which the composer desires to make must be done afterward. A computer can be used to work around many of the logistical problems previously associated with composition. A typical computer-based compositional system will include a computer, one or more electronic musical instruments (usually keyboard synthesizers), and an appropriate software program (called a sequencer). The instruments communicate with the computer using the Musical Instrument Digital Interface (MIDI) protocol, which specifies the data format for the exchange of digital information regarding such musical parameters as pitch (frequency; high versus low notes), dynamics (amplitude; loud versus soft), and rhythm (when sounds occur and how long they last). MIDI data is analogous to the paper roll on a player piano. It does not actually contain the sound, but it provides information to the instrument which then produces the music. The sequencer can be used to record, manipulate, and play back the data received from the MIDI instruments. The software used in this study was Vision Professional Sequencing Software by Opcode Systems.

REDUCING THE TIME BETWEEN INSPIRATION AND REALIZATION

Sequencing programs are capable of recording multiple "tracks" of MIDI data individually and then playing them all back simultaneously. This means that, for example, a composer can try out many musical ideas for a symphony without having access to an orchestra. These immediate results allow for experimentation and revision which might otherwise be very time-consuming or very costly. It should be noted that in this case the computer is not intended to replace the orchestra. Rather, the computer allows the composer more freedom to experiment and rework his composition before the parts are passed out to the orchestral players.

There are also cases where a composer may choose to write a piece of music specifically for performance by a computer system, such as the piece used in this study. This allows the composer to use timbres other than those found in traditional groups of instruments, and even to write music which is too difficult for human performers. In many of these cases, the computer system actually replaces the human performers. However, such pieces often include one or more parts intended for live performance. Pieces which include both live performance and computer-generated elements have become popular in recent years.

The advantages mentioned above would be lost if the program were not easy to use. For this reason, most sequencing software programs use an intuitive tape recorder style format for basic record and playback functions.



Replace
Seq mvt3
Trk
JX-1
Woody 2
00:01:24:04
29 · 2 · 66
♩= 120.00
Internal
Countoff
piano solo

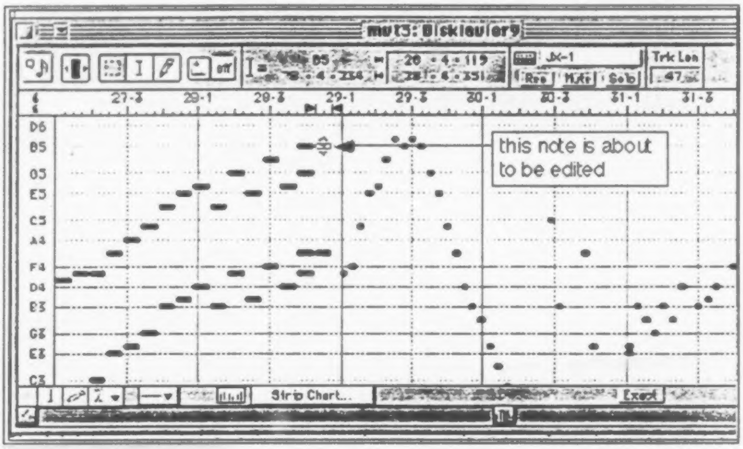
Figure 1: Basic controls use a tape recorder style layout.

MANIPULATING MUSICAL PARAMETERS

Sequencing programs can be used for simple recording and playing of musical excerpts. However, the real advantage of such programs lies in their great flexibility in the area of data manipulation. Because all of the information used in a sequencing program is in a digital format, any number of musical parameters can be individually altered without disturbing other aspects of the music. The most commonly edited parameters include pitch, rhythm, and timbre (tone color; e.g. a clarinet as opposed to a trumpet).

Editing Parameters Graphically

If a part is played incorrectly during recording, wrong notes can be corrected in the sequencing program with the mouse. Furthermore, as the composer revises his work, changes can be made without the re-recording the part. Simply changing a note on the screen with the mouse will cause the playback to be changed.



this note is about to be edited

Figure 2: Individual pitches or rhythms can be easily altered with the mouse.

Figure 2 shows the edit window, where the music can be edited graphically. Time is shown on the x axis, while pitch is shown on the y axis. Since the data is all digitally recorded (and represents instructions rather than sound), changing the pitch of an individual note will not affect any other parameters of the performance (for instance, raising the pitch will not cause the playback to speed up).

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Rhythm is another parameter which can easily be edited graphically. As in the pitch domain, if a rhythm is played incorrectly during recording, or if the composer decides to change the rhythm as the piece is revised, this can be accomplished by dragging notes on the screen. Another practical use for the graphic editing of rhythm is augmentation or diminution, compositional processes which have been common since the Eighteenth Century. Augmentation and Diminution involve the proportional increasing or decreasing (respectively) of the time values of all the notes of a theme or motive. Graphic editing provides a simple way to use these techniques. Again, because of the digital format used, changes do not affect any other parameters of the music. Changing the rhythm will not cause the pitch to be altered.

A third parameter which is easily edited graphically is timbre. If the composer decides to change his orchestration, altering what is called "program change" or "patch" data will cause the part to be played back on a different instrument and/or a different sound.

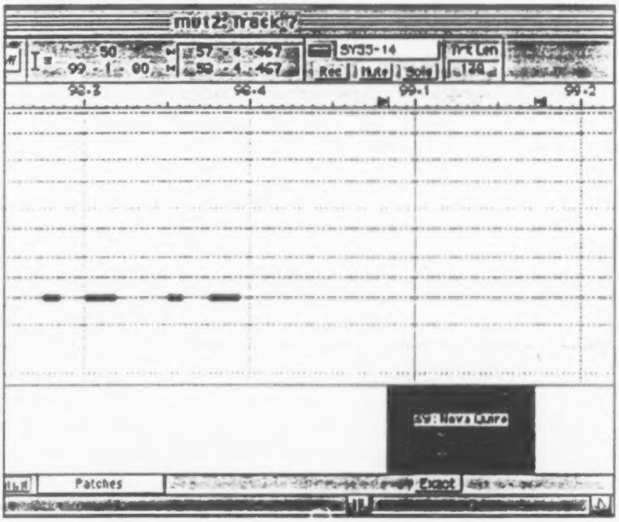
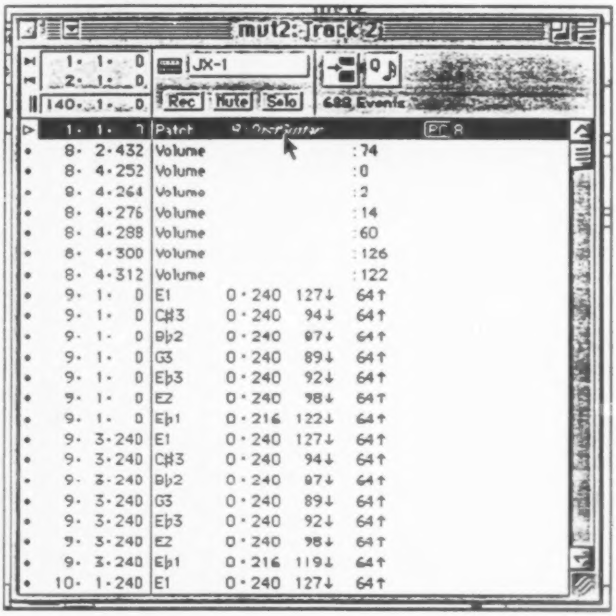


Figure 3: This "program change" will instruct the instrument to switch to a new sound, or "patch" ("NovaQuire" is the patch name in this case).

Editing parameters graphically has many advantages. It is an easy and intuitive process. Furthermore, all changes that are made can easily be undone; a fact which encourages experimentation while removing some of the inherent risk.

Manipulating Parameters Mathematically

In contrast to the graphical interface, parameters can also be dealt with in a mathematical format. Figure 4 illustrates a "list window," where data specifying events is listed in chronological order. In this format, the data is more precise and more complete than in the graphic edit window. Events are listed at their precise moment in time, and data which may not be shown in the graphic edit window is displayed. In this window, editing can be done by selecting the appropriate parameter and typing in a new value. This is the most simple type of mathematical manipulation. More complex mathematical manipulation has opened up some of the most exciting new possibilities. It has allowed composers to develop material in ways that were previously impossible. For example, Figure 5 shows eight individual parts. The lower six parts are all mathematically derived from the upper two parts. This was primarily done by selecting small portions of the original part and pasting them over longer or shorter amounts of time. This can easily be done with the "Scale Time" function shown in Figure 6. Many of the newly created passages are also transposed to a new pitch level, and some of them are backwards. The result is a passage that is "organic" in construction, meaning that all of the various parts are closely related to one another, but in a way that is too complex to be obvious. Since all



```
   1·  1·    0  Patch                    PC 8
   8·  2·432    Volume            :74
   8·  4·252    Volume            :0
   8·  4·264    Volume            :2
   8·  4·276    Volume            :14
   8·  4·288    Volume            :60
   8·  4·300    Volume            :126
   8·  4·312    Volume            :122
   9·  1·    0  E1     0·240 127↓  64↑
   9·  1·    0  C#3    0·240  94↓  64↑
   9·  1·    0  Bb2    0·240  87↓  64↑
   9·  1·    0  G3     0·240  89↓  64↑
   9·  1·    0  Eb3    0·240  92↓  64↑
   9·  1·    0  E2     0·240  98↓  64↑
   9·  1·    0  Eb1    0·216 122↓  64↑
   9·  3·240    E1     0·240 127↓  64↑
   9·  3·240    C#3    0·240  94↓  64↑
   9·  3·240    Bb2    0·240  87↓  64↑
   9·  3·240    G3     0·240  89↓  64↑
   9·  3·240    Eb3    0·240  92↓  64↑
   9·  3·240    E2     0·240  98↓  64↑
   9·  3·240    Eb1    0·216 119↓  64↑
  10·  1·240    E1     0·240 127↓  64↑
```

Figure 4: The list window provides all recorded data in a numerical format.

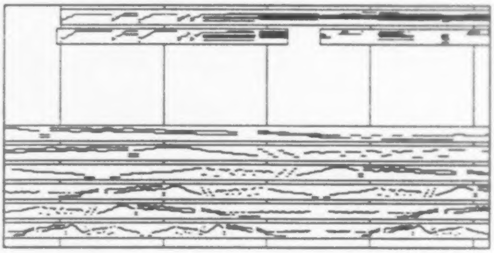
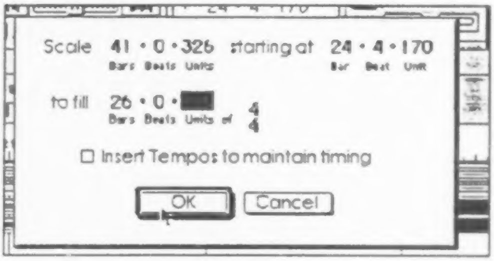


Figure 5: The lower six parts are derived from the upper two parts.



Scale 41 · 0 · 326 starting at 24 · 4 · 170
Bars Beats Units / Bar Beat Unit

to fill 26 · 0 · Bars Beats Units of 4/4

☐ Insert Tempos to maintain timing

Figure 6: The "Scale Time" function allows a passage to be pasted over a larger or smaller amount of time.

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of the individual lines are so closely related, there is a real sense of cohesiveness within the passage. This idea of "organic construction" is certainly not a new one. Composers such as Philippe de Vitry and Guillaume de Machaut used this idea in the isorhythmic motets of the Fourteenth Century (Stolba 118). However, it has never before been possible to use it at this level of complexity.

CONCLUSION

Computer-based compositional systems have provided a number of new possibilities for musical composition. A reduction in time between an inspired idea and its realization allows for more experimentation and revision. The ability to simulate any number of performers eliminates many logistical considerations. Revision and experimentation are further facilitated by the computer system's powerful data manipulation capabilities. As computer systems continue to become more powerful, these capabilities and their implementation will expand as well. Recent improvements have allowed for the manipulation of digital audio files in the many of the same ways that MIDI data can be manipulated (Basserman 70). As computers become more "interactive," the possibilities continue to increase. Tod Machover, a professor at the MIT Media Lab, is currently touring with a production of his called the Brain Opera. It is a computer generated composition that is affected by audience participation! (Wilkinson 26) As this technology continues to improve, these tools, placed in the hands of talented composers, will allow for even more creative expression. Perhaps eventually the technology will become completely transparent; so powerful and intuitive that the composer will not be impeded at all by the complexities of such systems.

ACKNOWLEDGMENTS

All figures shown are screen shots from Vision for the Mac OS by Opcode Systems.

REFERENCES

Basserman, Gerry. "The Persistence of Vision." Electronic Musician Oct. 1996: 70-85.

Stolba, K. Marie. The Development of Western Music. 2nd ed. Dubuque: Brown & Benchmark, 1994. 114-118.

Vision. Vers. 3.02. Computer software. Opcode Systems, 1996. Apple Macintosh version.

Wilkinson, Scott. "The Phantom of the Brain Opera." Electronic Musician Jan. 1997: 26-39.

91

The Conception of "Poet" In The Work of Bei Dao

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Bei Dao has been a leading figure of the Chinese Literary scene for over 20 years and has lived in exile since 1989. While his poetry of dissent is officially suppressed in China, it has nevertheless been extremely influential. This investigation focuses on Bei Dao's convictions regarding his own craft and the role of the poet. Bei Dao never directly defines what he believes the role of the poet should be. However, it will be shown that he does define what the role of the poet should be through reversal, a criticism of what a poet should not be. The details in Bei Dao's criticisms reveal his convictions regarding the role of poetry in society, the poet's responsibility as a poet, and the poet's ultimate responsibility as a human being. Bei Dao believes that a poet must write originally, personally, and subtly. He or she must be strong and humble in order to remain true to the self and to reality.

Poetry has traditionally been one of the most important means of expression in China. It has a written history of over 2,500 years and verbal tradition going back even further. Originally Chinese poetry was a very expressive art form. Over time it became a codified system of the upper classes, serving as the format of civil service examinations. The original spirit of Chinese poetry has been resurrected by modern mainland poets who focus on self expression and political expression. Modern Chinese poets draw inspiration from both traditional and western sources.

Bei Dao was born in 1949, the year of the birth of People's Republic of China. His education was suspended in 1966, at age 16, with onset of the Cultural Revolution. Like his fellow classmates, he became a Red Guard, but soon became disillusioned as the tyranny of the old was replaced by the tyranny of the new. Bei Dao began to educate himself and began writing poetry in 1970, at the age of 20. In 1978 he co-founded *Today*, an underground literary journal which had great influence on poets of his generation. His work was rarely seen in official publications. In the late 1980's he was allowed to obtain a passport to attend conferences and be a gust of foreign universities as a visiting scholar. During the 1989 Tiananmen Square Protest, while Bei Dao was in Berlin, student protesters re-published his most famous poems in student newspapers and featured lines from his poetry on protest banners. After the massacre on June 3-4 1989, Bei Dao was not allowed to return to China. He has lived in exile in Europe and the USA ever since. His wife, the artist Shao Fei, and daughter have not been allowed to leave China to join him.

In his poetry Bei Dao never directly defines what he believes the role of the poet should be. This, however, does not mean he never reveals his conception of the role of the poet and of poetry. Bei Dao tells us what the role of the poet should be through a reversal, a criticism of what a poet and poetry should not be. "The Artist's Life," and "Portrait of a Young Poet," both written between 1979 and 1983 (Bei Dao is not concerned with precise dating), are caustic criticisms of what a poet should not be and should not do. In this manner, he defines what a poet should be. "The Artist' Life" tells the story of a poet who degenerates by giving into governmental policy after being reprimanded for dealing with the truth and questioning the system. "Portrait of a Young Poet" is the ugly picture of a poet who has already given into the government long ago. [While both poems are about poets, to avoid confusion I will refer to the poet in "The Artist's Life" as 'the artist,' and the poet in "Portrait of a Young Poet" as 'the poet.' Anytime I refer to 'a poet,' I mean a poet in the abstract sense.]

At the beginning of "The Artist's Life," Bei Dao notes the four choices available to a poet in China. These are: to write about the mundane:

> go and buy a radish
> —mother said

To write on officially approved topics in officially approved modes:

hey, mind the safety line
—the cop said

To stop writing all together and retreat into a self destructive refuge:

ocean where are you
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Or, rather than ignoring the problems of China as these approaches do, to deal with reality:

why have all the street lights exploded
—I said

The last option, which asks the question 'what's wrong here?' is the one a poet should choose, and indeed is the option the artist does choose until the state exerts it's force and he or she recants to safety of option two. Dealing with the reality of contemporary China carries the risk of government persecution. The artist cracks under this pressure and turns into an evil, unfulfilled person who forces others to also conform to governmental standards. Bei Dao's criticism in the description of this conversion shows his belief that Chinese poets must deal with contemporary reality. In order to stay viable, current and critical, poets must be morally strong and humble. Their poetry must be subtle, original and be founded on a standard of quality.

Bei Dao believes poets need to be morally strong, unable to be coerced, bought out, or otherwise corrupted. They must be true to themselves. His sardonic description of the artist who does the opposite shows the spite Bei Dao feels to those who sell out. The artist sells out to the system:

and so I became a model patient
sneezing loud and clear
closing my eyes to figure out the mealtimes

In becoming a model poet, who like a model patient is very much like a zombie, and forcefully spewing forth poetry which is obvious ("loud and clear") in it's adherence to governmental policy, the artist internalizes the governmental programs and gives up his or her own beliefs. Now the artist no longer needs outside reminders to keep with the program, just as a patient who internalizes a hospital program no longer needs a clock to figure out when it is time to eat. This process culminates with the artist being "taken on as a doctor too." The artist becomes a government official with, one suspects, all the perks.

During this process of selling out the artist has given his or her talent and life away to the bloodsucking government:

donating blood to the bedbugs
with no time to sigh

By internalizing the government program, the artist has not only lost him or herself, but also the time and even the ability to see what is really going on in the world. Allowing one's life to be sucked away is too consuming and tiring to even sigh. Left with nothing, the artist resorts to pacing:

. . . up and down the corridor
to while the evenings away

Ultimately a poet who sells out is a pitiful sight. But the greatest problem with selling out, with doing what the authorities want loudly, vigorously and obviously, is that one ends up enforcing those values in others also—either through intimidation of persecution, or through actual persecution itself:

holding a thick hypodermic
I pace up and down in the corridor
to while the evenings away

Pacing with the hypodermic is intimidation, actually using it, however, is persecution. For poets who sell out, Bei Dao notes, there is no chance to see the current reality of China. Such poets become used to the lies they spew and blind to what is going on around them. All they can do is persecute and incriminate others who are free of the system and still see reality, just as the artist was originally incriminated for asking what was wrong with China:

why have all the street lights exploded
—I said

a blind man passing by
nimbly raised his cane

and pointed out the artist as the one to be taken away. Dupes of the government, those who are blind, become so used or the darkness of the regime that when anyone questions it they convict that person, having become adept at pointing out anyone who doesn't fall into party line. For these people, the ability to see actual reality is irrelevant once they have taken on the government's program of reality. The artist has come full circle, from being the persecuted, to being the persecutor.

In "Portrait of a Young Poet," Bei Dao criticizes the poet in a similarly harsh manner, for selling out and for continuing to repetitiously write the same old things the government wants, just to get money:

. . . you
don't mind repetition
saying again that money isn't clean
but everyone is pretty keen on it

or just to get drugs, which support the weak nature which resulted in the poet selling out in the first place:

thanks to a poor constitution, you
have to swallow several hormone pills a day
making your voice as tender
as the cat next door in heat

The poet is weak and the drugs are the government payoff which result in his writing of poetry in the approved style. This writing (the poet's "voice") in the approved style is necessarily unsubtle, obvious, and obnoxious. Corruption seems acceptable as the poet convinces himself that everyone else is also "pretty keen" on money, and that all the other poets are just as corrupt and stink like him, "skunks, all of us."

But corruption doesn't pay. The poet loses that which is necessary to life itself—truth to self—and in so doing comes closer and closer to death. Worse yet, he can't even tell he is in the process of dying:

the weather is mortally cold; blood
darkens, numb
is the night
like a frost bitten toe . . .

The poet is freezing to death, selling out has rendered him so out of touch with himself, so cold that is, that he can't even feel when it is overtaking him. He doesn't realize he has lost that which he needs to survive (blood darkens as it loses oxygen, without oxygenated blood, one dies). There is no escape after selling out to and becoming a part of the system. The poet has become crippled, and couldn't even stand up for himself if he wanted to:

. . . you
limp
in and out of the brake beside the road
meeting laurel-wreathed louts

He staggers in and out of his dealings with the government (the brake[*]), and it's officials (the laurel-wreathed louts), too weak to hold himself up against them. The young poet has aged rapidly since giving in to the wishes of the government: becoming bald, losing teeth, and gaining a limp. He is feeble and, like the artist who also sold out, practically dead.

The poet is anything but humble. Bei Dao describes him as enervated and childlike with creeping ambition:

. . . ambition grows as ever
around the edges of your baldness
taking out your false teeth, you look even more childish

The poet is, in fact, so desperate to have his name known that:

as soon as one's back is turned you scribble your name
on a public lavatory wall

---

[*] rough or marshy land overgrown with one type of plant (Webster's New International Dictionary, 3d ed., s.v. "brake.")

He is an ambitious immodest man who is all the more wretched for it. The artist lost any humility when he or she achieved stature by becoming a part of the system. Both the artist and the poet end up as contemptible and ugly human beings.

Bei Dao believes that poetry must be subtle. He criticizes the poet for writing from that which is outwardly obvious, "the inspiration drawn from your sleeve ." The poet's voice isn't subtle or nuanced, it's obvious, harsh and wailing, like a cat in heat. His poems are sneezed out, fast, messily and without care onto the page. The artist also sneezed his or her poems, writing loudly and obviously, without any subtlety. By describing the poetry as sneezed, Bei Dao says poetry which is not subtle is quite simply, waste.

Bei Dao believes poetry must be original and personal. Indeed, the non original 'safe' subject matter can never be subtle, it must be forcefully obvious, "sneezed loud and clear." Furthermore, poets who write to government standards can only create propaganda designed to numb the people, as the artist does, pacing with the hypodermic. Bei Dao feels a poet should never simply write what the government wants. The poet's governmentally approved poems are simply strung-out, obvious, trite old lines:

> The inspiration drawn from your sleeve
> is never-ending; you
> pass day and night through strung-out lines and
> lanes. . .

He only writes about subject matter which he thinks is safe:

> the moon which has paid it s insurance premium
> or the ponderously heavy
> axe which hasn't

In other words, he either writes about traditional worn images such as the moon, or in praise of the government (the axe). The poet and the artist who only sneeze the outward poetry the government wants are described throughout both poems as pathetic human beings. But Bei Dao warns, not only are they pathetic, they are mislead. The poet who tries to play it safe never can: the government, which "weighs more than thought" is not safe; governmental policy changes at whim, and anything written in support of the government today can be taken as counter revolutionary tomorrow.

The poet is subject to constant reminders of the program to which he has committed himself. From the fire engine which "wails insanely" to the government agents everywhere he turns (the owls watching in every tree), he is reminded to stick to the current party line. But even worse are the reminders from people he knew in his past, reminders of his life before becoming a government dupe. The poet assuages his guilt by choosing to believe all the other poets of his generation have also given up their previous ideals and standards, and have sold out, too.

The measure of poetry should be should be a standard of quality, not quantity, according to Bei Dao. The poet spews forth poems in never ending quantities, regardless of their quality. He pours out "never-ending" lines, but they are "strung out," tired and trite. He writes prolifically, but that doesn't mean he takes time or care with his work:

> nine sneezes in a row
> drop on paper, you
> don't mind repetition

Each poem only says the same old thing and is merely sneezed out waste. Quantity does not necessarily mean anything.

Through his criticisms in "The Artist's Life" and "Portrait of a Young Poet," Bei Dao notes what he believes a poet should do as a person and in poetry. As a person a poet must be strong and humble. A poet must write subtly, originally and personally, to a standard of quality not quantity. To be viable, current and critical, as Bei Dao suggests a poet must be, requires being present as a human being to the surrounding environment and to oneself.

REFERENCES

Bei Dao. "The Artist's Life." In *The August Sleepwalker*, trans. Bonnie S. McDougall. New York: New Directions Books, 1990. Translation of *Shi Xuan* (2d ed. Canton: 1987).

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The Artist's Life

go and buy a radish
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hey, mind the safety line
—the cop said
ocean, where are you
—the drunk said
why have all the streetlights exploded
—I said
a blind man passing by
nimbly raised his cane
like pulling out an antenna
an ambulance arriving with a screech
took me to hospital

and so I became a model patient
sneezing loud and clear
closing my eyes to figure out the mealtimes
donating blood to the bedbugs
with no time to sigh
in the end I was taken on as a doctor too
holding a thick hypodermic
I pace up and down the corridor
to while the evenings away

Portrait of a Young Poet

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even though ambition grows as ever
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making your voice as tender
as the cat next door on heat
nine sneezes in a row
drop on paper, you don't mind repetition
saying again that money isn't clean
but everyone is pretty keen on it
a fire engine wails insanely
reminding you to praise
the moon which has paid its insurance premium
or praise the ponderously heavy
axe which hasn't
the axe which weighs more than thought
the weather is mortally cold; blood
darkens, numb
is the night
like a frost bitten toe, you
limp
in and out of the brake beside the road
meeting laurel-wreathed louts
every tree
with its own owl
running into people you know is a pain
how they do like to bring up the past
the past, yes, you and me
skunks, all of us

Bei Dao's Poet

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97

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making your voice as tender
as the cat next door in heat

The poet is weak and the drugs are the government payoff which result in his writing of poetry in the approved style. This writing (the poet's "voice") in the approved style is necessarily unsubtle, obvious, and obnoxious. Corruption seems acceptable as the poet convinces himself that everyone else is also "pretty keen" on money, and that all the other poets are just as corrupt and stink like him, "skunks, all of us."

But corruption doesn't pay. The poet loses that which is necessary to life itself—truth to self—and in so doing comes closer and closer to death. Worse yet, he can't even tell he is in the process of dying:

the weather is mortally cold; blood
darkens, numb
is the night
like a frost bitten toe. . .

The poet is freezing to death, selling out has rendered him so out of touch with himself, so cold that is, that he can't even feel when it is overtaking him. He doesn't realize he has lost that which he needs to survive (blood darkens as it loses oxygen, without oxygenated blood, one dies). There is no escape after selling out to and becoming a part of the system. The poet has become crippled, and couldn't even stand up for himself if he wanted to:

. . . you
limp
in and out of the brake beside the road
meeting laurel-wreathed louts

He staggers in and out of his dealings with the government (the brake*), and it's officials (the laurel-wreathed louts), too weak to hold himself up against them. The young poet has aged rapidly since giving in to the wishes of the government: becoming bald, losing teeth, and gaining a limp. He is feeble and, like the artist who also sold out, practically dead.

The poet is anything but humble. Bei Dao describes him as enervated and childlike with creeping ambition:

. . . ambition grows as ever
around the edges of your baldness
taking out your false teeth, you look even more childish

The poet is, in fact, so desperate to have his name known that:

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*rough or marshy land overgrown with one type of plant (Webster's New International Dictionary, 3d ed., s.v. "brake.")

as soon as one's back is turned you scribble your name
on a public lavatory wall

He is an ambitious immodest man who is all the more wretched for it. The artist lost any humility when he or she achieved stature by becoming a part of the system. Both the artist and the poet end up as contemptible and ugly human beings.

Bei Dao believes that poetry must be subtle. He criticizes the poet for writing from that which is outwardly obvious, "the inspiration drawn from your sleeve ." The poet's voice isn't subtle or nuanced, it's obvious, harsh and wailing, like a cat in heat. His poems are sneezed out, fast, messily and without care onto the page. The artist also sneezed his or her poems, writing loudly and obviously, without any subtlety. By describing the poetry as sneezed, Bei Dao says poetry which is not subtle is quite simply, waste.

Bei Dao believes poetry must be original and personal. Indeed, the non original 'safe' subject matter can never be subtle, it must be forcefully obvious, "sneezed loud and clear." Furthermore, poets who write to government standards can only create propaganda designed to numb the people, as the artist does, pacing with the hypodermic. Bei Dao feels a poet should never simply write what the government wants. The poet's governmentally approved poems are simply strung-out, obvious, trite old lines:

The inspiration drawn from your sleeve
is never-ending; you
pass day and night through strung-out lines and
lanes . . .

He only writes about subject matter which he thinks is safe:

the moon which has paid it's insurance premium
or the ponderously heavy
axe which hasn't

In other words, he either writes about traditional worn images such as the moon, or in praise of the government (the axe). The poet and the artist who only sneeze the outward poetry the government wants are described throughout both poems as pathetic human beings. But Bei Dao warns, not only are they pathetic, they are mislead. The poet who tries to play it safe never can: the government, which "weighs more than thought" is not safe; governmental policy changes at whim, and anything written in support of the government today can be taken as counter revolutionary tomorrow.

The poet is subject to constant reminders of the program to which he has committed. From the fire engine which "wails insanely" to the government agents everywhere he turns (the owls watching in every tree), he is reminded to stick to the current party line. But even worse are the reminders from people he knew in his past, reminders of his life before becoming a government dupe. The poet assuages his guilt by choosing to believe all the other poets of his generation have also given up their previous ideals and standards, and have sold out, too.

The measure of poetry should be should be a standard of quality, not quantity, according to Bei Dao. The poet spews forth poems in never ending quantities, regardless of their quality. He pours out "never-ending" lines, but they are "strung out," tired and trite. He writes prolifically, but that doesn't mean he takes time or care with his work:

nine sneezes in a row
drop on paper, you
don't mind repetition

Each poem only says the same old thing and is merely sneezed out waste. Quantity does not necessarily mean anything.

Through his criticisms in "The Artist's Life" and "Portrait of a Young Poet," Bei Dao notes what he believes a poet should do as a person and in poetry. As a person a poet must be strong and humble. A poet must write subtly, originally and personally, to a standard of quality not quantity. To be viable, current and critical, as Bei Dao suggests a poet must be, requires being present as a human being to the surrounding environment and to oneself.

REFERENCES

Bei Dao. "The Artist's Life." In *The August Sleepwalker*, trans. Bonnie S. McDougall. New York: New Directions Books, 1990. Translation of *Shi Xuan* (2d ed. Canton: 1987).

Bei Dao. "Portrait of a Young Poet." In *The August Sleepwalker*, trans. Bonnie S. McDougall. New York: New Directions Books, 1990. Translation of *Shi Xuan* (2d ed. Canton: 1987).

The Artist's Life

go and buy a radish
—mother said
hey, mind the safety line
—the cop said
ocean, where are you
—the drunk said
why have all the streetlights exploded
—I said
a blind man passing by
nimbly raised his cane
like pulling out an antenna
an ambulance arriving with a screech
took me to hospital

and so I became a model patient
sneezing loud and clear
closing my eyes to figure out the mealtimes
donating blood to the bedbugs
with no time to sigh
in the end I was taken on as a doctor too
holding a thick hypodermic
I pace up and down the corridor
to while the evenings away

Portrait of a Young Poet

The inspiration you draw from your sleeve
is never-ending; you
pass day and night through strung-out lines and
lanes; you
were old when you were born
even though ambition grows as ever
around the edges of your baldness
taking out false teeth, you
look even more childish
as soon as one's back is turned you scribble your name
on a public lavatory wall
thanks to a poor constitution, you
have to swallow several hormone pills a day
making your voice as tender
as the cat next door on heat
nine sneezes in a row
drop on paper, you don't mind repetition
saying again that money isn't clean
but everyone is pretty keen on it
a fire engine wails insanely
reminding you to praise
the moon which has paid it's insurance premium
or praise the ponderously heavy
axe which hasn't
the axe which weighs more than thought
the weather is mortally cold, blood
darkens; numb
is the night
like a frost bitten toe, you
limp
in and out of the brake beside the road
meeting laurel-wreathed louts
every tree
with it's own owl
running into people you know is a pain
how they do like to bring up the past
the past, yes, you and me
skunks, all of us

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"There Is No Loneliness Like Theirs": James Wright's "A Blessing" and C.K. Williams' "On Learning of a Friend's Illness" Examined

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"On Learning of A Friend's Illness," by C.K. Williams was published in his 1983 collection of poetry *Tar*. It recalls a journey outside the city into a barren field that is now a sanctuary for tired old horses. Anyone familiar with James Wright's often anthologized "A Blessing" can easily recognize in "On Learning" an attempt on the part of Williams' to recreate the events of Wright's poem. In fact, the similarities are so evident that one could easily see the parallels between the two poems. Yet, perhaps for those who do not immediately recall Wright's poem, C.K. Williams does make an indirect reference to "A Blessing," by dedicating his poem to the late James Wright, who had died in 1980. By having "On Learning" borrow from and, in many ways, reenact "A Blessing, Williams undoubtedly seeks to honor Wright. However, Williams' bleak, grim poem not only shows appreciation for Wright but also criticizes the optimism expressed in "A Blessing." Williams further complicates his poem by suggesting that he finds himself lacking by failing to share Wright's optimism.

Of James Wright and *The Branch Will Not Break*, the volume of poetry in which Wright's "A Blessing" appears, critic Peter Stitt writes;

> The basic strategy Wright employs in *The Branch Will Not Break* is that of a quest. In his search for happiness, for comfort, for consolation, and for sustenance, the poet turns from the city to the country, from society, to nature, from human beings to animals, and from a fear of the finality of death to a trust in immorality. (Stitt 145)

"A Blessing" enacts such a quest and results in the discovery that appears as the central idea in "A Blessing." The quest ends as the title suggests, in a religious experience: "Suddenly I realize/ That if I stepped out of my body I would break/ Into blossom." In these lines, Wright expresses what Stitt calls and "intimate kinship" with nature, a kinship that is felt in the possibility of metamorphosis; of man and nature blending together. What seems to emphasize Wright's optimism is a belief in the possibility that a human can somehow become a flower; that somehow, the distinctions between things can break down.

Early on in "A Blessing," Wright seems to establish the possibility of interchange between substances. He sets the poem in a spring twilight, which he states "bounds softly forth." Wright allows the twilight to "bound," an action usually attributed to deer or ponies. He further blurs lines of distinction when he tells readers that the ponies' eyes "darken with kindness," thus giving them an attribute of the twilight. This melding of nature and beast establishes a suggestion of oneness that anticipates his final epiphany.

In contrast, Williams writes of a similar situation, but despite Williams' efforts at reenacting those actions reported by Wright in "A Blessing," Williams realizes that, at least to his sensibilities, all things are not interchangeable, even if they appear to be so. In the opening lines of "On Learning," Williams describes a scene where everything *looks* the same. Everything appears gray: "The morning is so gray that the grass is gray and the side of the white horse grazing /is as gray and hard as the harsh, insistent wind gnawing the iron surface of the river . . . ." Yet, despite appearances, Williams goes on to show that these elements are, in fact, not interchangeable, and he is so determined to eliminate the idea of metamorphosis, that by the end of the poem, he has destroyed the possibility of anything breaking into blossom. In fact, in Williams, the oneness that makes "A Blessing" so attractive has become grim. Instead of the possible change that leads to blossoming in "A Blessing" we find that the change in "On Learning" leads only to deterioration and decay.

The contrasts between the two settings of the poems make clear that Williams is calling into question Wright's optimism in "A Blessing." Instead of depicting a warm spring evening in the countryside, Williams takes us to a bitter cold winter morning just outside a large, urban city. What is willows in a field in "A Blessing" becomes a "brushy hollow" in "On Learning." The barbed wire that Wright quickly moves past in "A Blessing" would easily fit within the lines of "On Learning," for, as readers, we have gone from a rural, country garden of Eden to an urban wasteland composed of "scruffy fields[and] scattered pines and stands of third-growth oak...." Though "On Learning" is a reenactment of "A Blessing," the setting has changed. It is no longer what it used to be when first detailed in "A Blessing." In fact, the scene in "On Learning" is so desolate that the speaker sees urban industrialization as more attractive than the nature surrounding it. For "far off on the other shore, the eruptions from the city seem for once more docile and benign /than the cover of nearly indistinguishable clouds they unfurl to insinuate themselves among." Ugliness, only brought up briefly in the barbed wire and then quickly dismissed in "A Blessing," is a focus in "On Learning."

However, it is not only the landscape that has changed from "A Blessing" to "On Learning." The horses have changed as well. The Indian ponies of "A Blessing" have been replaced by old, shaggy, unkempt horses. Wright compares the two ponies in "A Blessing" to both swans and the delicacy of a young girl's skin, again blurring lines of distinction. However, in "On Learning," there is little delicacy about the horses, and the only thing graceful about them is their flight when the speaker scares them. These horses are old, raggedy beasts, who are "wild-eyed, shaggy, unkempt mares," whose "necks, rumps, withers, even faces [are] begrimed with patches of the gluey, alluvial mud."

In addition to the transformation of the horses from "A Blessing" to "On Learning," the relationships that exist between the animals and the speakers have altered. In the Wright poem, the two Indian ponies have eyes that "darken with kindness," and the speaker tells us "They have come gladly out of the willows /To welcome my friend and me."

Moreover, the speaker states that these two ponies "can hardly contain their happiness /That we have come." It seems by this description that the ponies were expecting their visitors, almost wondering what had taken them so long to arrive. But in "On Learning," the speaker is obviously not expected, nor welcome, but instead viewed as a threat to the herd. The speaker tells us that he startles the herd as he approaches: "All of them at once, their nostrils flared, their tails flung up over their backs like flags, /are suddenly in flight, plunging and shoving along the narrow furrow of the flood ditch, /bursting from its mouth, charging headlong towards the wires at the pastures end...." They are animals who are "reverting" and "becoming less and less approachable, more and more the symbols of themselves."

In "A Blessing," the horses are more than "approachable." Wright tells readers that his reaction to the two ponies makes him want to

> ...hold the slenderer one in my arms,
> For she has walked over to me
> And nuzzled my left hand.
> She is black and white,
> Her mane falls on her forehead,
> And the light breeze moves me to caress her long ear . . . .

This interaction between horse and man has clearly been initiated by the horse, and it is this exchange that leads, along with the light breeze, to the speaker to his epiphany. However, the speaker of "On Learning" does not have such an experience; rather, it is he who has to initiate the contact with the one horse that does not flee, and then it is not the beautiful, respectful, and enlightening exchange that is seen in "A Blessing." Instead, the speaker tells us, "I slip up on her, hook her narrow neck, haul her to me, hold her for a moment, let her go." The result of this action brings him not to a revelation, but instead to a further questioning. There is no joyful epiphany for the speaker of Williams' poem.

Instead of an ecstatic revelation of the possibility of metamorphosis, the interaction between Williams and the horses brings him only to a questioning of himself that leads to further despair. "I can hardly remember any more what there ever was out here that keeps me coming back /to watch the land be amputated by freeways and developments, and the mares, in their sanctuary . . . ." The possibility of epiphany seems gone, and in its place is a piece of the horses' manure that the speaker picks up and watches as "it crumbles in my hand, its weightless, wingless filaments taken form me by the wind and strewn /in a long, surprising arc that wavers once then seems to burst into a rain of dust."

All of these contrasts between "A Blessing" and "On Learning" give the sense that, despite the dedication to Wright, Williams actually is -- determined to call into question Wright's optimism. However, Williams is not the only poet to question Wright. Robert Bly has also recognized that Wright has a tendency to soften reality and make it more appealing and inviting than it really is. Bly complains of Wright's tendency to beautify what he sees:

> If we begin to pay attention to the faults in James Wright's work, we find that we are constantly aware of a kind of softness. In the early poetry, the softness is a vague, romantic

> mist that wraps everything. From the beginning his tendency has always been to make his own experience more literary than it really is . . . . [I]t is difficult for Wright to actually live in the present. He sees himself surrounded by a world so entirely hostile that writing poetry becomes for him at times a sort of step sideways into another dimension-- the dimension of beauty, rather than wrestling with ugliness. (Bly 112-113)

Wright's "step sideways" is what informs "A Blessing." The barbed wire disappears, and the result is a "vague, romantic mist" that allows ponies to behave as if they are twilight, the twilight to behave as if it were an animal, and this sidestep is what allows Wright himself to be transformed into a flower. This mist is what Wright expresses in "A Blessing," and it is also what is absent in "On Learning."

It is Williams who does not "step sideways." Instead, he echoes Bly's criticism by seeming to revel in "wrestling with ugliness." When he attempts to reenact Wright's "blessed" journey off the highway, Williams finds himself in despair in a desolate landscape. He finds no epiphanies; instead he finds

> No comfort here, nothing to say, to try to say, nothing for
> anyone. I start the long trek back,
> the horses nowhere to be seen, the old one plodding wearily
> away to join them,
> the river, bitter to look at, and the passionless earth, and the
> grasses rushing ceaselessly into place.

But, if Williams is being critical of Wright's "literary softness," "On Learning" is a less attractive poem than "A Blessing" for lacking that poem's beauty. Whereas Wright's poem strives to gloss over the negative and less attractive elements of life, Williams' poem, by striving to include them, lacks any traces of softness and delicacy that give Wright's poem its charm. There is no kindness or love or happiness in Williams' work, only barrenness and despair. The love that existed between the two Indian ponies in "A Blessing" has disappeared entirely in "On Learning." Wright has a friend along with him, and the ponies he encounters are in love. The happiness of his encounter ends in an exhilaration the reader wants to embrace. Williams, on the other hand, does not have a companion, and the old mare that he does encounter does not come to him voluntarily. Their meeting is anything but happy and affectionate. It is simply a lonely encounter in an ugly landscape.

Williams has clearly found the loneliness through his reenactment of "A Blessing"; however, it is not the loneliness he was looking for. While Williams may not agree with Wright's optimism, Williams longs for it. He does not want the emptiness that he has found; instead, he wants the loneliness Wright speaks of-- a loneliness that exists between kindred. Williams states that he "hardly can remember anymore what there ever was out here that keeps me coming back;" yet it is clear that, no matter how foggy the memory, he does indeed remember. Why else the dedication to Wright and why else the attempt to experience what Wright outlines in "A Blessing"? Williams' desire for something other than what he finds is notably suggested when the manure he throws into the air bursts into a "*rain* of dust" [emphasis mine]. This hint of a transformation of refuse into rain-- a life-bringing element which is noticeably absent from "On Learning"-- suggests Williams longing for what Wright seems to have found in "A Blessing." What Wright values so much in "A Blessing" is the darkness and naturalness of the two ponies and their setting. Even more he values their love-- a love, he tells his readers, that creates a transforming loneliness. And Williams, despite his criticism and skepticism, seems to value this too, and, despite faulting Wright for his lack of realness, nonetheless wishes to share the blessing that Wright has had.

Works Cited

Bly, Robert. "The Work of James Wright." *The Heart of Light.* Peter Stitt and Frank Graziano, eds. University of Michigan Press, Ann Arbor, MI. 1990. 94-116.

Stitt, Peter. "The Quest Motif in *The Branch Will Not Break.*" *Ibid.* 144-156.

Williams, C.K. "On Learning of a Friend's Illness." *Selected Poems.* Noonday Press, New York. 1994. 91-92.

Wright, James. "A Blessing." *Above the River: The Complete Poems.* Noonday Press and UP of New England. 1990. 143.

Embrace of Dionysus
The Presence of African Art
In D.H. Lawrence's Women in Love

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D.H. Lawrence's novel Women in Love can be seen as a commentary on the degeneration of a man's soul through an embrace of the wholly primitive or the wholly civilized. This embrace blocks out the ability of man to achieve self-realization or maintain a healthy relationship with another human being. Lawrence's extensive reading on primitive cultures, his exposure to African art, and his selective disgust for the trappings of European civilization all manifest themselves in this novel. From these influences, Lawrence portrays the struggle men and women endure to find love with another. This love, however, is won or lost under extreme duress due to the internal struggle these individuals encounter as they try to decide between following the primitive, internal yearnings of their soul or the civilized sensibility of their society.

The characters of Women in Love represent a dichotomy of personalities much like the Apollonian and Dionysian states of consciousness found in Friedrich Nietzsche's The Birth of Tragedy. Externally, the characters represent an "Apollonian consciousness." Apollo, described by Nietzsche as "lucent", with eyes like the sun (1872) embodies the "enlightened" and civilized sensibility of the characters. This is Gerald Crich in Women in Love. He is associated with sobriety, intellectual knowledge, industry, and a European or Caucasian heritage; a Dionysian reflects "the primitive", drunkenness, sensual knowledge, nature, darkness, and the exotic or African. Rupert Birkin, although of a European heritage, sees the need for the presence of the Dionysian in Apollonian life at the beginning of the novel. Nietzsche sees the conflict erupt when the characters realize "with a shudder...that [their] Apollonian consciousness was but a thin veiling hiding them from the whole Dionysian realm" (1872). This realization can lead to either life or death, as the relationships in the novel reveal.

In the chapters "Fetish" and "Creme de Menthe", Lawrence uses African art to show the appreciation Rupert has for the sculpture and the contempt in which Gerald holds it. The sculpture they view is a fertility fetish from the Yoruban tribe of West Africa. This particular type of sculpture emphasizes the sexual organs, and the woman, holding her protuberant breasts, suggests one of two images. The first is of explicit, aggressive sexuality. Her position, squatting and low, conveys an invitation for sex in which she would be on top--a sign of female dominance. The second is one of autoeroticism. The woman acts to please only her herself; she extends no invitation.

Gerald first finds her "wonderful, conveying the suggestion of the extreme physical sensation, beyond the limits of mental consciousness" (Lawrence, 1920). Although Gerald recognizes the sensual nature of the carvings, the wonder he expresses is not one of intellectual curiousity, rather it is of fear and dread. As Rupert and Gerald view the statues, Rupert states, "They are art, because they convey the complete truth of that state, whatever you want to feel about it" (Lawrence, 1920). Gerald's reply is conventional, he thinks they are obscene. He also tells Rupert there is no culture in the carving because it is not "high art." Rupert answers, "Pure culture is sensation, culture in the physical consciousness, really intimate physical consciousness, mindless, utterly sensual. It is so sensual as to be final, supreme" (Lawrence, 1920). This produces form Gerald only simple denial: "You like the wrong things, Rupert." Gerald's response reflects his Apollonian outlook on a culture that is different from his own. The African sculpture evokes images of darkness and sensuality--qualities deemed unacceptable according to Gerald's Apollonian point of view.

Gerald's Apollonian affinity points to Greek sculpture. The artistic opposite of African sculpture, it is the "ideal form" that represents the enlightened civilization in which the Apollonian lives. For example, an Classical Greek statue of Venus, while evoking sensuality, conveys a different message from the African. She is neither invitational nor autoerotic, and is meant to be admired, but not touched. While the African women unabashedly uses her hands to expose herself, Greek sculpture often shows its subjects covering themselves to hide their nudity. Gerald sees light and civilization in these white marble creations, while the African carvings, of a rich, warm wood, evoke images of darkness and sensuality. Later in the novel, Lawrence has Rupert come to the realization that the "mindless sensuality" found in the carvings is just as destructive as the Apollonian image of civilization. Rather than cultivation of an extreme, Lawrence must have Rupert seek a balance between his Apollonian and Dionysian states. Rupert, as the voice of Lawrence, knew the value of learning from the art, from Africa, and from the "primitive," however, one should not go native like Conrad's Kurtz.

African sculpture came to serve the needs of Lawrence through his studies on cultural development theories formulated in the late nineteenth and early twentieth centuries. Lawrence intensely studied the sculptures described in Sir James Frazer's The Golden Bough and Totemism and Exogamy, Sir Edward Tyler's Primitive Culture, and Jane Harrison's Ancient Art and Ritual. Paul Guillame describes the knowledge available at the turn of the century:

> Negro sculpture was known only to an occasional missionary, who would write home with horror of the "hideous idols" of the savages, and to a few explorers and ethnologists, who collected them among other phenomena of African life, without suspecting that it might ever be taken seriously as art. (1926)

African sculpture was discovered by European explorers during the late fifteenth century, and the first African pieces made their way to a museum in Ulm, Germany in the late sixteenth century. They may still be viewed there today. Texts disagree, however, on the exact time the material culture of Africa began to be appreciated for an aesthetic, rather than ethnographic purpose. Dates for the initial appreciation range from 1904-1907, but culminated in 1915 with the publication of Negerplastik, the first book on African art, authored by Karl Einstein. African sculpture had begun to shape the cultural arts, and artists themselves began to show an African sway to their pieces. Waclaw Korabiewicz notes that four years after the publication of Negerplastik, "the periodical Action printed 'Opinions on Negro Art'" (1966). One of the co-authors was Pablo Picasso. Picasso's cubist movement was strongly influenced by African sculpture. Lawrence himself appreciated Picasso for "his wizard, sensuous apprehension of the earth" (1920). Picasso's paintings bear a similarity to African art: angular yet sensual, his work explicitly displays sexuality, and demands admiration.

While the writings of Harrison, Tyler, and Frazer do discuss the material culture of Africa, they also treat the subject with an edge of European ethnocentrism. Inez Morris notes that Lawrence probably realized this because his descriptions of the art "emphasize culture and elegance, rather than barbarity" (1983). In Lawrence's letters we find strong evidence that he felt some connection with what Harrison, Tyler, and Frazer were stating in their works, yet he often went one step further, and postulated his own theories on the development and origin of man and culture. In a letter to Bertrand Russell, Lawrence describes his reaction to Frazer:

> I have been reading Frazer's Golden Bough and Totemism and Exogamy. Now I am convinced I what I believed...there is another seat of consciousness [other] than the brain and nervous system: there is a blood consciousness which exists independently of the ordinary mental consciousness....One lives, knows, and has one's being in the blood, darkness. And the tragedy of this our life, and of your life, is that the will has gone completely over to mental consciousness, and is engaged in the destruction of your blood being...the final liberating of the one, which is death in result. (1917)

In this letter to Russell, Lawrence defines the ultimate struggle that all humankind faces and later writes about in Women in Love. The Dionysian blood instinct must form a balance with the Apollonian mental consciousness without one becoming too dominant. The blood instinct is internal, and pulses with life. The intellectual consciousness, while also internal, all too often dictates the choices and actions of one's existence. These two states of consciousness must coexist in peace in order for the individual to achieve a fulfillment of being. In this struggle rests the tragedy of Gerald Crich. His will goes completely over to one side, and he finds only death due to this adherence to an extreme. Lawrence would have been more accurate in titling his novel Men and Women in Love, because this struggle between the blood consciousness and mental will is a conflict known by both sexes.

While the writings of Harrison, Tyler and Frazer are important in discussing the influences on Lawrence's work, the actual presence of African sculpture in the life of Lawrence also impacted his writing. Two collections, one public and the other private, are known to have been seen by Lawrence. One collection, housed in the British Museum, was visited by Lawrence in September of 1914:

> I know...what we are after. We want to realize the tremendous non-human quality of life--it is wonderful. It is not the emotions, nor the personal feelings that matter....Behind us all are the tremendous unknown forces of life, coming unseen and unperceived...driving us, forcing us, destroying us if we do not submit to be swept away.

In the sculpture of these past civilizations, Lawrence sees an embodiment of the sensual nature he desires, yet it is a small remnant of time already past. Lawrence feels that the modern societies of today can learn from the sensual wisdom represented by the by this culture, and in doing so, become more in touch with a side of man too long repressed.

While Lawrence's letters reflect his perceptions of African art in public exhibits, his experience with a private collection made it into Women in Love. Julius Halliday, owner of the two sculptures Rupert admired in the chapters "Fetish" and "Creme de Menthe" had a real life

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counterpart in Lawrence's friend Philip Heseltine, who also owned two. Rupert and Gerald, in discussing Halliday's personality, hint at an Apollonian and Dionysian contrast, "on the one hand he is a religious maniac and on the other he is fascinated by obscenity" (95). Halliday's vacillation between a life of Apollonian purity and Dionysian revel in the senses is yet another example given by Lawrence of a failure to maintain a balance between the two.

With Lawrence's placement of African sculpture in Women in Love comes both praise and criticism. While some see Lawrence's use of the sculpture as an enlightened move, embracing the culture of Africa, others deem it to be yet another romanticized misinterpretation of Africa by a disillusioned European. While these two notions both contain some merit, they are both flawed. The controversy rests in whether Lawrence was and advocate for primitivism or merely expressed enthusiasm for the art of Africa. Viewing Lawrence's work through the context of time, however, points to a blending of both notions, rather than an embrace of one instead of the other.

Lovejoy and Boas define primitivism as "the discontent of the civilized with civilization....It is the belief of men living in a relatively highly evolved and complex cultural condition that a life far simpler...is a more desirable life" (1965). Lawrence may have appreciated this definition because of the conditions surrounding him while he was writing Women in Love. Europe was in the midst of World War I and the novel was written in 1916, the bloodiest and most terrifying year of the conflict. At the end of the novel Lawrence himself notes,

> it is a novel which took its final shape in the midst of the period of war, though it does not concern the war itself. I should wish the time to remain unfixed, so that the bitterness of the war may be taken for granted in the characters. (1920)

It is no wonder Lawrence appreciated aspects of primitive cultures. World War I was a war between nations of the highest industrialized order, and yet, at the risk of self-annihilation, countries who considered themselves the apex of "civilization" were producing machines of death and destruction with which they committed unspeakable acts of atrocity against their fellow man.

Lawrence's enthusiasm for the cultures described in the writings of Harrison, Frazer, and Tylor were an important influence in his writings, yet his primitivist impulses may have also been shaped by writings on primitive cultures that had little scientific merit to them, or were works of pure fiction. For example, Olive Schreiner's The Story of an African Farm, Herman Melville's Omoo and Typee, and Joseph Conrad's Lord Jim all involve the adventures of Europeans in exotic locales. In a letter to Robert Montsier, Lawrence rues, "To think what has become of Melville's beautiful Typee! A million curses on European civilization. It is collapsing and deserves to collapse. I spit on it" (1917). Lawrence's disgust for European ways does give credibility to both an embrace of African culture because it lacks the qualities of development and industry found in Europe, and a romanticized notion of the culture because in it he saw an idyllic quality of life.

Lawrence's appreciation for African sculpture may be quixotic, but he is not alone in his manner of thought. By the standards of today, many people of both the early twentieth century and the present still maintain misconceptions about "primitive" art. Sally Morris points out these false perceptions and misunderstandings when she lists, side by side, definitions of primitive art. The first, considered "authentic," is scientifically accepted by anthropologists and historians: "Properly, it is the art of those people who have remained until recent times at an early technological level, who have been oriented towards the use of tools, but not machines" (qtd. in Kramer 1989). The second definition, cited by the author, is a more generic, commonly held term that glaringly illustrates an ethnocentrism still held by many people today:

> Any art made by persons, who, in Westerner's metaphorical imagery of the Family of Man...genetically related and genealogically equal but not yet trained to repress their natural urges in conformance with the rules of civilized behavior. (1989)

Herein lies the problem of Women in Love. While the sculptures were carved with simple tools rather than machines of industry, Lawrence equates the sensuality he sees as destructive to the order of life. The people represented, Lawrence perceives, face only self-annihilation due to their inability to merge their sensual and sensible natures. In looking at the art of another culture, Lawrence understood man must not take an Apollonian stance and view it from within the context of his own society. Rather, he must remain open to a Dionysian influence without being consumed by it.

While Women in Love illustrates Lawrence's vision of the destructive nature of extremes, it is not an apocalyptic vision of the end of man due to his inability to reconcile his sensuous and sensible consciousness. The mind cannot exist without the body, just as the Dionysian cannot exist without the Apollonian. As Jack Stewart observes, Lawrence's concept of culture was not a "continuum," but "a series of experiments along parallel lines" (1980). Humanity is not a straight path originating in birth and ending in death; rather it is a continuing process from which we learn from the experience of others. Culture and civilizations do die, but they are reborn again and again in other cultures. Lawrence sums up his vision of African sculpture and European society in a critique he wrote shortly after Women in Love was completed:

> No man can look at the African grotesque carvings...without seeing in them the infinitely sophisticated soul which produces distortion from it own distorted psyche, a psyche distorted through myriad generations of degeneration. (1921)

In Lawrence's eyes, the presence of African art then becomes a mirror to the inner consciousness of the viewer. This is why Gerald, as the "sophisticated" Nordic exploiter, is repulsed by the carvings and Rupert, as the embracer of sensuality, admires them. Lawrence warns, however, that while the carvings encourage sensuality, they must serve as a reminder of the destruction the generations face if they clutch an extreme existence. Humankind must not be an embrace of Dionysus or Apollo, it must be a relation of synthesis between light and earth.

WORKS CITED

Boas, George, and Arthur Lovejoy. Primitivism and Related Ideas in Antiquity. New York: Octagon, 1965.

Boulton, James. ed. The Letters of D.H. Lawrence. 7 vols. Cambridge: U of Cambridge P, 1981.

Guillame, Paul. and Thomas Munro. Primitive Negro Sculpture. 1926. New York: Hacker Art Books, 1968.

Korabiewicz, Waclaw. African Art in Polish Collections. Warsaw: Polonia,1966.

Lawrence, D.H. Women in Love. 1920. Ed. David Farmer, Lindeth Vasey, and John Worthen. New York: Penguin, 1987.

Morris, Inez. "African Sculpture Symbols in Women in Love." The D.H.Lawrence Review. 16:1 (1983) 25-43.

Nietzsche, Friedrich. The Birth of Tragedy and the Genealogy of Morals. 1872. Ed. Francis Golffing. New York: Doubleday and Anchor, 1956.

Price, Sally. Primitive Art in Civilized Places. Chicago: U of Chicago P, 1989.

Stewart, Jack. "Primitivism in Women in Love." The D.H. Lawrence Review. 13:1 (1980) 45-62.

A Poststructural Analysis of Richard Wright's "Big Black Good Man"

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In *Playing in the Dark: Whiteness and the Literary Imagination*, Toni Morrison speaks of Miss Haversham, a character from *Sapphira and the Slave Girl*, being trapped in her decaying body and escaping her condition by mistreating Nancy, one of her slaves. Morrison further states that if the "Africanist characters and their conditions are removed from the text of *Sapphira*, we will not have a Miss Haversham immured or in flames. We have nothing . . ." (26). This assertion can easily be applied to the characters in Richard Wright's short story "Big Black Good Man."

Wright's story is one of misunderstanding and fear between the main character, hotel clerk Olaf Jensen, and the big black good man (whose name, Jim, appears only *once* in the story). "Black" is the key word here because without the blackness of the African Americans, Wright would have no story. This leads directly to the suggestion of what many literary critics call the "black aesthetic."

Adam David Miller claims a black aesthetic stems from African American writers writing about themselves "from a point of view that takes black life seriously, that views it in scale, with human dimensions" (380). In writing "Big Black Good Man," Wright applies a postmodern spin to the black aesthetic by demonstrating Olaf's lack of awareness about the black condition and by showing Olaf's own insecurities.

In presenting Olaf's insecurities, Wright invites a psychoanalytical reading of his work. Sigmund Freud's theory of projection, defined by Eagleton as "ascribing to others . . . feelings and wishes which are actually our own" (159), can be applied to the animosity Olaf feels towards a complete stranger (the big black good man) who simply wants a room for a few nights. The confrontation between the two is unprovoked, yet Olaf 's mental anguish nearly pushes him to murder the big black man. And the mentality with which both male characters, and even Wright himself, approach the female characters invites a feminist reading.

"Big Black Good Man" was written by a male with the main characters being male and, in this patriarchal setting, the female characters tend to have either a hostile voice or no voice. "This pattern," Priscilla L. Walton contends, "reflects the position of women within patriarchy wherein they are 'objectified,' or turned into objects whose purpose is to support the male subject[s]" (255). Objectification of the female characters is consistent throughout Wright's work and, with the advent of feminist criticism such as Walton's, his work is frequently attacked as a result of this trait.

This paper addresses the issues raised above in three interwoven parts, beginning with the idea of a black aesthetic present in Wright's story. Miller thinks of aesthetics as *"a way of viewing and sensing and the results of what is viewed and sensed"* (374). In these terms, aesthetics can apply to anyone, including Olaf. Wright gives the reader insight into Olaf's view of *his* own world early in the story:

> Through the open window Olaf Jensen could smell the sea and hear the occasional foghorn of a freighter; outside, rain pelted down . . . drumming softly upon the pavements of Copenhagen . . . [he] said half aloud . . . "I'll be sixty tomorrow. I'm not rich, but I'm not poor either . . . Got good health. Traveled all over the world and had my share of

> the girls when I was young . . . I own my home. Got no debts. And I love digging in my garden." (721)

Olaf, at sixty, tries to convince himself that he is not a failure. He makes further references in the passage to money by stating "money ain't everything" and laments the fact that he and his wife never had children. "Karen and I," he says, "could of had some children, though. Would of been good company" (721-22). His viewpoint can be labeled as his aesthetic because he sees the world around him through this ideology, peculiar to himself. It is precisely this blindness to other viewpoints that causes him to react negatively to the presence of the big black good man.

When Olaf is first confronted by the black man, a sailor in search of a room, he is stunned. Olaf stares "at the huge black thing that filled the doorway. . . . [it was] the biggest, strangest, and blackest man he'd ever seen in all his life" (723). He notices that the "ebony giant is well dressed . . . and [wears] black shoes that [gleam]" (724). Olaf realizes quickly that he is dealing with a successful black man—the binary opposite of Olaf's situation—and quickly judges the black man to be trouble. The problem with Olaf is that he is a "victim of . . . limited vision; that is, [he] lacks the psychological insight or the ability to fathom reality, except from [his] own narrow perspective" (Taylor 44). Instead of being aware of the big black man as having perspectives or aesthetics of his own, Olaf simply sees him as an object, albeit a threatening one.

Two of the binary opposites found in "Big Black Good Man"—rich/poor and white/black— are common in many works of literature, including Morrison's *Beloved* and Wright's *Native Son*. What is interesting about Wright's presentation of the binary opposites in this story is that the normal relationship between the pairs has been inverted. In stereotypical Western society, it is safe to say that rich/white are almost always aligned, as are poor/black. However, Wright reverses the normal order by depicting the black man as financially solvent and the white clerk Olaf as poor. This reversal lends strength to the role of the black man and, since it is not the norm, increases Olaf's discomfort in the situation.

The reasons for Olaf's perceiving the black man as a threat are perhaps best understood using psychoanalytic methods. In the opening paragraphs, Wright presents Olaf as satisfied (although it seems as if Olaf must convince himself of it) until he is confronted by something he is not and will never be—successful. At the age of sixty, Olaf's life is winding down. He has a wife, a garden, a house, no debts, and a dead-end job. His life would be considered a success by some standards but not nearly as glamorous and successful as the life of the well-to-do sailor wanting a room. Olaf, already struggling *not* to feel inadequate, lacks enough confidence in himself and his present situation to avoid feeling inferior to the big black man. Wright writes:

> There was something about the man's intense blackness and ungainly bigness that frightened and insulted Olaf; he felt as though this man had come here expressly to remind him how puny, how tiny, and how weak and how white he was. Olaf knew, while registering his reactions, that he was being irrational and foolish; yet, for the first time in his life, he was emotionally determined to refuse a man solely on the basis of the man's size and color. (724)

This reaction of Olaf's relates directly to Sigmund Freud's theory of repression, which contends that "much of what lies in the unconscious mind has been put there by consciousness, which acts as a censor, driving underground unconscious or conscious thoughts or instincts that it deems unacceptable" (Murfin 208). The big black man represents everything that Olaf wants, like monetary wealth, but could not achieve. He gives Olaf "two thousand six hundred" dollars to hold so the black man can "get drunk"(725). Also, the black man gets "a bottle of whiskey and a woman," which Olaf, "wild with anger and insult," supplies (726). As a clerk, Olaf frequently attends to requests for women, yet it bothers him to cater to this black man's desires. It is apparent that Olaf struggles with the perception that the black man has power over him, the reverse of which Olaf has never enjoyed.

Wright portrays whites as assuming all African Americans are evil in their blackness, even before any meaningful contact is made and even if the whites do not *think* of themselves as racist. A typical example would be the revulsion Olaf experiences when he makes the observation that "this particular black man . . . didn't seem human. Too big, too black, too loud, too direct, and probably too violent to boot" (724). However, another reading can just as easily be made if one considers Freud's hypothesis that "all of us have repressed wishes and fears; we all have dreams in which repressed feelings and memories emerge disguised" (Murfin 209). This reading can be viewed as a manifestation of Wright's subconscious in the form of the big black good man as a representation of African Americans—especially after the persecution experienced by them at the hands of slave traders—gaining power over whites. Freud states that "the creative writer does the same as a child at play. He creates a world of phantasy [sic] which he takes very seriously—that is, which he invests with large amounts of emotion—while separating it sharply from reality" (421). The racism prevalent during Wright's career undoubtedly affected his work and could have easily led to latent desires for power. The big black man, it can be construed, demonstrates consistently his power over Olaf. For example, when Olaf reaches for the black man's suitcase to carry it to his room, the big black man says, "That's too heavy for you, big boy; I'll take it" (726). Later in the story, Wright writes of Olaf reflecting on the big black man:

> . . . he could not shake off a primitive hate for that black mountain of energy, of muscle, of bone; he envied the easy manner in which it moved with such a creeping and powerful motion; he winced at the booming and commanding voice that came to him when the little tiny eyes were not even looking at him; he shivered at the sight of those vast and clawlike hands that seemed always to hint of death. (728)

Not only does the big black man represent everything that Olaf desires; he has complete control over Olaf as well. Through the use of such terms as "envied," "powerful," and "commanding," Wright shows Olaf to be helpless in the presence of the black giant. The most important manifestation is Wright's use of the concept of death created in Olaf's mind. There is nothing more powerful than the ability to give life or to take life; and, although this perception appears to be strictly a construct of Olaf's unstable mentality, it can just as easily be seen as Wright's own wish or dream covertly making its presence felt.

Freud suggests, in his theories concerning the conscious and unconscious mind, that "the powers motivating men and women are *mainly* and *normally* unconscious" (Murfin 208). Armed with this hypothesis of Freud's, one can easily recognize that Wright might not have been aware of this urge to reverse the power structure between African Americans and whites when writing "Big Black Good Man." Furthermore, one cannot blame Wright for subconsciously desiring this reversal. But to further neglect the inferiority complex that is Olaf's true liability would diminish the overall impact of the work.

The inferiority complex is apparent in Olaf's wish for the black man's destruction after he checks out of the hotel. In fact, the wish becomes an obsession, especially in light of the embarrassing incident in which a terrified Olaf, thinking the black man is about to strangle him, wets his pants as the big black man measures Olaf's neck with his hands for his shirt size (730-31). Later that night, Olaf

> lay awake . . . dreaming of revenge. . . . The ship would sink slowly to the bottom of the cold, black, silent depths of the sea and a shark, a *white* one, would glide aimlessly about the shut portholes until it found an open one and it would slither inside and nose about until it found that swollen, rotting, stinking carcass of the black beast and it would begin to nibble at the decomposing mass of tarlike flesh, eating the bones clean. . . . Olaf always pictured the giant's bones as being jet black and shining. (732)

The fantasy, for Olaf, "lived persistently on . . . and when Olaf found himself alone, it would crowd and cloud his mind to the exclusion of all else" (732-33). This passage is key to understanding Olaf's psychological blueprint. Freud was "interested in writers . . . who relied heavily on symbols. Such writers regularly cloak or mystify ideas in figures that make sense only when interpreted, much as the unconscious mind of a neurotic disguises secret thoughts" (Murfin 210). Wright's symbolism is intense and detailed, even down to Olaf's perception that the giant's bones were black. The big black man has become the personification of all that Olaf dislikes about himself and Olaf projects these distasteful traits onto him. Olaf sees the big black man as violent, yet only Olaf entertains violent thoughts; Olaf sees him as a killer, yet only Olaf feels a need to pull a gun on the big black man when he gives Olaf some shirts. After all, when Olaf first encountered the big black man, he was simply a man. Olaf actively bestowed the negative characteristics on him.

Recognition of his narrow-minded and foolish actions comes to Olaf at the end of the story when he realizes the big black man is not planning to kill him. Olaf begins living a nightmare when the big black man walks through the door of the hotel after an absence of more than a year. When the big black man reaches into a bag, Olaf reaches for his gun, determined to have his revenge. However, he is shocked to find that the big black man wants to give Olaf six shirts, one for each night he spent with the prostitute, Lena. Olaf finally comes to the realization that there is a "compassion" in the big black man's "stare that he had never seen before" (735). Olaf becomes aware of the big black man as a person for the first time and ceases to project his own inadequacies on the black man.

While the power struggle between Olaf and the big black good man is resolved by the end of the story, the women in this story are continuously objectified and, with the possible exception of Lena, stand no chance of ever gaining a voice. Wright objectifies the three female characters in the following passage in which Olaf ponders his fear and the availability of someone to discuss it with:

> Olaf kept his counsel. He never spoke to Karen about the sordid doings at the hotel. Such things were not for women like Karen. He knew instinctively that Karen would have been amazed had he told her that he was worried sick about a nigger and a blonde whore. . . . No; he couldn't talk to anybody about it, not even the hard-bitten old bitch who owned the hotel. She was concerned only about money; she didn't give a damn about how big and how black a client was as long as he paid his room rent. (728)

In this passage, Karen is seen by Olaf as someone not to share problems with although she is his wife—theoretically, his partner and confidant. Yet, she is portrayed as one-dimensional, lacking intelligence enough to be told of events affecting Olaf's life. Lena is referred to only as a "blonde whore." Finally, Olaf says the owner of the hotel (his boss) is simply an "old bitch." In presenting his female characters in this fashion, Wright "utilizes the gender power imbalance by taking it upon himself to represent femininity, at the same time that he distances himself from femininity through his masculine signature" (Walton 254).

Lena's lack of status at the beginning of the story contrasts heavily with her importance to the big black good man at the end of the story. The big black man receives a bottle of whiskey and Lena on the first night he spends at the hotel. And when he calls for her the next night, it sounds as if he is ordering groceries: "'I want that Lena again tonight. And another bottle of whiskey'" (729).

Olaf says to the big black man at the end of the story (after realizing he isn't going to be killed), "'You want Lena, don't you? . . . But I don't know where she is. She never came back after you left—.'" The big black man replies, "'I know where Lena is. . . . we been writing to each other. I'm going to her house'" (735). Ironically, Wright uses a member of the oppressed race to raise the standing of a member of the oppressed gender by allowing the big black good man to end Lena's need to work as a prostitute to support her four children. Yet, Lena is still denied a voice because, as Walton explains, "any indication of desire on her part signals her attempt to perform as a subject of discourse, and this is a position that the patriarchal order cannot afford her, for it requires her objectification in order to affirm the subjectivity of the male" (256). In other words, Lena is present *only* in the conversation between Olaf and the big black good man.

Although the majority of Wright's characters in "Big Black Good Man" are white, there is still a black aesthetic present in his work, though it is largely unseen. Wright set his story in Denmark in order to allow the big black man the luxury of confidence and to accommodate his boldness. If Wright had set the story in the United States, the character might have had the characteristics of Bigger in *Native Son*. Due to the racial conflicts pervading the United States during Wright's lifetime, he was aware of the need to figuratively leave the country in order to create a successful African American character. The presence of mind that allowed Wright this insight can only come from views peculiar to African Americans, hence, the black aesthetic.

"Literature," according to Addison Gayle, Jr., "and Black literature in particular, should afford revelation and insight into truth when created under conditions favorable to free, honest expression" (526). Richard Wright achieves both revelation and insight into truth in "Big Black Good Man." Through the use of African American criticism, psychoanalytical criticism, and feminist criticism (as well as smatterings of poststructuralism and Marxist criticism), there are a plethora of lessons to be learned from Wright's short story. The presence of a confident African American figure on foreign soil and the resultant psychological struggles of Olaf are two of the more fascinating facets. This short story also gives valuable insights into the female characters as objects rather than subjects having a voice.

The truly liberating part of researching this work through the use of poststructuralist criticism is discovering how completely interwoven the various critical approaches are. Wright, in a masterful, complex, and layered short story, raises many postmodern questions common to current literature. Like Sethe in Morrison's *Beloved* reaching answers about her own self-worth after killing her child, Olaf even begins to get answers by the end of the story, especially concerning the goodness of the person Olaf now labels as the "big black *good* man."

Works Cited

Eagleton, Terry. *Literary Theory: An Introduction.* Minneapolis: U of Minnesota P, 1983.

Freud, Sigmund. "Creative Writers and Day-Dreaming." *Criticism: Major Statements.* 3rd ed. Ed. Charles Kaplan and William Anderson. New York: St. Martin's, 1991. 419-28.

Gayle, Addison Jr. "The Son of My Father." *New Black Voices.* Ed. Abraham Chapman. New York: Penguin, 1972. 525-37.

Miller, Adam David. "Some Observations on a Black Aesthetic." *The Black Aesthetic.* Ed. Addison Gayle. Garden City, New York: Anchor, 1971. 374-80.

Morrison, Toni. *Playing in the Dark: Whiteness and the Literary Imagination.* New York: Vintage, 1992.

Murfin, Ross C. "What is Psychoanalytic Criticism?" *Case Studies in Contemporary Literature: The Turn of the Screw.* Ed. Peter G. Beidler. Boston: Bedford, 1995. 207-18.

Taylor, Willene P. "The Blindness Motif in Richard Wright's *Native Son.*" *CLA Journal* 34 (Sept. 1990): 44-58.

Walton, Priscilla L. "'What then on earth was I?': Feminine Subjectivity and *The Turn of the Screw.*" *Case Studies in Contemporary Literature: The Turn of the Screw.* Ed. Peter G. Beidler. Boston: Bedford, 1995. 253-57.

Wright, Richard. "Big Black Good Man." *Richard Wright Reader.* Ed. Ellen Wright and Michel Fabre. New York: Harper, 1978. 720-36.

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WILLIAM SHAKESPEARE'S
OTHELLO: THE MOOR OF VENICE
A CASE STUDY IN THE THERMODYNAMICS OF EVIL

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ABSTRACT

WILLIAM SHAKESPEARE'S OTHELLO: THE MOOR OF VENICE - A CASE STUDY IN THE THERMODYNAMICS OF EVIL APPLYING DYNAMIC TENSION: A QUANTIFIED, ANALYTIC THEORY OF EVALUATION. Roger A. Harris (Dr. Linda K. Barlow), Department of English, Fayetteville State University, 1200 Murchison Road, Fayetteville, NC 28301

This essay applies the principle laws of thermodynamics as filters in determining the nature, progression, and final state of Evil present in William Shakespeare's romantic tragedy Othello, the Moor of Venice. Further, through the application of the theorem entitled Dynamic Tension, it introduces a means of quantifying the analysis of literature by graphically revealing the dynamic structural devices a writer (Shakespeare) must employ when creating thematic movement within a work. Dynamic Tension's application allows an audience to "see" the key aspects of a pres4enter's analysis of a particular literary work (Othello, The Moor of Venice).

This essay's synthesis of knowledge from the fields of science, literature, and mathematics (Economics) reflects the growing importance and legitimate practical application of, as well as the relevant inter-connections to be realized, when cross-discipline research is encouraged, attempted, and successfully accomplished.

Shakespeare's romantic tragedy, Othello: The Moor of Venice, is one of the most striking works on the subject of Evil in all of literature. While many analysts have chosen to focus on the various sub-themes in the work (jealousy, hate, envy, misogyny, racism, bigotry) and the various sub-plots used to illuminate their dark and sinister relationships, it is yet the overwhelming imbued presence of evil that binds their wicked intent and raises their dark and unified effect into a singular, horrific oneness; an evil expressed throughout the breath of the play that becomes its ultimate, lone, screaming voice unto the plays horrific end. Indeed, a close reading of the work leaves the scholar questioning (1) the true source of Iago's deeply evil hatred of and for Othello and (2) how a man of Othello's intelligence and experience could be so easily duped by Iago's contrived and pretentious schemes. And although the play offers some textual explanations that hint at a suggested reasoning for the evil that overwhelms the work, one falls short in trying to access the true level, degree, and intensity of that same evil which overrides all other thematic attributes concerning Othello.

However, when first viewed as a form of energy and then filtered through the laws of thermodynamics, the contagious evil that so cancerously infects the play is not only more easily explained, but also a deeper appreciation of Shakespeare's knowledge of the cosmic force and affect of Good and Evil is likewise gained and understood. And, when contrasted to Salvation, Othellos unveiled, dominantly negative, yet universal and spiritual theme reveals that just as a sinner can be overtaken and redeemed through righteousness and Faith, so too can righteousness and Faith be overwhelmed, possessed, and even destroyed by an all-forsaking evil. The overpowering presence and nature of evil within Othello therefore will be filtered through the laws of thermodynamics to not only explain the play's thematic "gaps," but also to gain a more keen insight of and for its reason, purpose, and application within the work.

One can textually identify and define at least four limited motivations of and for Iago's contemptuous hatred and evil as (1) his pedestaled jealousy at Cassio's appointment to lieutenant (1.1.8-34); (2) his deluded belief that Othello was having an affair with his wife (1.3.387-391); (3) his secretly hidden love for Desdemona (2.1.292-294); and (4) his stilted love affair with Cassio (3.3.426-440). Yet, even if these explications are accepted, either singularly or combined, they still can not and do not explain Iago's raging evil. Indeed, the renowned poet, scholar, and philosopher Samuel Taylor Coleridge stated that detecting the source of Iago's evil amounted to "the motive hunting of a motiveless malignity." Here, Coleridge is very simply yet very specifically speaking to a cosmic presence as the source for Othellos evil as opposed to the grounded explanations offered above. Shakespeare, in seeming agreement with Coldridge's cosmic assertion, textually reveals as much when he states through Iago that "I am not what I am (1.1.67)" and again in act five with Iago's response to Othello's claim that when stabbed, if he (Iago) dies he is a man but that if he lives, that he be a devil: Iago responds "I bleed, sir, but not killed (5.2.296)." The evil force that infects Iago and corrupts Othello as a whole is thus revealed as a principality of and with a cosmic source: the Devil (5.2.308-311). Indeed, the words "devil" and "hell" are used jointly not fewer than thirty times throughout the breadth of Othello, obviously a very dominant (and one would think purposeful) structural application and thematic characteristic designed to create and enhance the work's dark mood and sobering effect; an ingenious and masterfully applied Shakespearean foil that forces Othellos audience to both confront and contend with the evil nature of Man while also recognizing and comprehending the very Cosmic nature of Evil itself.

When viewed in this Cosmic sense and accepted on this Cosmic level, the connotative essence and presence of Evil/Devil/Hell as applied to Othello then become merely grounded societal reference points of and for a type or degree of negative cosmic energy, just as Goodness/God/Heaven likewise become grounded societal reference points of and for the same such type or degree of positive cosmic energy. By extension, these societal labels of Good and Evil can further be viewed scientifically as, and represent, ordered forms of energy that indicate the source of evil in Othell, explain its thematic gaps, and also mark the entry point at which the play is conjoined with and filtered through the first law of thermodynamics. This law states that Energy can neither be created nor destroyed, only transformed. Further, that ordered energy is useful, whereas disordered energy cannot be harnessed to do work. Applying this theory explains the plays first thematic gap: both how and why Iago was transformed into a raging beast--he was possessed by the harnessed negative, Cosmic energy of evil. His hate was amplified by both degree and circumstance because he yielded himself, through his own hate, unto the negative universal presence and force of evil within Nature.

Indeed, everyone in the play that died was afflicted by an infectious, grounded, negative energy that became amplified by the corrosive nature of negative evil: Brabantio's (Desdemona's father) racism (5.2.211-216); Roderigo's (Iago's rogue) lust of and for Desdemona (4.2. 193-198); Emilia's (Iago's wife and Desdemona's maid) traitorous deception of Desdemona (3.3.317-336); and Othello's self-doubt (3.3.211-221) and raging jealousy. Only the honest and chaste Desdemona dies guiltless among the sinning (5.2.126); she is an innocent victim, no less, of the power and force of a negative energy that was so powerfully transformed and boosted (both in proportion and degree) by the negative people surrounding her that her complete, whole and true innocence was literally consumed alive by their incarnate evil; a presence whose Cosmic force was transferred from the Devil, through Iago and Othello, then unto Desdemona herself, thus destroying her "Good Innocence."

The two combatively dominant themes present in Othello are evil as represented by Iago (1.1.7-9) and good as represented by Othello (1.1.17-28, 31-32). Of these two themes (or energies), evil would be considered the "hotter" of the two, both because it was presented to the reader first (through Iago: 1.1) and also because it sustained its perverse dominance throughout the breath of the work.

Also, good Othello weakened his righteous state when he indignantly eloped with Desdemona (1.3.78-81) instead of first asking her father for her hand in marriage (as was custom). A man at that time in good standing with both Brabantio (1.3.129-147) and the Duke (1.3.51-52, 173-177), Othello stood well to benefit by following protocol. By abandoning his noble character and eloping with Desdemona, he tainted and weakened his righteousness (positive energy), thus tempering his being for the onslaught of Iago's Evil fury.

Realizing this factor is key to explaining the plays second thematic gap (Othello's blazing descent from righteousness) and also in understanding its connection to and with the second law of thermodynamics.

This law states that a highly ordered system (Iago's hotter, dominant, negative energy) will tend to slide spontaneously toward and overtake a less ordered system (Othello's cooler and now submissive, positive energy) until equilibrium (a balanced and total dominance) is achieved. Applying this law helps one to understand how an otherwise experienced, righteous, and forthright Othello could so easily succumb to Iago's rather contrived innuendoes and simplistic accusations. Simply, it is a heated Cosmic negative energy (dominant evil in the form of Iago) that, being brought into thermal contact with Othello's tainted and weakened righteousness, rapidly overwhelms and possesses Othello; that rapidly proceeds to negatively balance these now disordered systems; that rapidly reduces Othello's righteousness to a state of uniform temperature as the negative energy flows from the hotter system (Iago's Evil) to the colder system (Othello's righteousness).

Indeed, it would seem that Othello's deep and abiding love for Desdemona would have provided the one absolute defense against the evil that so easily possessed Othello and drove him to murder the innocent Desdemona. Even attempts to explain his descent into this swampy evil based on his self-loathing are strictly inadequate when contrasted with his obvious success as a general and his generally held standing as a man of virtue (1.3.290-293). And even if one concedes this weak textual support as a causal point of departure for Othello's slipping into darkness, it still falls far short of the mark when factoring the time between his self-doubt and his possession. He released his self-pride, self-worth, and fell head-long into his self-doubt and self-contempt not in a matter of months, weeks, or days, but rather in a matter of hours. This temporal contrast seems to contradict Othello's noble character and nature established earlier within the play and thus bares and warrants a deeper observation and scrutiny from which to explain the cause of his later deterioration. The second law of thermodynamics (equilibrium) satisfies this need.

> The approach to equilibrium is therefore an irreversible process. The tendency toward equilibrium is so fundamental to physics [and Othello] that the second law is probably the most universal regulator of natural activity known to science (Britannica, p.702b).

There is, in fact, an often overlooked factor within Othello that supports the above quotation: it is, very simply, that even as Iago is the vehicle through which this Cosmic evil is transported, delivered, and distributed, he is yet the only major character within the work that survives its horrific wrath. To this point and in this sense it can be stated then, both in circumstance and effect, that equilibrium has been attained (literally in the form of Iago's lone survival, and specifically with respect to the play's transition from a countered evil in its beginning unto that same evil's amplified dominance and prevailing, overwhelming totality of sound and sense at the play's end).

The renowned Shakespearean critic David Bevington would have one to believe that

> Othello's reaffirmation of faith in Desdemona's goodness undoes what the devil-like Iago has most hoped to achieve: the separation of Othello from his loving trust in one who is good (Bevington, p. 1121).

This "reaffirmation of faith" matters not because Othello murdered Desdemona. Indeed, penance after the fact of sin is sometimes a greater crime than the sin itself. Further, Bevington offers the thought to the reader that "She [Desdemona] is the sacrificial victim who must die for Othello's loss of faith and by dying, rekindle that faith (Bevington, p. 1121)." What does Othello's "rekindled faith" matter when he kills himself also? Neither murder nor suicide is heroic, especially at the suggestedly narcissistic expense of self-knowledge or self-growth.

Bevington's assertions neatly underscore and introduce the third theory (In this case, not a law!) of thermodynamics, called entropy. Entropy is simply the constant movement of a system (e.g., this play) from a state of order to a graduated state of disorder. Having achieved this state, the system is said to be in equilibrium. Within Othello, the play's entropic progression from order to disorder may then be viewed as an example of the general tendency of chaotic disruptions (Evil) to disturb organization (the play) and structure (Othello). Any system that is subject to random agitation will eventually attain its most disordered condition, thus the haunted ending to this play.

With *Othello*, Shakespeare has done far more than simply, beautifully, and exquisitely investigate and reveal the human dynamics of jealousy, envy, hate, racism, and evil. He has synthesized their related human, mortal, and base associations into a singular platform used to springboard the unveiled and explained cosmic nature, expression, and dimensions (either Spiritual or thermodynamic) of evil in its most heightened state, ushered forth by the most articulate and accurate voice of his day on the subject; in a manner, of a level, and to a degree that only his vaulted genius would allow.

And in this Cosmic sense (as is offered by *Othello*), on any given day, one energy force, whether Good or Evil, can overwhelm the other and can also overwhelm you. Yet deeper still, I offer that either energy, whether Good or Evil, actually operates cosmically as a universal constant and that we, by our actions and interactions as instruments of conduction, are the only true variable that can ultimately determine (if only to a limited degree) the final degree to which either force will prevail and effect our life, state, time, and place. We need only touch to feel; we need only listen to hear; we need only see to relate.

DYNAMIC TENSION

Dynamic Tension is a theorem that, when applied, allows one to quantify their analysis of a work of literature by providing a two-dimensional representation of their analysis. Its simple, accessible, and strong foundation is based upon the observation that in order to move a readers psychological condition from a mute state to one that will follow the path of a theme presented within a work, that the theme must be counter-positioned against another theme to create movement. The force created by the counter-positioning of these themes is called Dynamic Tension. Thematic movement is determined by the dominance of (or emphasis upon) a particular theme (as with the theme of evil in *Othello*). Once a reader identifies what they feel are the two major themes, they would very simply place one theme on a horizontal axis, the other theme on a vertical axis, and by using their interpretive analysis to determine the points or degrees of measure, and use those points or degrees of measure to plot the thematic progression of the work.

In *Othello*, I have identified Evil (Iago) and Good (Othello) as its two major themes. Placing Good on the horizontal axis and Evil on the vertical axis, I then used the play's 15 scenes as my degree of measure. I have used negative numbers on the vertical axis to indicate and re-inforce my contention that the play ends in a totality of evil. Three major situations have been charted that reflect Dynamic Tension's usefulness. In Act 1, Iago pronounces his hatred of Othello, Othello's righteousness is established, even as Iago reveals its fall with the announcement of Othello's and Desdemona's elopement. In Act 3, when Iago convinces Othello that Desdemona is unfaithful while also obtaining her handkerchief. In Act 4, when Othello misunderstands Cassio's boosts. All circumstances presented within the play are resolved in Act 5.

The beauty of Dynamic Tension is that it is flexible to each reader's analysis. It doesn't force a predetermined outcome, it merely supports and quantifies the analysis that is offered by the reader. It is a very young theory, but also, I feel, both a relevant and revolutionary theory. It will change the way that we discuss, analyze, and present literary analysis, and I humbly request your input, critique, and responses.

REFERENCES

Bevington, David, ed. *The Complete Works of Shakespeare*. Chicago: Harper Collins, 1992.

"Thermodynamics." *Encyclopaedia Britannica: Micropedia*. 1987.

Wilde's Christ: Exemplifying Aesthetic Morality

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Wilde's Christ does not conform to Victorian society, a society obsessed with productivity and order -- a scientifically-ordered society which places emphasis on proven fact (Morris 516). Instead, Christ embodies the rebellious aesthetic values which Wilde himself represents. Christ becomes a manifestation of beauty. He is given the status of both artist and artwork. He becomes a voice crying against "the blind mechanical forces of society."

Thus, Wilde adopts Christ, the very basis of Victorian religious morality, and transforms him into an activist against Victorian belief. Wilde displays his own ability as an artist, a creator of beautiful things, by translating Christ into an advocate of his own rebellion, an example of aestheticism.

In "The Critic as Artist" Wilde explains his belief that aesthetics are "higher than ethics" belonging to "a more spiritual sphere." He indicates the belief that beauty is truth and is resultantly the highest goal of all art and life. "They are the elect to whom beautiful things mean only Beauty," he wrote in the Preface to *The Picture of Dorian Gray* (Abrams 1627). Good and bad must be determined by their relationship to beauty.

Ethics, Wilde writes, have nothing to do with art. They are totally separate (Morley 73). But if the traditional determinants of morality are no longer acceptable, then something needs to replace the accepted moral structure, to transcend it as a higher good. This is where beauty manifests itself. Wilde envisions beauty not as the constraining, systematized ethics of old, but as a liberated vision in which beauty is the goal which defines the good, and the bad serves as everything which corrupts beauty. No standard of beauty can be given. The understanding of beauty is, like faith, something that cannot be learned from another person.

Aestheticism has often been referred to as the "Cult of Beauty" (Freedman 7). But it is a cult in which each of its adherents must find his or her own vision of beauty; there is no standardized vision. To standardize the vision would be to rigidify it, to halt imagination. To dogmatize or systematize beauty would simply transform it into an ironic mimicry of the reigning Victorian system -- the system which jailed Wilde because he did not conform to its standards.

The search for beauty allows one to transcend human limits. In creating and viewing art that is not harnessed in reality and systemization, humanity can overcome the imperfections of nature and the world. Wilde envisions a beauty that allows one to step out of the confinement of systems and science, away from earthly limits, traditional ideas of truth, and the tedium of everyday frivolity. To abolish the limits of truth, Wilde presents art as a lie, because art does not have a single meaning but is indefinite and infinitely suggestive. He writes, "No artist desires to prove anything. Even things that are true can be proved" (Abrams 1627). Since art is unconstrained by truth, it should also be unaffected by traditional ethics and morality.

Wilde asserts that life is failure from an artistic point of view. Nature and life are full of ugliness and imperfections, but Wilde insists that "art imposes form on the chaos of life and miraculously turns its raw material into things eternally beautiful" (Longxi 160). From this belief in art's ability to right all wrongs, he carried this artistic search beyond his critical theory and literary works into all aspects of his life. In the conclusion of *The Renaissance*, Pater seemed to advocate a hedonistic lifestyle: "Not the fruit of experience, but experience itself is the end" (Abrams 1533). The young Oscar Wilde declared *The Renaissance* to be "the golden book of spirit and sense, the holy writ of beauty" (Kimball 16). His search for sensation and beauty in the form of hedonism later became synonymous with Decadence and scandal.

Since no standard values of right or wrong exist within the aesthetics' solipsistic vision of ethics, the search for beauty can take many different directions. Nasaar writes about the dangers of this undirected search for beauty:

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> Art that delves into the dark caverns of the soul and fully explores and celebrates the evil within can remain beautiful, but a way of life that seeks fully to translate inner evil into action will finally cease to be beautiful and become an inescapable nightmare. (Nasaar 72)

Thus, Nasaar's words imply that heedless search for sensation can result in decadence, corrupted beauty.

As a result of Wilde's flaunted "decadent" rebellion against the norm, many of his contemporaries did not take his work seriously. W.H. Auden's characterization of Wilde as "a phony prophet but serious playboy" adequately expresses the prevailing perception into the beginning of the twentieth century (San Juan 4). But Wilde's decadence should not be perceived as the defining characteristic of his morality -- for he eventually realized that the search for sensation must be moderated so that beauty prevails. In *De Profundis*, the letter written in 1897, during the time that he was jailed for sodomy, Wilde openly rejected his slip into a decadent lifestyle yet still asserted the primacy of beauty (Hart-Davis 423). Wilde writes, "I blame myself for allowing an unintellectual friendship, a friendship whose primary aim was not the creation and contemplation of beautiful things, to entirely dominate my life" (Hart-Davis 425).

Within *De Profundis* Wilde expresses his belief in beauty as the highest good and proposes Christ as a revelation of beauty. Quintus writes that *De Profundis* contains Wilde's fullest treatment of Christ and of Wilde's religious ideas (524). In this letter he depicts Christ as a paradigmatic aesthete. De Profundis, meaning "from the depths," is not the name that Wilde gave to his letter written from prison. He entitled the letter *Epistola: In Carcere et Vinculis*, which translated is Epistle: Imprisoned and in Chains. The title that Wilde gives his letter "recalls St. Paul's letters to the Colossians and the Philippians, from prison and in chains, and written for the education of new Christians in their faith" (Andersen 1). Thus, Wilde frames his letter as an epistle of aestheticism and himself as the suffering apostle spreading the "Gospel of Beauty."

Wilde's association of himself with Christ serves several possible purposes. First, it alleviates him of any guilt that he might hold about rejecting religion and belief in God. By incorporating traditional religious figures into his own ethics he is able to overcome any guilt that might have been caused by his abandonment of belief and morality:

> Given Wilde's love of artifice and his homosexuality, a sense of guilt or remorse seems inescapable within a Victorian context, unless Wilde could reject Christianity and embrace atheism or any religious position that countenanced his behavior and freed him of religious scruples regarding his mode of life. (Quintus 514)

By embracing Christ as an aesthete, Wilde can comfortably reject traditional Christianity without guilt.

More importantly, by depicting Christ in an unorthodox manner, by portraying Christ as a proponent of his radical ethics, Wilde is able to undermine Victorian ideas of morality and assert the supremacy of his own. He displays Christ as an artist, a work of art, and a prophet against systems -- a man embodying his own aesthetic beliefs.

Wilde clearly establishes Christ's identity as an artist in *De Profundis*. He asserts that Christ is "the true precursor of the romantic movement in life" (Hart-Davis 476). He is not concerned with Christ as a religious figure but as an aesthete. Indeed, Wilde proceeds to credit Christ with all of the qualities that are necessary in his conception of an artist:

> The very basis of his nature was the same as that of the nature of the artist, an intense and flame-like imagination. He realized in the entire sphere of human relations that imaginative sympathy which in the sphere of Art is the sole secret of creation. He understood the leprosy of the leper, the darkness of the blind, the fierce misery of those who live for pleasure, the strange poverty of the rich. (Hart-Davis 476)

By possessing an active imagination, Christ has the requisite ability of the artist to both judge and create beauty.

The Preface to Wilde's novel *The Picture of Dorian Gray* begins, "The artist is the creator of beautiful things" (Abrams 1627). Thus, the creation of beauty, not truth or a recognized moral value, is immediately established to be the primary purpose of art. Wilde's Christ is manifested as an artist because he reveals beauty in sorrow and even in sin, where most people are unable to perceive it. Wilde writes, "He regarded sin and suffering as being in themselves beautiful, holy things, and modes of perfection. It sounds a very dangerous idea. It is so. All great ideas are dangerous. That it was Christ's creed admits of no doubt. That it is the true creed I don't doubt myself" (Hart-Davis 487).

Wilde explains that the teachings of Christ the artist, which have often been interpreted into moral doctrines by orthodox Christianity, were merely suggestions that would allow people to possess more beauty in life; they had no moral purpose:

> When he says "Forgive your enemies," it is not for the sake of the enemy but for one's own sake that he says so, and because Love is more beautiful than hate. In his entreaty to the young man whom when he looked on he loved, "Sell all that thou hast and give it to the poor," it is not of the state of the poor that he is thinking but of the soul of the young man, the lovely soul that wealth was marring. (Hart-Davis 480)

Christ has the ability to use his imagination to recognize beauty, and thus find 'truth,' in places that many other people are unable to discover it, in places where the Victorians would never admit that beauty could possibly exist.

Christ also adheres to a solipsistic vision of beauty. Wilde points out the ability of Christ to create his own vision: "The strange figures of poetic drama and ballad are made by the imagination of others, but out of his own imagination entirely did Jesus of Nazareth create himself" (Hart-Davis 482). Wilde's Christ is a man of intense imagination who creates his "own dream of a world."

Christ's kinship with the aesthetic artist establishes him as an ally of Wilde's rebellious morality. His actions, his idea of good and truth, his very morality is determined by his pursuit of a personal vision of beauty. Ellman sums up in his biography of Wilde, "Christ is a precursor of the romantic movement, a supreme artist, a master of paradox, a type of Wilde in the ancient world" (515).

It is very important to remember that this affinity that Christ has to Wilde, Christ's profession as artist, is not a fact that immediately manifests itself in the Gospels. The Victorians certainly would not have maintained that the Christ they worshipped shared Wilde's aestheticism. So Wilde's act of portraying Christ as an aesthete and artist is the result of Wilde himself performing the function of artist and making Christ into an artwork that can then undergo transformation.

This perception of Christ as surface and symbol, a work of art, is central to Wilde's presentation of Christ as an example of aestheticism. For portraying Christ as an an artwork enables Wilde to perform the creative act of the critic. In his essay "The Critic as Artist," he writes that criticism "treats the work of art simply as a starting point for a new creation" (Abrams 1625). He further writes, "His [the critic's] sole aim is to chronicle his own impressions" (Abrams 1624). It is by first treating Christ as a work of art that Wilde can then use his imaginative observation process to reveal Christ as a new creation. Using the same materials that produced traditional ideas of Christ, he produces a Christ who manifests Wilde's own values.

In the Preface to *The Picture of Dorian Gray*, Wilde writes, "All art is at once surface and symbol" (Abrams 1627). Christ's transformation into art causes him to become the surface and symbol that can then become an image to reveal beauty. Wilde insists that Christ brings out the beauty in everyone, whether or not one has faith in him, for merely by coming in contact with him people find that the ugliness of their sins disappears and the beauty of their sorrow is revealed -- for Christ became the ultimate symbol of beauty (Hart-Davis 481). It is only as a symbol that he is able to transcend the mere human image. Wilde writes of Christ:

> And feeling, with the artistic nature of one to whom Sorrow and Suffering were modes through which he could realize his conception of the Beautiful, that an idea is of no value till it become incarnate and is made an image, he makes of himself the image of the Man of Sorrows, and as such has fascinated and dominated Art as no Greek god ever succeeded in doing. (Hart-Davis 48)

Christ becomes a concrete manifestation of the beauty for which Wilde searches. And since Christ can be perceived as an image, he is accessible. "He is just like a work of art himself. He does not really teach one anything, but by being brought into his presence one becomes something," Wilde writes (Hart-Davis 487). Christ's appeal as an artwork aids in a demonstration of the supremacy of beauty.

In addition to Christ's role as artist and artwork, Wilde contributes to Christ's aesthetic completeness by attributing Christ with the role of prophet against social system. Wilde's Christ shares the aesthetic disgust with the dogma and system of society. He is not content with society's lack of energy and imagination but attempts to catalyze humanity into an active pursuit of beauty. Christ does not accept the laws of society which restrain the full expression of his energies. Wilde writes:

> Christ had no patience with the dull lifeless mechanical systems that treat people as if they were things, and so treat everybody alike: as if anybody, or anything for that matter, was like aught else in the world. For him there were no laws: there were exceptions merely. (Hart-Davis 485)

Because Wilde's Christ does not believe in the restraining boundaries of traditional morality or adherence to the laws, he does not condemn the sinner. "Christ, through some divine instinct in him, seems to have always loved the sinner as being the nearest possible approach to the perfection of man," Wilde explains, "To turn an interesting thief into a tedious honest man was not his aim" (Hart-Davis 486).

Wilde explains that the essence of "things" lies in what we make of them. "Where others see but the Dawn coming over the hill," he quotes Blake, "I see the sons of God shouting for joy" (Hart-Davis 511). Wilde certainly shared Blake's ability to perceive things according to his desires; his presentation of Christ as the imaginative artist, artwork, and prophet who cries out against the restraints of society culminates in the image of a Christ who is a paradigmatic representative of aestheticism. Wilde perceives and transforms Christ into a superior example of the aesthetic life and a precursor of his own rebellion. The statement that Wilde makes about Christ's imaginative abilities could aptly be applied to Wilde himself. Wilde writes, "Christ's place is indeed with the poets. His whole conception of Humanity sprang right out of the imagination and can only be realized by it" (Hart-Davis 477).

WORKS CITED

Abrams, M.H. The Norton Anthology of British Literature. Vol 2. New York: W.W. Norton and Company, 1993.

Andersen, M.C. "Document of Division: Oscar Wilde's De Profundis" Unisa English Studies Sep. 1989: 1-11.

Freedman, Jonathon. Professions of Taste: Henry James, British Aestheticism, and Commodity Culture. Stanford, California: Stanford University Press, 1990.

Hart-Davis, Rupert, ed. The Letters of Oscar Wilde. New York: Harcourt, Brace, and World, 1962.

Kimball, Roger. "Art vs. Aesteticism: the Case of Walter Pater." The New Criterion May 1995: 11-18.

Longxi, Zhang. "The Critical Legacy of Oscar Wilde." Critical Essays on Oscar Wilde. NewYork: G.K. Hall and Co, 1991.

Morris, Andrew R. "Wilde and the Eclipse of Darwinism." Studies in History and the Philosophy of Science Oct. 1993: 513-540.

Morley, Sheridan. Oscar Wilde. London: Weidenfeld and Nicolson, 1976.

Nassaar, Christopher S. Into the Demon Universe: A Literary Exploration of Oscar Wilde. London: Yale University Press, 1974.

Quintus, John Allen. "Christ, Christianity, and Oscar Wilde" Texas Studies in Literature and Language Winter 1991: 514-27.

San Juan, Epifanio. The Art of Oscar Wilde. Princeton: Princeton University Press, 1967.

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Pearl's Scarlet Soul: The Influence of Spenser's Una on Hawthorne's Ideal Vision of Daughters

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Many scholars have shown how Edmund Spenser's *The Faerie Queene* influenced Nathaniel Hawthorne's literary works. Evidence of Hawthorne's repeated readings of *The Faerie Queene* indicates that he knew the poem intimately and that it influenced the development of his allegorical writing style. However, Spenser's impact on Hawthorne's personal life has yet to be studied. Biographers agree that Hawthorne's admiration for Spenser led him to name his daughter after Spenser's Una in Book I of *The Faerie Queene*. This paper proposes that Hawthorne's reading of Book I of *The Faerie Queene* helped construct his vision of the ideal daughter. By naming his daughter Una, Hawthorne presupposed that she would embody the childlike qualities of truth, innocence, beauty, and femininity of Spenser's Una. However, as Una Hawthorne grew into a young girl, her appearance, temperament, and behavior more closely resembled Spenser's devilish Duessa, complicating Hawthorne's ability to bond with her. Hawthorne's ambiguous relationship with Una is projected onto his portrayal of Pearl in *The Scarlet Letter*, where he attempts to reconcile his feelings of loss and deception. In Pearl, Hawthorne integrates the allegorical meanings of Spenser's Una and Duessa, thereby achieving an understanding of the duality of his daughter's true human nature.

Unquestionably, Hawthorne read *The Faerie Queene* many times throughout his life. Spenser's poem was the first book Hawthorne purchased as a child with his own money (Martin 3). As an adult, in the late 1830's and early 1840's, Hawthorne boarded in the house of George Stillman Hillard, a close friend and editor of the first American edition of *The Faerie Queene*. In 1839, Hillard published *The Poetical Works of Edmund Spenser*. Consequently, Hawthorne reread *The Faerie Queene* in 1840 as evidenced by his letters to Sophia Peabody (*Letters 1813-1843* 473, 477). In 1842 and 1843, Hawthorne read Spenser aloud to his wife during his first winter at the Old Manse (Lathrop 54). Later, Hawthorne read the poem to his children while residing in England from 1853 through 1857 (*Hawthorne & His Wife* 9). Clearly, Spenser's poem made an uncommonly deep impression on Hawthorne's mind (Stewart 197).

By naming his daughter Una, Hawthorne ascribes to a view of femininity reflected in Book I of *The Faerie Queene*. To appreciate what Spenser's Una meant to Hawthorne, we must see how Hawthorne read Spenser through the perspective of nineteenth-century views of women and children shaped in the preceding century by Jean-Jacques Rousseau. According to this view, the ideal woman is pure, pious and submissive. In December 1829, Hawthorne read Rousseau's popular half-treatise, half-novel *Émile* (Books 69). Prior to *Émile*'s publication in 1762, children were viewed as miniature, imperfect adults. In response to this view, Rousseau proposed educational reforms in every aspect of a child's life, from before birth to adulthood and parenthood (Jimack xiii). With *Émile*, Rousseau transformed the fundamental attitude of parents toward children (xxv). It became fashionable among "enlightened" parents to bring up their children "a la Jean-Jacques" (xxiv).

Hawthorne's reading of Rousseau helped create a vision of daughters that parallels the image of angelic femininity in Spenser's Una. Rousseau considered *Émile* to be a work of moral philosophy because he believed that men were naturally good (ix). In fact, Rousseau begins his philosophy: "God makes all things good; man meddles with them and they become evil" (5). Thus, protecting nature and the natural good from the corrupting influences of society should be the goal of education (Rousseau 6-7, Jimack xiv). However, Rousseau believed that the education of women is absolutely subordinate to the needs of men (Jimack xviii). By nature, men should be strong and active with power and will (Rousseau 322). Conversely, women should be weak, passive and offer little resistance (323). Women can not fulfill their purpose in life without men's aid (328). According to scholar Patricia

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McAlexander, women came to be regarded as domestic angels belonging to "The Cult of True Womanhood" (McAlexander 252-254, Welter 151-174).

The emergence of "The Cult of True Womanhood," however, required the repression of all those human traits not in accord with angelic femininity. Feminist critics Sandra Gilbert and Susan Gubar address literature's domestic angel in their comprehensive study of the struggle of the female writer in the nineteenth-century. Gilbert and Gubar use Book I of *The Faerie Queene* to show the existence of a monster beneath the angelic surface of women. According to Gilbert and Gubar, the essence of literary power is actually male sexuality because a literary text's author is a father, progenitor and procreator who generates life and creates a posterity for himself (4, 6). Furthermore, male authors have historically generated the ideal image of women as passive and morally pure. The image of feminine purity became recognized in the Middle Ages with the Virgin Mary. However, as Gilbert and Gubar explain, in the more secular nineteenth-century, "the eternal type of female purity was represented not by a madonna in heaven but by an angel in the house" (20). The angel in the house denies her assertiveness, aggressiveness and other male characteristics that in a woman appear monstrous, unfeminine and unpure (28). Thus, a monster is concealed within the angel. Monsters in the shape of women and women in the shape of monsters are common characters within male texts (29). Gilbert and Gubar use Spenser's Una and Duessa to illustrate their point: "Duessa deceives and ensnares men by assuming the shape of Una, the beautiful and angelic heroine who represents Christianity, charity, docility" (30).

As several critics have shown, *The Faerie Queene* profoundly contributed to Hawthorne's conception and development of his allegorical writing style (Jones 71, Martin 20, Himelick 21). But I also argue that Hawthorne's reading of Book I of *The Faerie Queene* helped construct his vision of the ideal daughter; to him, Spenser's Una represented the truth about women's nature (*Letters 1843-1853* 37). In Book I of *The Faerie Queene*, Una is introduced as the allegorical representation of Truth, including the true faith of Redcrosse and the true church (I.i.4, ft. 4, Spenser 7). Una signifies the indivisibility of Truth through her Latin name, meaning "one." As the one true church, Una leads a milk-white lamb. The lamb symbolizes Una's innocent purity and links her with Christ as the sacrificial lamb in John 1:29-30 (I.i.4, ft. 5, Spenser 7, Heale 27). Similarly, Una's humility is evident by comparing her "lowly Asse" to Jesus' young donkey in John 12:14 and Matthew 21:5 (I.i.4, ft.4, Spenser 7). Una's white complexion suggests her simplicity, beauty, femininity, and frailty. Furthermore, throughout Book I, the vulnerable and helpless Una wanders in search of her protector, Redcrosse (Meyer 42). In short, Spenser's Una represents truth, innocence, purity, vulnerability, simplicity, beauty, femininity, and frailty. Analogously, these characteristics are often portrayed in literature through the archetype of the child. Therefore, by naming his first daughter Una, Hawthorne presupposed that she would embody the childlike nature of Spenser's Una.

With Spenser's Una in his mind as the ideal daughter, Hawthorne strove to bond with his newborn daughter, but she soon began to reveal traits that were more Duessa-like than Una-like. For example, Una Hawthorne's red hair apparently did not fit her father's idea of femininity or beauty. On the day of Una's birth, Hawthorne wrote to his sister Louisa that the baby has *red* hair. In the letter's postscript, Hawthorne begged his sister not to mention the *red* hair in her reply (*Letters 1843-1853* 15). Hawthorne's next letter to Louisa reveals an assessment of Una's carrotty tinged hair. While Hawthorne believed his daughter would become pretty in time, she needed a little brown wig to be pretty now (20-21). One senses exasperation in Hawthorne's tone when his sisters and mother denied that Una's beautiful hair was tinted with red (30). In December 1844, Hawthorne conceded that, despite her snub nose and red hair, Una was a dear little thing (68).

As Una grew into a young girl, Hawthorne's assessment of her wavered ambiguously depending on how much she fulfilled his vision of ideal femininity. At four years old, Hawthorne considered his daughter most beautiful wearing a dark, shaded mousseline de laine morning gown against her fair complexion (*American* 193). This vision of his daughter's beauty sharply resembles Spenser's image of Una wearing a black stole and veil against her white face (I.i.4, Spenser 7). Unfortunately, three years later, Hawthorne felt disappointed when his daughter's fair skin became freckled and tanned (*Letters 1843-1853* 453).

Sometimes Una Hawthorne's voice reinforced her father's ideal of femininity; at other times, her voice dismayed him. For example, the feminine Una spoke "in a tone of the softest and sweetest milk and honey" (*American* 194). In admiration, Hawthorne commented, "She pours out an apparently half unconscious rhapsody, rhythmical, flowing along like a river, dim and vague" (205). Yet, at eleven months old, Una began to say "Adam"! Naively, her mother Sophia thought that Una was referring to her father as God's first man. Shortly, Una's statement was correctly interpreted: "Damn-damn-damn-often in dulcet tones, and then again as loudly and emphatically as if she were firing a cannon" (Miller 231). Consequently, Hawthorne concluded that Una was graceful and beautiful only when she was perfectly quiet (*American* 205).

In fact, Una's beauty seemed to be uncertain and transitory, suddenly appearing when least expected. Glancing sideways at Una, Hawthorne caught flashes of beauty as "rare and precious as the vision of an angel" brightening her face. However, the flashes mysteriously disappeared as she turned to face her father (201). Hawthorne described the momentary appearance of Una's beauty as the reflection of her soul: "[a] grace, delicacy, an ethereal fineness" (201). Furthermore, Una's feminine qualities of tenderness, wisdom, and the finest essence of delicacy yielded to her masculine tendencies of boldness, hardness and an unshrinking comprehension of everything. Observing his daughter, Hawthorne felt shaken and unsettled: "[T]here is something that almost frightens me about the child--I know not whether elfish or angelic, but, at all events, supernatural. . . . I cannot believe her to be my own human child, but a spirit strangely mingled with good and evil, haunting the house where I dwell" (210-211). Hawthorne's daughter sharply contrasts with the truthfulness, purity, simplicity, vulnerability, and frailty of Spenser's Una.

Undoubtedly, Una Hawthorne was a complex little girl. Lacking any humor, she could not stand to be laughed at for unintentionally saying or doing something funny. Furthermore, her attempts to be funny resulted in eccentricity, a wild grimace or an unnatural tone (*American* 199-200). Her nature was passionate, tragic and tempestuous (200). She had a "rhinocerous-armor against sentiment or tenderness" (202). Consequently, she ungraciously demanded favors in an imperative mood (201). Although she craved sympathy, Una simultaneously defied sympathy by continually putting herself in a position where she knew that she cannot receive it (200). Unlike Spenser's vulnerable and dependent Una, Hawthorne's daughter threw off male protection. Frequently, without giving her parents the slightest notice, the indefinitely adventurous child flew off through the front gate of her home into the unknown world (208).

Una's increasingly independent, wild and unearthly temperament and behavior baffled her father. She stared so intensely and remorselessly into her parents' faces that she "embarrass[ed] the springs of spiritual life and the movement of the soul" (201). To Hawthorne, Una seemed to be possessed by an "earthly monster, who lays his grasp on her spinal marrow, her brain, and other parts of her body that lie in closest contiguity to her soul" (205). With the devil in her, Una rushed from corner to corner of the room with the force and violence of a cannon-ball (202). Hawthorne noted that the image of a cherub or an angel peers out from the eyes of an innocent child and the image of the devil peers out from the eyes of a vicious person (117). Although Hawthorne envisioned a daughter in the image of Spenser's angelic Una, Hawthorne's daughter more closely resembled Spenser's devilish Duessa.

One can conclude that Hawthorne felt deceived by the false presuppositions that he had formed of his new daughter. Una Hawthorne failed to display the childlike qualities of her Spenserian namesake. Although Hawthorne loved his daughter, he felt frightened and bewildered by her. Nevertheless, Hawthorne seems to have understood the special responsibility of a father to respond to his daughter with love, admiration and guidance. According to psychologist Suzanne Fields, the father is a daughter's loving escort to the larger world. Fields writes, "The ties that bind a girl to her father must be fastened with a slipknot that moves as she moves, that does not constrict to impede growth" (76). Hawthorne's persistent attempts to protect and bond to his daughter ended in resistance and struggle. "[C]omplaining of cold, father wraps her in a blanket,--she resists--father insists--There is a terrible struggle--and she gets into almost a frenzy; which is now gradually subsiding and sobbing itself away in her mother's arms" (*American* 197).

This background on Hawthorne's ambiguous relationship with his Una-like/Duessa-like daughter helps explain Hawthorne's complex portrayal of Pearl in *The Scarlet Letter*. Many critics have shown that Una Hawthorne is the biographical source of Pearl, but they have not shown how associating Pearl with Spenser's Una and Duessa helps explain her allegorical function. My argument is that, through Pearl, Hawthorne integrates the allegorical function of Spenser's Una and Duessa and thereby comes to understand the duality of his daughter's true nature. To put it another way, Hawthorne gives Pearl both Una-like and Duessa-like traits. Within much of *The Scarlet Letter*, Hawthorne creates Pearl in the image of Duessa. For example, the narrator characterizes Pearl as an "airy sprite" (64), "evil spirit," "little elf" (67), and "a demon offspring" (165). Una Hawthorne's red hair also links her with Pearl as the personification of the scarlet letter ("[Pearl] was the scarlet letter in another form, the scarlet letter endowed with life" 70). As the perfect representation of the scarlet letter, Pearl is arrayed in a crimson velvet tunic of a peculiar cut, embroidered with fantasies and flourishes of gold thread (*Scarlet Letter* 70). Pearl's clothes are fanciful, decorative, gorgeous dresses and robes of the richest tissues (62-63). Hawthorne envisioned Pearl almost identically to Spenser's description of Duessa. Dressed in scarlet red, Duessa is decorated with "gold and pearle of rich assay and wears a Persian mitre on her head garnished with crownes and brooches" (I.ii.13, Spenser 23). Duessa hides herself behind the appearance of the innocent and pure Una to lead Redcrosse to carnal and spiritual sin. Duessa's sinfulness, seductiveness, independence, complexity, ugliness, aggressiveness, and strength are concealed within the external appearance of Una's innocence, purity, vulnerability, simplicity, beauty, femininity, and frailty. In *The Faerie Queene*, the outward appearance of Una as a domestic angel hides Duessa's monster within her. This monstrousness is most evident in Pearl's "wild, desperate, defiant mood, the flightiness of her temper, and even some of the very cloud-shapes of gloom and despondency that had brooded in her heart" (*Scarlet Letter* 63).

However, in *The Scarlet Letter*, Pearl also possesses characteristics of Spenser's Una. As a hidden angel, Pearl is "a lovely and immortal flower . . . worthy to have been brought forth in Eden; worthy to have been left there, to be the plaything of the angels, after the world's first parents were driven out" (*Scarlet Letter* 62). As an "infant princess," Pearl possesses a native grace and faultless beauty (63, 62). Pearl's rich and luxuriant beauty permeates through her bright complexion, intense and glowing eyes and deep, glossy brown hair that darkens to blackness as she grows older (70). Complementing her beauty, Pearl's feminine laughter rings with merriment and music (64). According to critic Julian Hawthorne, the opposite poles of being, sin and innocence, are mingled in Pearl's nature (*Faust* 83). True human nature appears to be a melding of masculine and feminine. My research has shown that, in literary genres, true human nature is often represented by the coexistence of the monster and the domestic angel. Therefore, the duality of Pearl's nature represents both the doubleness and deceit of Duessa and the truth of Spenser's Una.

Thus, Pearl also represents truth as shown by critic Claudia Johnson. Johnson writes, "Pearl is the hardest truth-sayer in the novel. Not only does she speak the truth, but she pursues the truth. The scarlet letter, which Pearl embodies, is also a totality of truth about human nature and relationships" (6). To advance her argument, Johnson points out that Pearl recognizes the deceit and evil of Chillingworth; he is the devil or the "Black Man" who has hold of Dimmesdale (6, *Scarlet Letter* 93). Furthermore, Pearl deduces that Dimmesdale holds his hand over his heart for the same reason that her mother wears the scarlet letter (Johnson 6, *Scarlet Letter* 122).

Johnson sets forth evidence of Pearl's search for the true meaning of the scarlet letter. When her mother lies to her about the letter's significance, Pearl persistently questions her (6, *Scarlet Letter* 123-124). Pearl senses that the truth of the letter lies in the public joining of hands between her, her mother and Dimmesdale (Johnson 6, *Scarlet Letter* 105). Unveiling his own scarlet letter, Dimmesdale shatters the illusion of his saintliness and acknowledges the moral truth of his sinfulness and passion through his public confession. Finally, Dimmesdale and the community recognize Dimmesdale as Hester's lover and Pearl's father. Thus, Pearl's kiss on her father's lips transforms her from being either monster or angel; it frees her into being a little girl. As her tears fall on her father's cheek, they signify the human joy and sorrow of a woman (Johnson 6, *Scarlet Letter* 173). Johnson concludes that the duality of true human nature means that we all wear a scarlet letter (19).

Thus, to understand the duality of his daughter's true human nature, Hawthorne had to integrate the allegorical extremes of Spenser's Una and Duessa. Hawthorne had to come out of the world of faeries, magic, symbols, ideals, moral extremes, and simplicity to find the truth of reality. Hawthorne realized that life presents a mixture of sin and innocence, ugliness and beauty to form a balance of independence and domesticity. Therefore, Hawthorne was eventually able to look beyond his daughter as the ideal Spenserian daughter to see her and love her as his true daughter, red hair and all.

WORKS CITED

"Books Read by Nathaniel Hawthorne, 1828-1850. From the 'Charge Books' of the Salem Athenaeum." *Essex Institute Historical Collection.* 68 (1932): 65-87.

Fields, Suzanne. *Like Father, Like Daughter: How Father Shapes the Woman His Daughter Becomes.* Boston: Little Brown, 1983.

Gilbert, Sandra M. and Susan Gubar. *The Madwoman in the Attic: The Woman Writer and the Nineteenth-Century Literary Imagination.* New Haven: Yale UP, 1979.

Hawthorne, Julian. "The Scarlet Letter: The New England Faust." *Hawthorne's Faust.* Gainesville: U of Florida P., 1953. 104-122.

- - - . *Nathaniel Hawthorne & His Wife.* Boston: Houghton, 1855.

Hawthorne, Nathaniel. *The American Notebooks.* Ed. Randall Stewart. New Haven: Yale UP, 1932.

- - - . *The Letters 1813-1843: The Centenary Edition of the Works of Nathaniel Hawthorne.* Ed. Thomas Woodson. Vol. 15 of 18. Columbus: Ohio State UP, 1962-1985.

- - - . *The Letters 1843-1853: The Centenary Edition of the Works of Nathaniel Hawthorne.* Ed. Thomas Woodson. Vol. 16 of 18. Columbus: Ohio State UP, 1962-1985.

- - - . *The Scarlet Letter.* 1864. Ed. Seymour Gross, et al. New York: Norton, 1988.

Heale, Elizabeth. *The Faerie Queene: A Reader's Guide.* Cambridge: Cambridge UP, 1987. 1-44.

Jimack, P.D. Introduction. *Émile.* By Jean-Jacques Rousseau. London: Dent, 1974.

Johnson, Claudia Durst. *Understanding The Scarlet Letter: A Student Casebook to Issues, Sources and Historical Documents.* Westport: Greenwood, 1995.

Jones, Buford. "Hawthorne and Spenser: From Allusion to Allegory." *Nathaniel Hawthorne Journal.* 5 (1975): 71-90.

Lathrop, Rose Hawthorne. *Memories of Hawthorne.* Boston: Houghton, 1897.

Martin, Terence. *Nathaniel Hawthorne: Revised Edition.* Boston: Twayne, 1983.

McAlexander, Patricia Jewell. "The Creation of the American Eve: The Cultural Dialogue on the Nature and Role of Women in Late Eighteenth-Century America." *Early American Literature.* 9 (1975): 252-266.

Meyer, Russell. *The Faerie Queene: Educating the Reader.* Boston: Twayne, 1991. 3-48.

Miller, Edwin Haviland. *Salem is My Dwelling Place: A Life of Nathaniel Hawthorne.* Iowa City: Iowa UP, 1991.

Rousseau, Jean-Jacques. *Émile.* London: Dent, 1974.

Spenser, Edmund. "The Faerie Queene." *Edmund Spenser's Poetry.* Ed. Hugh MacClean and Anne Lake Prescott. New York: Norton, 1993. 5-161.

Stewart, Randall. "Hawthorne & The Faerie Queene." *Philological Quarterly.* 12 (1933): 196-206.

Welter, Barbara. "The Cult of True Womanhood: 1820-1860." *American Quarterly.* 18 (1966): 151-174.

Agrarianism in the American South: From the Vanderbilt Agrarians to Wendell Berry, A Shift from Regional Myth to Practicable Ideal

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In 1930 the "Twelve Southerners" published *I'll Take My Stand: The South and the Agrarian Tradition*, a collection of essays defending Southern traditions and culture against what the authors felt to be intrusive and exploitative Northern industrial capitalism. Most of the twelve Southern Agrarians, including John Crowe Ransom, Allen Tate, Donald Davidson, Andrew Lytle, Robert Penn Warren, and Frank Owsley, were associated with Vanderbilt University in some way, either as students or as faculty. The twelve men fought against industrialization's grave potential to reshape the South and undermine its traditions. Adopting "Northern" industrialization and its consumptive, isolating, competitive ideologies, they feared, would endanger their "simple" Southern lifestyles marked by kindliness, cooperation, and leisurely pursuit of culture (Santmyer 13).

Contemporary essayist, poet, and Kentucky farmer, Wendell Berry echoes many of the Twelve Southerners' arguments against industrialization within his own writings. Common themes between Wendell Berry's writing and the earlier Southern Agrarians are most evident within the works of Andrew Lytle, also a farmer. As agrarian critics, Berry and Lytle both call for practicable, small scale farming as an alternative to industrialism, emphasize the value of work, and illustrate nature's binding of God and man within their writing. Ultimately, though, the following discussion will show that Lytle and Berry write from very different perspectives. Lytle defends the rural South primarily because it offers a last remaining seedbed for the *human* institutions he holds dear. The farm, for Lytle, is a place offering an organic, ordered society in which families are supportive, religion remains unifying and in tact, and in which every participant has a place within the hierarchy. Berry, on the other hand, defends a rural--not necessarily Southern--existence primarily because he believes it offers a life in harmony with the land and its *natural* cycles. Thus, while the Twelve Southerners and their 1930s Agrarian movement are often regarded as *the* definitive Agrarian defense, a closer look at the variant voices within the movement, as well as the contributors' motivations for writing *I'll Take My Stand*, suggests that Wendell Berry aims to offer the more literal, practical, and ecological defense of farming as a way of life.

I'll Take My Stand: The South and the Agrarian Tradition was published in 1930, the outcome of a "Southern symposium of prose" which Allen Tate and John Crowe Ransom had been planning since 1927 (Rubin 197). *I'll Take My Stand*'s "Statement of Principles" written by John Crowe Ransom identifies broadly the Agrarians' purpose in publishing their manifesto. It stresses their mistrust of modern America's ever-increasing industrialism. They hoped to warn their fellow Southerners of the dangers of the "Northern way" of unchecked industrialism and of sacrificing their region's unique cultural heritage to become part of a homogenous, industrialized nation.

Undeniably, the Twelve Southerners were united in their distaste for industrialism and in their hope to preserve what they felt were distinctively *Southern* ideals. Yet just what the Twelve Southerners were *advocating* as an alternative to the Northern industrial mentality is less clear. The twelve essays included in *I'll Take My Stand* vary greatly. Topics range from Stark Young's accolades for the Old South plantation aristocracy to Andrew Lytle's celebration of the yeoman farmer, and from Allen Tate's discussion of the state of Southern Religion to Robert Penn Warren's controversial prescription for Southern race relations. Because such diverse cultural and humanistic themes are far more common than economic ones, critics such as Louis D. Rubin, Jr. argue that *I'll Take My Stand* fails to offer a unified, realistic defense of a practical agricultural economy (Rubin 228).

Clearly, for Robert Penn Warren and Allen Tate, the agrarian movement *was* far more a call for the preservation of Southern ideals than a hope for a literal return to a South of subsistence farmers. For Tate and Warren, even from the earliest stages of the movement, the farm represented a metaphor, a means of embodying the values present in an anti-industrial lifestyle. Tate and Warren were so adamantly against *I'll Take My Stand: The South and the Agrarian Tradition*'s being labeled *only* as an agrarian text that they fought against the title; they feared linking their book so closely to agrarianism would obscure their real aims in publishing it. Tate preferred calling the book a "defense of religious humanism" (Ransom et al. xxxiv), while Warren, who thought the title "I'll Take My Stand," from a line in the Southern hymn, "Dixie," was a "goddamned outrage," pushed to name the book, "Tracts Against Communism" (Lucas 21). Later, Tate was so angered when the book went to press with the present title in place that he wrote a scathing note to the others:

> It is over now. Your title triumphs. And I observe that Alexander [a writer with the Nashville *Tennessean*] today on the basis of the title defines our aims as an "agrarian revival" and reduces our real aims to nonsense. These are, of course, an agrarian revival in the full sense, but by not making our appeal through the title to ideas, we are at the mercy of all the Alexanders--for they need only to draw portraits of us plowing or cleaning the spring to make hash of us before we get a hearing. (Santmyer 21)

Tate was skeptical of the project's success "in the practical sense" (Rubin 228) but felt that the movement's real merit was its humanistic affirmation. In a letter to Davidson, Tate wrote:

> You evidently believe agrarianism was a failure; I think it was and *is* a very great success, but then I never expected it to have any political influence. It is a reaffirmation of the humane tradition, and to reaffirm that is an end in itself. (Rubin 230)

Donald Davidson, however, *had* hoped that the Agrarian movement would be more than merely an affirmation of ideals; he hoped for a literal resurgence of Southern agriculture. Unlike Tate and Warren, who feared being linked to images of the plow, Donald Davidson and Andrew Lytle, in particular, *were* sincere in their defense of the practicality of subsistence agriculture in the initial stages of the Agrarian movement. For them, the farm represented not merely a metaphor for Southern culture, but a legitimate means of economic independence and prosperity. Lytle's *I'll Take My Stand* essay, "The Hind Tit," is the most agrarian of all the essays in its detailing the simple, moral existence of a yeoman farmer free of industrial gadgets. Accordingly, Mark Lucas, author of *The Southern Vision of Andrew Lytle*, calls the author's tone in "The Hind Tit" not that of a "disinterested type-writer agrarian, but of a fiercely loyal southern farmer" (23).

Yet even Andrew Lytle, who returned to the South to live and farm his family's land until his death in 1995 at the age of ninety-two, and whose essay was perhaps the *most* agrarian of the agrarian essays in *I'll Take My Stand*, eventually agreed that the term "agrarian" had been too limiting for the group's purposes and admitted that he had romanticized the ideal of the yeoman farmer as a "kind of literary exercise" (Purdy 214-5). Further, in an interview for a 1952 issue of *Shenandoah* magazine, Lytle admitted that the "agrarians made a tactical error in allowing the word agrarian . . . to stand for their protest" (*Shenandoah* 31).

Lytle's retrospective comments on the agrarian movement suggest that he eventually acknowledged the twelve men's efforts as a defense of Southern religion rather than a narrowly defined defense of farming itself. Still, Lytle's decision to remain in the South in order to farm while all the other Agrarians accepted Northern university positions illustrates that his push for small-scale agriculture--regardless of the degree to which it may have been mixed with humanistic motivations--was, indeed, literal and sincere.

Indeed, many common themes are evident within Berry's and Lytle's writing. Berry and Lytle each affirm the significance of small farms where families own just enough land for subsistence, free from the restricting forces of industrial, "agribusiness" techniques. Lytle proposes the ideal size of a family farm as one "not so large that [the farmer] cannot know the fields intimately, nor so small that he will fear want" (Lytle 37).

Also, as a means of countering modern society's materialism and devaluation of labor, Berry and Lytle praise the farm as a place where work is spiritually uplifting as well as valued and varied. The farm provides a haven away from the "the spiritual sterilization" of monotonous jobs faced by factory workers in urban areas (Lytle 40-41). Lytle and Berry's criticisms of industrial agriculture often invoke a similar rhetoric as well. In "The Hind Tit," Lytle claims modern agriculture's biggest challenge will be getting its farmers to think in terms of, and place value on, a non-absolute such as time, rather than the absolute of land. Berry also regrets the results of such an artificial value system, criticizing American farmer's adoption of the country's industrial mindset in managing their farms in pursuit of short-term efficiency, immediate monetary gain, and ease, rather than in search of a healthy stewardship with the land (*Unsettling* 32). Both Lytle and Berry dismiss the applicability of an industrial perspective--bent on precision, quantity, and technology--to agricultural, biological processes.

As critics of modern society, both men allude to humans having usurped their proper role in the Great Chain of Being. Berry claims that humans have placed "the human will in charge of itself and of the universe" (*Unsettling* 55). Lytle echoes such sentiments in his attack against "the gradual displacement of God by man" wherein mankind has been left with only an ineffectual science to solve its problems (Lytle 189). Both men see farming as one of the few remaining ways of life which can counter modern society's anthropomorphism. Berry attributes his awareness that "little of the beauty and the richness of the world is of human origin" to his intimacy with the land as a farmer (*Recollected* 52). For both men, farming offers a re-emphasis of humans' place in the continuum of Creation.

Yet while both men merit the land's role in fostering religion, religious perspectives between Lytle and Berry differ greatly. In fact, the authors' differing religious perspectives offer one insight into their larger divergence in motivations for supporting an agrarian lifestyle. Ultimately, Berry's and Lytle's varying views of religion, history, and ecology overshadow their agrarian similarities.

Any discussion of Berry's sense of religion begins and ends with the land. Berry distrusts formal religion and uses the term more loosely to define the relationship between man, creation (often in specific terms of the land), and the Creator. Berry is "uneasy" with organized religion's tendency to dismiss the importance of existence on the earth in its pursuit of Heaven. Berry's Christian ideal is based in nature, rather than in an other-worldly Heaven.

Unlike Berry, Lytle was a strict adherent to formal, Christian religion. Lytle's fundamentalist Episcopal views pervade his works and are inherent in his attack against the evils in the fall of "Christendom." Lytle's religious conservatism is complex but emanates primarily from his European consciousness. In Lytle's thinking, a Christianity free from modern debaucheries and embodying Christianity's central force, the family, is the South's one remaining cultural tie to its "true," European, pre-industrial heritage (Lytle 164). According to Lytle, the South has "to go back" to a time when "the King was God's secular overseer, the bishop His spiritual," "before the days when Christendom was rent"; only such a return, he feels, would provide the world with order (Lytle 182-3). For Lytle, then, the South represents a region fighting against not only Northern industrialism, but more importantly, Northern secularism.

Lytle believes that pure Christianity has a "structure [which] . . . bound all men together, from king to peasant"; he advocates farming, therefore, as an alternative to what he sees as the increasingly de-structuring, de-ordering forces of industrialism. Specifically, Lytle's uneasiness with modernity is closely connected to industrialism's destruction of traditional class hierarchies. Lytle praises Christendom's ability to give each man a place, from king to peasant, where his work was necessary. Such a Christian, ordered society, he believes, exists in the rural South.

So, for Lytle, the farm represents a means of *placing* people. From this perspective, part of rural agriculture's value is its providing a system of order--albeit a hierarchical one--in which every person fulfills a distinctive role. Lytle praises the farm's role in providing an ordering buffer against Northern capitalistic and bureaucratic influences, as well. Agriculture becomes a means of "slowing down the process of central power" so long as small farmers are "distributed . . . sufficiently over the state" (Purdy 214-5). The livelihood farmer battled government bureaucracy and economic dependence by providing for his own needs.

The "health" implicit in Lytle's idealization of the small farm exits, then, in so far as it preserves the health of *human* institutions. For Lytle, the strengths of farming are its preservation of the family and religious and social structures dating back to the origins of Western civilization, as well as its providing economic and political independence from a national government he deemed oppressive. In contrast, organized religion, government, and social class--though defining themes for Lytle--are subordinate points in Berry's agrarianism which is defined much more by a respect for *natural* cycles.

Berry writes frequently of the complex ties within which every person lives his or her life. Humans are tied to their place, to their ancestors, and to their progeny. It is this "complex inheritance" which intrigues Berry so much (*Recollected* 74). In marked contrast to Lytle's definition of "place" as a means of social order, for Berry, one's "place" becomes a deeply-felt

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identification with his or her home, family, and personal historical inheritance. Lytle's sense of history is one of large-scale, institutional declines; Berry's historical sensitivity, on the other hand, is more local, more personal, and more dependent upon a basis in the *land* than in social institutions. Berry's realization that he follows in the successes and failures of his ancestors, and that his own successes and failures will form the world his children will inherit, shapes in his work a search for an ecology, a connection to the natural cycles of death and rebirth, and a sense of responsibility:

> Each of us is a part of a succession. I have come here following Curran Matthews. Who was here or what was done before he came, I do not know . . . I do not know who will follow me. These realizations are both aesthetic and moral; they clear the eyes and prescribe an obligation. (Berry, *Recollected* 46)

Berry acknowledges that individuals cannot leave the world without having made it either better or worse for their existence. The desire to leave a better world--and proposals for *practical* means of doing it--form the basis of Berry's agrarianism. For Berry, agrarianism represents a life beautifully in touch with natural cycles, a life which is ecologically sound. Unlike Lytle's agrarianism which centered on man-made ideas and institutions, Berry centers on the natural cycles of death and life. By participating in the "Wheel of Life" in planting and reaping his fields, the farmer is reminded of his *own* participation in a wider succession of deaths and rebirths. Berry's poetry offers frequent and powerful images of such a life founded upon one's *return* to the land (*Recollected* 85-86).

Berry's agriculture, then, far from the metaphoric or socially-centered agrarianism of the Twelve Southerners, calls for a literal, practical return to subsistence agriculture. While Tate feared being depicted behind the plow, Berry *fosters* such an image of himself as a farmer in tune with the land. In effect, Berry is "a man born to farming":

> The grower of trees, the gardener, the man born to farming,/whose hands reach into the ground and sprout,/to him the soil is a divine drug./ He enters into death yearly, and comes back rejoicing. . . . (Berry, "The Man Born To Farming," *Collected Poems*, 103)

As a man who rejoices in farming, Berry writes to provide suggestions for means to preserve the health of the land, the farming community, and the farmer himself. Berry focuses much of his writing in suggesting alternative or organic agricultural methods which can both aid in the health of the land and still be financially feasible.

The difficulty in determining affordable, practical answers to agricultural problems, according to Berry, is the complexity of finding solutions which solve for the problem as a whole, or at its roots, rather than merely covering one of its manifestations. To find *true* solutions, Berry insists that many questions must be asked. Among the most important is: How to use the land well? (*Gift* 106) Other necessary questions include considerations of proper scale, balance, diversity, and quality in agriculture (*Gift* 122). Significantly, Berry, unlike many fundamentalist ecologists, does not believe that most land should be sanctioned off, and preserved from human use. Rather, the land should be used *well*. Similarly, tools should be used *well*. By asking his readers to truly consider the added benefit of an electric scythe over a hand-held, well-crafted blade (*Gift* 173) or the necessity of using tractors in cases where horse-drawn wagons would be more efficient (*Gift* 190), he challenges society as a whole to become a more conscious, beneficial contributor to the pattern of health that includes all Creation.

Still, the all-important question of practicality remains. While Berry claims he seeks practical solutions, it may well be that modern agricultural procedures have come too far in their dependence on large-scale, chemically based farming to turn back. Statistics from the United States Department of Agriculture seem to suggest that America's trend toward fewer, large-scale industrial farms and away from multiple small-farm operations has pushed ahead steadily since 1930 and will likely continue. While there were roughly thirteen million American workers employed on approximately seven million acres of farmland in 1935, by 1990 those numbers had dropped to three million workers on two million acres of farmland (USDA, fl_frmwk.htm). Additionally, the number of farmers who depend on outside jobs to supplement their income is increasing rapidly. In Kentucky, according to the 1992 census, of the state's farmers, forty-one percent worked at least two hundred days off the farm. In essence, Berry's ideals for small-scale agriculture simply are not feasible for most farming families today.

Yet that his values have not been widely adopted by the larger community should not dismiss Wendell Berry's aesthetic and moral value. As Berry himself admits, the morality inherent in his message stems primarily in the questions he asks and challenges he raises, rather than in their answers:

> After more than thirty years I have at last arrived at the candor necessary to stand on this part of the earth that is so full of my own history and so much damaged by it, and ask: What is this place? What is in it? What is its nature? How should men live it in? What must I do? I have not found the answers, though I believe that in partial and fragmentary ways they have begun to come to me. But the questions are more important than their answers. In the final sense, they *have* no answers. . . . They are a part of the necessary enactment of humility, teaching a man what his importance is, what his responsibility is, and what his place is, both on the earth and in the order of things. (Berry, *Recollected* 101)

It is Berry's persistence in asking the questions which "must be asked" (*Recollected* 101) and in developing an ecological perspective encompassing the health of the farm and rural communities--as *well* as the land on which they survive--which enriches his agrarian views in comparison to the Twelve Southerners' agrarianism. Berry pursues practical solutions; yet always, even in failing, his search offers a "moral and aesthetic" vision--founded upon respect for the land and for one another--which provides an alternative to modern society's excessive industrialization, materialism, and isolation.

REFERENCES

"The Agrarians Today: A Symposium." Shenandoah 3 (Summer 1953): 14-33.

Berry, Wendell. Collected Poems. New York: North Point Press, 1995.

---. The Gift of Good Land. San Francisco: North Point Press, 1981.

---. Recollected Essays: 1965-1980. New York: North Point Press, 1995.

---. The Unsettling of America. San Francisco: Sierra Club, 1977.

Lucas, Mark. The Southern Vision of Andrew Lytle. Baton Rouge: Louisiana State University Press, 1986.

Lytle, Andrew. From Eden to Babylon. Ed. M.E. Bradford. Washington, D.C.: Regnery Gateway, 1990.

Purdy, Rob Roy. Fugitives' Reunion: Conversations at Vanderbilt, May 3-5, 1956. Nashville: Vanderbilt University Press, 1959.

Ransom, John Crowe, et al. I'll Take My Stand. Baton Rouge: Louisiana State University Press, 1995.

Rubin, Louis D., Jr. The Wary Fugitives: Four Poets and the South. Baton Rouge: Louisiana State University Press, 1978.

Santmyer, Sue Patrick. "The Nashville 'Agrarians' as Critics of American Society." Diss. Vanderbilt University, 1951.

United States Department of Agriculture. "U.S. Number of Farms and All Farm Workers 1910-1995." National Agricultural Statistics Service: http://www.usda.gov./nass/aggraphs/fl_frmwk.htm

Margaret Fuller's *Woman in the Nineteenth Century*: An Appeal for the Inclusive Self

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"There is but one law for souls," writes Margaret Fuller, one of America's earliest and most vocal feminists. Fuller, an influential transcendentalist and advocate of equal rights for all people, lived from 1810 to 1850. During her lifetime, she produced writings that brought to light a variety of social issues; prominent among them was the rights of women. As a champion of women's rights, she challenged American society with her radical ideas concerning the equality of the sexes, particularly with the 1845 publication of her book *Woman in the Nineteenth Century*. In her writings, she strove to uncover an all-inclusive individual, a whole person encompassing both masculine and feminine traits.

Sarah Margaret Fuller was born to Timothy and Margarett Crane Fuller in Cambridge, Massachusetts in 1810. Timothy Fuller had wanted a son, a longing which would shape his daughter's life into something unheard of for the nineteenth century. A learned man, Timothy thought it important to teach his daughter as most male children would be taught, instilling in her the knowledge she would need to become an accomplished author, journalist and critic. Margaret, as she preferred to be called, learned history, literature, foreign languages and all subjects that were usually taught to boys but not girls.

Perhaps because of this unusual upbringing, Fuller gained a discerning perspective on certain issues. She states her thesis in the preface to her book: "I believe that the development of the one [man] cannot be effected without that of the other [woman]. My highest wish is that this truth should be distinctly and rationally apprehended, and the conditions of life and freedom recognized as the same for the daughters and the sons of time; twin exponents of a divine thought" (Fuller, *Portable* 229).

Fuller was a unique woman for her time, when women were viewed chiefly as domestic objects. They were not allowed to vote, therefore having no voice in matters that decided their paths. She, however, believed that a woman's freedom should be "acknowledged as a right, not yielded as a concession" (Fuller, *Portable* 244). When she began writing, she often investigated social issues and suggested reforms. Her androgynous perspective, acknowledging both masculine and feminine traits in herself, perhaps allowed her to view the issue of gender equality more objectively than many other people.

Her thinking not only included radical feminist ideas, but also the growing Transcendental perspectives of her day. She was such an integral part of this group, she even edited the transcendentalist journal, the *Dial*, for two years from 1840 until 1842.

Among her various contributions to the *Dial*, Fuller published the essay "The Great Lawsuit. Man Versus Men: Woman Versus Women" in July 1843, which she expanded into the full-length *Woman in the Nineteenth Century*. This book explores Fuller's feminist philosophy by detailing a number of examples of the ideal woman, a woman possessing both masculine and feminine qualities. These ideas were not widely accepted when first published.

Many thought Fuller was stepping beyond her "sphere" and were appalled to hear of a woman who thought that all creatures, regardless of gender, should be treated equally. Fuller asks for a common gender in words that spoke not only to women of the nineteenth century but also continue to speak to women of the twentieth century.

In her preface, she states that she is writing for both men and women, hoping to incite women to "search their own experience and intuitions for better, and fill up with fit materials the trenches that hedge them in." All that she requires of men is a "noble and earnest attention," to consider her ideas with an open mind (Fuller, Portable 229).

Fuller writes that from the beginning of time, humans have one soul and one body, and "the growth of Man is two-fold, masculine and feminine." Because of her vantage point, she knows the importance of both characteristics. "There cannot be a doubt that, if these two developments were in perfect harmony, they would correspond to and fulfill one another, like hemispheres, or the tenor and bass in music" (Fuller, Portable 326).

Believing that it is an essential truth that men and women should be part of the same sphere, Fuller tries to answer the query: why are women not regarded as equals? Man was developed first, and women were under the care of men. Men had the opportunity to teach women, but "as human nature goes not straight forward," men did not understand this opportunity, and therefore became the rulers over women instead of equal partners with them. Men were punished for this, because now instead of having an intellectual kindred with whom to share life, women were made into servants, and man "found himself a king without a queen." According to Fuller, man didn't recognize that woman was the other half of himself, and he could never achieve fulfillment while woman was not allowed to be fulfilled (Fuller, Portable 326).

Her sharp awareness of the dimensions of masculinity and femininity was, according to Jeffrey Steele, due to the influence she felt from both her father and mother. According to Steele, her "sense of gender duality led Fuller to define herself in bisexual terms. 'Will there never be a being to combine a man's mind and a woman's heart,' she once lamented," (xii). That question may have been posed by the mythical woman Fuller details in Woman in the Nineteenth Century. Her aim is to bring forth examples of the ideal woman, a woman not confined to a sphere, a whole woman who embodies ideal characteristics of both genders. Through these examples we learn what she believes a whole person is, one with an astute mind and a tender spirit. She struggled through her life to come to terms with her androgynous perspective. Through her writings, which grew out of her own struggle, she encouraged others who may have been attempting to understand what it means to be male or female. She writes, "Male and female represent the two sides of the great radical dualism. But, in fact, they are perpetually passing into one another. Fluid hardens to solid, solid rushes to fluid. There is no wholly masculine man, no purely feminine woman" (Fuller, Portable 293).

Her dual perspective enlightened her to perceive that "what woman needs is not as a woman to act or rule, but as a nature to grow, as an intellect to discern, as a soul to live freely and unimpeded, to unfold such powers as were given her when we left our common home" (Fuller, Portable 244). Encompassing everyone in this assertion, she says that all people come from the same place, our common home, and are created equally there. It is her wish that all people exercise their intrinsic powers and become whole persons, individuals with rights, not confined to any particular sphere.

Fuller believed she had some "masculine qualities-- a philosophical mind, love of learning, self-reliance, ambition, love of command," yet "she clearly saw the lot of women in her society: as childbearers, drudges, slaves, ornaments, bodiless ideals, superfluities," (Allen 135). It was this position of woman, this "sphere of her sex" that she chose not to accept. She compared women to slaves, in that they were not free, but were ruled by an unenlightened master: society. "Tremble not before the free man, but before the slave who has chains to break" (Fuller, Portable 260).

There were many who did not agree with Fuller's ideas, including both men and women. One of the most negative reviews of her works was written by Charles F. Briggs, and appeared in the *Broadway Journal* in March of 1845. In his vehement attack on Fuller's feminism, Briggs states:

> If there is anything clear in revealed and natural law, it is that man is the head of the woman. All the beauty, all the harmony, all the happiness of life is centred in this truth. The most perfect woman that the world has ever known, one who was tried as no other woman was ever tried, who was endowed by nature as few women have ever been endowed, the sweetest, purest being that ever bore the name woman, counted herself nothing but the wife of her husband, would know no law but his will, no happiness but his love; and when his love grew cold, and he became dead to her, though living, she still remained true to him (Myerson 10).

Briggs is reacting to Fuller's statements concerning women who think for themselves as any human being has the natural right to do. At that time, however, it is apparent that men believed women to be inferior, and Fuller is appealing to all people to become whole, embracing both genders.

On the other hand, Fuller's friend, John Neal, criticized her for not sufficiently inciting women to act on her ideas, to act by claiming their right to vote and participating in law-making. He said, "There is no life for woman, till she has a hand in making the law--no chance for her till her vote is worth as much as the man's vote. When it is, women will not be fobbed off with six pence a day for the very work a man would get a dollar for" (Von Mehren 198).

Fuller strove to break chains like these for other women, because she had already broken free through her education and awareness of the need for reform. Woman in the Nineteenth Century is an eloquent plea for an all-inclusive person, which would enable both men and women to live equally and harmoniously. She states that men must realize "that the idea of Man, however imperfectly brought out, has been far more so than that of Woman, that she, the other half of the same thought, the other chamber of the heart of life, needs now to take her turn in the full pulsation, and that improvement in the daughters will best aid in the reformation of the sons of this age" (Fuller, Portable 235). She says it is in society's best interests to give women the same rights as men. In 1845, that was a threatening thought for most men, and many women. Women had their realm, one which involved raising children, taking care of husbands and running the household. It was unheard of for women to write such ideas and publish them for the world to read. Fuller was criticized for not fulfilling the traditional role of wife and mother, since at the time of publication she was not married and had raised no family.

With Fuller's radical declarations, she was urging women to become "sea-captains," yet her pleas for equality would not be realized for years, and it is debatable whether they have been realized even today, on the eve of the third millennium. Women were not granted the right to vote until after World War I in 1920, though they had been working to gain that right since Fuller's time, when in 1848 in Seneca Falls, New York, the first suffragists gathered to unite and fight for their voice. Like Fuller, women today wish for woman to accept no placement, to grow as a whole being, and to obtain equality. Her ideas can serve as an axiom for feminists in the late twentieth century, or more appropriately, for humanists, individuals who recognize the worth of all people regardless of differences.

By articulating her integrated perspective, Fuller presented her truth to an 1845 audience. Her most triumphant work was behind her. She had put into writing the strong ideas and emotions she harbored on the subject of woman. The book was the culmination of years of internal struggle, and having opened her spirit to set her thoughts free, only served to enhance her complete self. When she finished the book, she proclaimed in a note to her transcendentalist contemporary and friend, William Henry Channing: "I felt a delightful glow, as if I had put a good deal of my true life in it, and as if, should I go away now, the measure of my foot-print would be left on the earth" (Chevigny 217).

Fuller's foot-print is firmly embedded in American literature and thought, a mark which she established in a tragically short life. Shortly after Woman in the Nineteenth Century was published, Fuller traveled to Italy as a journalist in 1846. In 1847 she met and fell in love with the Italian revolutionary Giovanni Ossoli, and soon bore him a son, Angelo. When the family fled Italy to escape the Italian Revolution, they sailed for New York in 1850, only to have their ship wreck off the coast of Fire Island on July 19. Within sight of scavengers on the shore, Fuller, Ossoli and Angelo drowned (Blanchard 336, 337). In only 40 years, Fuller had written such inspiring words that her foot-print will remain a symbol to enkindle in women the desire for totality and inclusiveness, the strength of will to become open-minded and compassionate individuals, and the determination to actualize the full potential of all humans.

WORKS CITED

Allen, Margaret Vanderhaar. The Achievement of Margaret Fuller. New York: The Pennsylvania State University Press, 1979.

Blanchard, Paula. Margaret Fuller: From Transcendentalism to Revolution. New York: Delacorte Press, 1978.

Chevigny, Bell Gale, compiler. The Woman and the Myth: Margaret Fuller's Life and Writings. New York: The Feminist Press, 1976.

Fuller, Margaret. The Essential Margaret Fuller. Ed. by Jeffrey Steele. New Brunswick, NJ: Rutgers University Press, 1992.

Fuller, Margaret. The Portable Margaret Fuller. Ed. by Mary Kelley. New York: Penguin Books, 1994.

Myerson, Joel, compiler. Critical Essays on Margaret Fuller. Boston, Mass.: G.K. Hall & Co., 1980.

Von Mehren, Joan. Minerva and the Muse: A Life of Margaret Fuller. Amherst, Mass.: University of Massachusetts Press, 1994.

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The Paradox of the Crucifixion Allegory in Ben Franklin's "The Kite Experiment"

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Ben Franklin was a preeminent American philosopher, politician, and scientist during the Enlightenment. He was vocal about his belief in one God, which is a tenet of Deism, his religious creed. Consequently, it is surprising to find such a straightforward crucifixion allegory embedded in his essay "The Kite Experiment" (1752).

My presentation will focus on and compare details of the manifest (scientific) and latent (religious) aspects of "The Kite Experiment." My reading will illustrate the conflict between the Deism endorsed by the intelligentsia and the traditional Christianity that prevailed in the early republic. Although Franklin's allegory may have been an unintentional result on his part, it invites contemporary theoretical approaches such as deconstruction and reader-response criticism when interpreting the tensions informing it.

Americans have an identity crisis. Why shouldn't we? Expressions of free-thinking individuality are usually crushed by the conservative consensus. Paradoxically, this obliteration of individuality is necessary for retention of this consensus. Furthermore, a consensus is compulsory for society to determine its boundaries. These boundaries determine for whom and what we stand. For instance, Anne Hutchinson and Thomas Morton were two examples of individuals who were persecuted for the sin of remaining true to their essential selves. They were banished from society because they crossed the accepted boundaries of their colonial society. Hutchinson and Morton were intelligent, educated persons. However, if they'd been *more* resourceful, like Ben Franklin over 100 years later. It's possible they could have retained their places in society by assuming masks, or personas. These masks were necessary in order to survive in a society whose rules and boundaries were forever changing.

Apparently, Benjamin Franklin – American philosopher, politician, and scientist – found it necessary to invent multiple masks for himself as a form of survival in America's evolving society during the Enlightenment. He adopted more than thirty masks in various works. At times, he signed his work as a woman – Betty Diligent, Alice Addertongue, or Abigail Twitterfield. Many of his masks were puns – Fart-hing, Hugo Greim, or Anthony Afterwit. And many were just plain clever – Silence Dogood or Censor Morum, Esq.

Yet, even with this repertoire of voices and our knowledge that Ben Franklin was quite vocal about his belief in one God, which is a tenet of Deism (Franklin's religious creed), it is still surprising that there is a clear crucifixion allegory embedded in his essay, written in the year 1752, "The Kite Experiment." By signing his true name to this essay, Franklin essentially "masked" this allegory within the framework of the actual experiment. This effectively made the allegory less dangerous (for the reader and, more importantly, for Franklin himself).

The discovery of the crucifixion allegory in the Kite text is unexpected. Unexpected because a Deist such as, such as Franklin, would never consciously advance Christian Humanist propaganda. The crucifixion story is, of course, the heart – the foundation of the Christian Humanist belief system – the prevailing religious system of the early republic.

This Christian religion is based on divine faith and grace – on an unconditional belief in things unknown and unseen in this world. This Christian faith is born of spiritual, supernatural, miraculous experiences. For Christians, an ever-present, omniscient, all-powerful God created the universe. This all-seeing God was, and is, entirely responsible for the minute details which compose our lives. In his book, The Philosophy of the Enlightenment, Ernst Cassirer writes that the seventeenth-century French philosopher, Pascal, established a doctrine which further explains this Christian belief system. In his thesis, Pascal "defends ... the absolute powerlessness of reason which is incapable of any kind of certainty by its own efforts, and can arrive at the truth only by means of an unconditional surrender to faith" (Cassirer 142). Furthermore, Pascal believed that the contradictions of the duel nature of fallen man in a supposedly harmonious world are illuminated when we study actual life experiences. "Thus all standards of logical and rational knowledge are reversed. In this knowledge, the unknown is explained by reducing it to a known quantity" (143). In Pascal's words: "Be humble impotent reason; be quiet, imbecile nature: ... learn from your Master of our true condition, of which you are ignorant. Hearken unto God!" (144).

Pascal's seventeenth-century concept of the absolute authority of the traditional Christian God continues into the following century yet differs from the Deist God endorsed by the intelligentsia of the American Enlightenment. Specifically, as Cassirer says, "Deism begins as a strictly intellectualist system; its aim is to banish mysteries, miracles, and secrets from religion and to expose religion to the light of knowledge" (171). The conventional view of a Deist God is one of a watchmaker who makes the watch, and then sets it in motion. The Deist God doesn't interfere with this allegorical watch-world after its motion has started. According to the Deist belief system, man is no longer solely dependent on God's grace for survival – instead Enlightenment-independent man is now actively involved with shaping his destiny. During the Enlightenment, which is when Deism climaxed, it was paramount for man's survival to understand and master Nature – through scientific investigative methods of collecting information on observable reality. Reason was the illuminating focus of the Deists. And progress was their teleological goal. According to historian Peter Gay, in The Enlightenment (An Interpretation) : The Science of Freedom, science was at this time "one area of human experience in which progress was reliable" (124).

It appears that Benjamin Franklin "worked his was into deism by devouring the tracts of English controversialists and perfected his knowledge of modern science by studying the English Newtonians" (Gay 559). In fact, Franklin was as respected and admired in England as a philosopher, a politician, and a scientist as he was in America. His kite essay, written in 1752, is perhaps his most famous recorded scientific experiment.

Franklin wrote this essay believing that "it may be agreeable to the Curious to be inform'd" ("kite" 375). On the surface, this essay appears to be a simple description of a scientific experiment. However, upon closer reading, it is obvious that there is a easily identifiable allegory of Christ's crucifixion embedded within the text. This allegory is problematic because although Franklin was quite familiar with Christian theology, he had publicly (in at least one letter to Ezra Stiles) expressed his doubts of Christ's divinity. Furthermore, the paradox of this text is the apparent representative microcosm of the tensions which existed between the scientific and religious worlds during the Enlightenment. In my reading, these worlds transcend their oppositional boundaries to blend and become a sort of good will sermon for all mankind. In another letter to Joseph Huey, Franklin states a possible motive for this probably subconscious blending of opposing belief systems. He writes that the faith subscribed by Huey "has doubtless its uses in the world; [he did] not desire to see it diminished, nor would [he] endeavor to lesson it in any Man" ("Huey" 476). He wished instead for Christian faith to be more active and productive. Franklin's essay has greater depth with this crucifixion allegory – everything rational has a correspondence in the natural world. This makes the text more productive by reaching all mankind as an audience. As Franklin wrote to Mr. Huey, "Mankind are all of a Family" (476).

At the start of this essay, Franklin instructs the reader, "Make a small cross…." What's on this cross? More importantly, *who's* on this cross?

"… the [ARMS] so long…"
"… the [EXTREMITIES] of [or on] this cross…"
"… the [BODY]…"
"… a [FOOT] …"
"…next the [HAND]…"
"…the [FINGER]…"
"…the [KNUCKLE]…"

A conventional reading of these phrases is Franklin's description of a kite. However, I believe that the arms, the extremities, the body, the foot, the hand, the finger, and the knuckle belong to Christ on the cross. Let's take a closer look at these symbols.

Franklin's kite, literally, is flying towards the clouds. This kite is a conduit from the man to the clouds. According to J.E. Cirlot, in A Dictionary of Symbols, Gaston Bachelard believes "that a cloud should be taken as a symbolic messenger" (Cirlot 50). Furthermore, this "aspect of the cloud is symbolic of forms as phenomena and appearance always in a state of metamorphosis, which obscure the immutable quality of higher truth" (50). So, the kite is a conduit to a higher truth – much like the Christian belief that only through Jesus can man attain the ultimate higher truth – God. In this way, Franklin's kite is an allegory for Christ.

The properties of this kite have symbolic meaning, also. Franklin instructs the reader that the kite is *not* made of paper because paper would not hold up as well as silk. Paper, as we know it, didn't come along until the fifteenth-century. All sacred Jewish texts were written on parchment – probably the Bible was was first recorded on this material. It's interesting that parchment was often made from sheepskins. Following this line of thought, the paper kite is an allegory for the weak lambs of the Lord – mankind. Jesus, was the shepherd to these sheep. Franklin's kite, instead, is made of silk – the strongest natural fiber. Silk fibers can be stretched (or abused), yet still these fibers will return to their original shape. In a similar vein, Jesus can be tortured and stretched on the cross to die, then according to the story, his restored body will resurrect in three days and then rise to heaven. With this in mind, Franklin's kite *had* to be made of durable silk to withstand the Kite essay's "Wet and Wind of a Thunder Gust>"

According to Cirlot, again, the value of wetness "...may be positive on the plane of natural life, it has an entirely negative effect on spiritual life" (Cirlot 370). An active wind means "regeneration" (373). The Thunder Gust, or thunder bolt "destroys all material forms." its purpose if top keep man down, away from a "higher world" (342). In this way, the "Wet and Wind of a Thunder Gust" is an allegory for the torture of Jesus' final three dark hours on the cross. Specifically, if Christ, during this time had succumbed to Satan's temptation to renounce God, he would have been kept down from the ultimate higher world of heaven. But, because he was strong and durable (as silk), he rose to heaven in his original shape.

The references, in this essay, to loops, strings, ribbons, and twine are obviously bindings. Franklin's kite was bound on crossed sticks. Christ, as we know, was bound on the cross. Specifically, the silk ribbon and the heavy, rough twine join – for the Key. This joining is symbolic of the embodiment, in Christ, of his divine and the human qualities. Furthermore, the silk ribbon will remain dry in the safe cover of a door or window, but special care must be given to ensure that the twine does not touch the "Frame of the Door or Window." The divine, in other words, is protected – while special care must be given to the weaker twine. The door and window are safe havens for the divine. For the weaker human element. They are "framed" as a potential means of escape – perhaps symbolizing temptation.

The Key for which these bindings join is the archetypal key – the "key of Eternal Life that opens up the gates of death on to immortality" (167). The key needs fire from above to unlock the gates to heaven.

The purpose of the kite is to attract "Electric Fire." Symbolically, there is a "parallel between fire and life, ...both must feed upon other lives in order to keep alive" (106). In this paradoxical way, Jesus died so that mankind could live. Additionally,

> Karl Jung comments that in some traditions the cross is a symbol of fire and of the sufferings of existence, and that this may be due to the fact that the two arms were associated with the kindling sticks which primitive man rubbed together to produce fire. (69-70)

According to Franklin's essay, when the Key has been "charg'd" and the Electric Fire has been "obtain'd," then, "Spirits may be kindled" with the help of a "Glass Globe" (the world). What are the results of this experiment? That "the Sameness of the Electric Matter with that of Lightening [be] completely demonstrated." This is another way of highlighting the relationship of man-made "fire," science, with natural "fire," religion.

Franklin's allegory may have been an unintentional result on his part. On the surface, this is a simple process essay. However, clearly he has the reader look at the hand on the cross – then, he narrows the focus to the finger – then, in increasingly sharper focus, he has the finger point (at the knuckle) to the text. Franklin's words literally tell the reader to look closely at the text. The resulting tension of rationalism and spiritualism subverts and illuminates this text. If Franklin's aim was to unify mankind, then indeed, in this Kite text, he accomplished a fusion of the major oppositional concerns of the Enlightenment – science and religion. Can we assign authenticity to this reading of Franklin's text? Philosopher Mercia Eliade asserts:

> two points of view are only superficially irreconcilable..., for it must not be thought that a symbolic connotation annuls the material and specific validity of an object or action. Symbolism adds a new value to an object or an act, without thereby, violating its immediate or "historical" validity. (Cirlot xiv)

Like Eliade, I believe that the paradox in this text makes it *more* exciting and adds *more* depth – yet, in no way does it deter from conventional, historical interpretations. Furthermore, I've read other Franklin essays with similar word choices, but not similar patterns of an underlying crucifixion message. Because Franklin was deeply versed in Presbyterian theology, this implies that his word choices were deliberate. Therefore, I believe that "The Kite Essay" is a "special case" of an Enlightened man illustrating a striving – consciously or subconsciously – for balance in the decidedly unbalanced world of the American identity crisis.

WORKS CITED

Cassirer, Ernst. The Philosophy of the Enlightenment. Princeton: Princeton UP, 1951.

Cirlot, J.E. A Dictionary of Symbols. Barnes and Nobles; 1995.

Franklin, Benjamin. "The Kite Experiment." Writings: Silence Dogood: Poor Richard's Almanacks, The Autobiography; Essays; Letters . New York: The Library of America, 1987. 475–477.

– – –. "Letter to Joseph Huey." Writings: Silence Dogood: Poor Richard's Almanacks, The Autobiography; Essays; Letters . New York: The Library of America, 1987. 374–375.

Gay, Peter. The Enlightenment, An Interpretation: The Science of Freedom. New York: Norton, 1969.

The Doorway to Wildness: Four Poems by Muriel Rukeyser and Adrienne Rich

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In Women who Run With the Wolves, Clarissa Pinkola Estés writes of the Wild Woman, the "force which funds all females" (8). According to Pinkola Estés, the Wild Woman is the innate source of women's creativity, strength, and harmony. She theorizes that, through socialization and domestication, women have become separated from their wilder selves. She writes:

> I call her Wild Woman, for those very words, wild and woman, create llamar o tocar a la puerta, the fairy-tale knock at the door of the deep female psyche. Llamar o tocar a la puerta means literally to play upon the instrument of the name in order to open a door. It means using words that summon up the opening of a passageway. (6)

This summoning of a door comes when a written or spoken word, line, or story is "so resonant, so right, it causes us to remember, at least for an instant, what substance we are really made from, and where is our true home" (7).

Four poems by Muriel Rukeyser and Adrienne Rich operate as llamar o tocar a la puerta by demonstrating for the reader the steps necessary in rediscovering the Wild Woman. Rich's "Diving into the Wreck" and "Integrity" and Rukeyser's "The Poem as Mask" and "The Speed of Darkness" illustrate the steps a woman must complete to regain contact with her wilder self. Pinkola Estés outlines these steps in the course of her book. First, a woman prepares for her journey. Then, she descends through her self, past the socializations and restrictive standards placed upon her by patriarchal society. Once she has cleared this wreckage, she explores what she has found. Through this exploration, she experiences a revelation or personal change. Finally, she returns to the outer world and lives with her new knowledge.

Of the four poems, Rich's "Diving into the Wreck" most explicitly demonstrates Pinkola Estés' five steps. The poem's narrative directly parallels these steps. On a literal level, "Diving" describes a woman scuba diving. The poem begins with her preparation for the journey:

> First having read the book of myths,
> and loaded the camera,
> and checked the edge of the knife blade,
> I put on
> the body-armor of black rubber
> the absurd flippers
> the grave and awkward mask. (1-7)

Rich, as the poet and as the speaker, has familiarized herself with myths surrounding gender and status, suggesting she recognizes the parts of her self which have been imposed upon her by patriarchal society. She must find the parts which are real.

Rich also prepares by bringing objects which are not instrumental to her movement or her physical survival. She brings a camera, suggesting she begins the journey with the goal of recording it for others. She intends to return and share her new knowledge; like the poem itself, her journey begins with the objective of communication. The knife, however, implies that the journey she makes will be dangerous. Rich writes, "It's exhilarating to be alive in a time of awakening consciousness; it can also be confusing, disorienting, and painful" (On Lies 34). A woman who searches for her Wild Woman runs the risk of becoming whole but socially unacceptable. She also risks uncovering parts of her self which she is not ready to recognize or accept. Rich knows a journey into consciousness can be dangerous, and she illustrates that in the preparatory stages of the poem.

"Diving" uses an evocative metaphor which incorporates the idea of the second stage, descent. Rich literally descends from the schooner, first down a ladder and then through the water. She crawls "like an insect down the ladder," suggesting the awkwardness with which she proceeds (30). With no one to instruct her, she must learn on her own through trial and error. Rich reveals her apprehension; " . . . there is no one / to tell me when the ocean / will begin" (31-33). Her statement suggests that she wants someone to tell her what to expect, but although she is fully equipped with others' ideas, she must continue her journey alone (Keyes 152). Rich's statement suggests the solitary nature of an exploration of the self and reiterates the possible danger which she prepared for earlier in the poem.

In the third step in "Diving," Rich explores the wreck, which can represent her past, her subconscious, and Western culture (Martin 189):

> I came to explore the wreck.
> The words are purposes.
> The words are maps.
> I came to see the damage that was done
> and the treasures that prevail. (52-56)

Her first goal is to assess the damage which was done to her while living under masculine control. The myths she read in preparation for the journey now reappear as a guiding force as she learns about herself. The words are "purposes" and "maps," stressing the importance of language and the need for communication. This relates back to the camera at the beginning of the poem. As she observes the damage, Rich prepares to pass her experience on to others; the references to communication connect to stress the need for shared knowledge.

Rich's second goal in her exploration is to salvage herself. She, as the speaker of the poem, must sift through her experience to find her identity as a woman. " . . . This drive to self-knowledge, for women, is more than a search for identity: it is a part of our refusal of the self-destructiveness of male-dominated society" (Rich, On Lies 35). The treasures she will salvage "prevail," suggesting that they exist in an important part of every woman, and that they will prove more powerful than the masculine influence. The word "treasures" implies that she will find an immense wealth when she develops her identity; her identity as a whole woman is valuable. This process of salvaging is necessary before she can, in a revelation, develop a new identity. She has achieved this step through realizing which parts of her are not her own.

Rich experiences a physical transformation in "Diving." When she enters the fourth stage of revelation, she becomes the objects she sees. She becomes "the mermaid whose dark hair / streams black, the merman in his armored body," "he / whose drowned face sleeps with open eyes," and the wreck's "half-destroyed instruments" (72-73, 77-78, 83). She has identified and acknowledged all of the dissimilar, contradictory, and complex details which comprise her true self. Her preparatory reading of the "book of myths" has given her the knowledge she needs to experience this transformation. In learning what society has imposed upon her, she is able to focus on any fragment she finds which has not been predetermined by masculine influence. Focusing on such a fragment results in her revelation. This union between the speaker and the wreck in the revelation suggests not only the unification of multiple interior selves, but the possibility for other women to experience the same union (Ostriker, Stealing 203).

After experiencing such a revelation, Rich must return to the rest of the world to live anew. However, Rich's poems "are, by their nature, more about method, about preparing oneself, about 'the will to change' than they are visions of a final resting place" (Kalstone 156). "Diving" ends:

We are, I am, you are
by cowardice or courage
the one who find our way
back to this scene
carrying a knife, a camera
a book of myths
in which
our names do not appear. (87-94)

Rather than the final resting place, the reader sees potential in this poem; she will find her way "back to this scene" (90). Rich presents the potential for living a full, unfragmented life, rather than an idealized picture of that life. She forces the reader to conjure some of the poem's images, emphasizing the reader's role in the triad. Rich gives the reader an incentive to pursue her wilder self by giving a suggestion of the outcome. Here, she creates llamar o tocar a la puerta by enticing the reader's curiosity.

While "Diving" describes a woman scuba diving, "Integrity," in an extended simile, describes a woman who is somewhere in a northern wilderness, observing her surroundings as well as examining her self. In "Integrity," we see the speaker's contemplation of her self only through her contemplation of her surroundings; she hovers around the stages of exploration and revelation. She sees the objects around her, noticing light and color. "The light is critical," she says (15). She sees "The glitter of the shoal / depleting into shadow" (18-19). The "stand of pines" is "violet-black really, green in the old postcard" (20-21). She notices the difference between the image of the area which was handed to her on a postcard and the reality of the scene; this parallels women's realization that the picture given by patriarchal society is not necessarily a true picture of reality. The realization of the need for a new feminine truth is another key to finding the Wild Woman. The distinction between truths allows Rich to renounce her "obedience to the fathers and recognize that the world they have described is not the whole world" (Rich, On Lies 207). This rejection of patriarchal "truth" is imperative in uncovering the wild self.

In "Integrity," Rich does not travel back over the water to civilization, but she does leave the two stanzas of introspection to return to the observation of her surroundings. The poem ends with a description of the cabin, its interior, and its former occupants. She concludes the poem with the lines, " . . . critical light / imperceptibly scalding / the skin these hands will also salve" (56-58). The word "critical" suggests importance as well as criticism, combining differing meanings in one word. The image also implies that the sun which burns her is the same sun which gives her light by which to examine herself.

Much as the "critical light" both burned and illuminated the need for change in Rich, "The Poem as Mask" presents presents Muriel Rukeyser's examination of herself in critical light. "'The Poem as Mask' is a myth of self-healing based on the process of critique" (DuPlessis 294). The speaker experiences a revelation based upon her critique of her previous behavior. The poem begins:

When I wrote of the women in their dances and
   wildness, it was a mask,
on their mountain, gold-hunting, singing, in orgy,
it was a mask; when I wrote of the god,
fragmented, exiled from himself, his life, the
   love gone down with song,
it was myself, split open, unable to speak, in
   exile from myself. (1-5)

Rukeyser experiences a twofold revelation in this poem. She first realizes that while she has seemed wild, she has really been hiding behind a mask of wild appearances. Just as Rich put on body armor, flippers, and a mask to begin her journey, Rukeyser first experienced life behind the mask before becoming able to attempt a change. Similarly, most women live behind masks for much of their lives and must reject those masks as they discover their wilder selves.

Rukeyser then takes the step of rejecting the mask. Once she has recognized and named her creations as ones she made under the influence of the mask, she is able to take her first step toward change. In naming the mask, she becomes able to identify and fight it. She has made the step of identifying patriarchal intrusion. It is this step which gives her the power to cry out, "No more masks! No more mythologies!" and to conclude the poem, "Now, for the first time, the god lifts his hand, / the fragments join in me with their own music" (10-12). Like Rich, she has joined the fragments of herself. The lifting of the god's hand suggests the removal of patriarchal control; she breaks away from the habits of her past to form a new life.

Rukeyser's "The Speed of Darkness" is a thirteen part poem, each section of which conveys a different emotional state, from angry to fearful to resentful. She includes statements of belief about the working of the world, statements which seem to have been developed through the process of analyzing the different images she presents. In the poem, the speaker experiences several revelations.

The strongest revelation in the poem occurs in the third and fourth parts. They begin:

> 3
> Stillness during the war, the lake.
> The unmoving spruces.
> Glints over the water.
> Faces, voices. You are far away.
> A tree that trembles.
>
> I am the tree that trembles and trembles.
>
> 4
> After the lifting of the mist
> after the lift of the heavy rains
> the sky stands clear. (11-19)

By using war as a context for the poem, Rukeyser creates an immediate sense of foreboding and uneasiness, much like the uneasiness developed in "Diving into the Wreck." The speaker's trembling is a physical sign of an inner state of turmoil, one which needs to be changed.

The third section is composed in entirely endstopped lines. Most of these lines contain fragments of sentences. Together, they suggest Rukeyser's thoughts are incomplete and disconnected. At the same time, she is noticing the absence of someone far away. However, in the fourth section, she suddenly becomes able to form one complex thought which spans several lines and is much more cohesive in its content. Something has occurred between these two stanzas which has changed her entire thought process. According to Denise Levertov, poetry makes more use of space than prose does (60). In allowing a change to take place in the space between to stanzas, Rukeyser forces the reader to contemplate what may have happened, and how she may experience a parallel change. In the space between the stanzas, Rukeyser found a source of inner strength which has allowed to her exist fully without fear; she has found her Wild Woman.

A second revelation occurs through the relationships between words in the conclusion of the fourth section:

> I remember the buildings are space
> walled, to let space be used for living
> I mind this room is space
> this drinking glass is space
> whose boundary of glass
> lets me give you drink and space to drink
> your hand, my hand being space
> containing skies and constellations
> your face

> carries the reaches of air
> I know I am space
> my words are air. (21-32)

The second revelation can be seen in the progression of the meanings of the word "space." Its first use is an abstraction, suggesting only a place in which to live. Buildings are reduced to their space rather than their structure; the focus is on absence or emptiness. Then, Rukeyser shrinks the focus from a whole building to a single room, then from a room to a glass. The abstraction slowly solidifies. The boundaries of a building, walls, and glass enclose the space. But, after the glass "lets me give you drink and space to drink," the abstraction expands again. The idea of the hands as space containing constellations suggests limitlessness. The constellations also fill the spaces which were left empty in the earlier lines. In saying "I know I am space / my words are air," Rukeyser reflects back to the "reaches of air," and again suggests limitlessness. She takes the abstraction of space as a large area with a use down to a single point of focus, then allows it to open and encompass everything. This suggests that she has, in the course of this observation, realized her own limitless potential. The uses of the word "space" relate to each other and to the Wild Woman; Rukeyser's discovery of her limitless power is like the discovery of the Wild Woman.

Adrienne Rich and Muriel Rukeyser leave these poems as "a map for those who follow . . . " (Pinkola Estés 15). They leave examples of Pinkola Estés' five steps to finding the Wild Woman as well as evocative descriptions of individual revelations. Their creation of llamar o tocar a la puerta through these descriptions gives the reader both the means and the incentive to search for her own Wild Woman.

Works Cited

DuPlessis, Rachel Blau. "The Critique of Consciousness and Myth in Levertov, Rich, and Rukeyser." Shakespeare's Sisters: Feminist Essays on Women Poets. Sandra M. Gilbert and Susan Gubar, eds. Bloomington: Indiana UP, 1979. 280-300.

Kalstone, David. Five Temperaments. New York: Oxford UP, 1977.

Keyes, Claire. The Aesthetics of Power: The Poetry of Adrienne Rich. Athens: U of Georgia, 1986.

Levertov, Denise. Light Up the Cave. New York: New Directions, 1981.

Martin, Wendy. An American Triptych: Anne Bradstreet, Emily Dickinson, Adrienne Rich. Chapel Hill: U of North Carolina, 1984.

Ostriker, Alicia Suskin. Stealing the Language: The Emergence of Women's Poetry in America. Boston: Beacon, 1986.

---. Writing like a Woman. Ann Arbor: U of Michegan, 1983.

Pinkola Estés, Clarissa. Women Who Run With the Wolves: Myths and Stories of the Wild Woman Archetype. New York: Ballentine, 1992.

Rich, Adrienne. Blood, Bread, and Poetry. New York: Norton, 1986.

---. "Diving into the Wreck." The Fact of a Doorframe: Poems Selected and New, 1950-1984. New York: Norton, 1984. 162-64.

---. "Integrity." The Fact of a Doorframe: Poems Selected and New, 1950-1984. New York: Norton, 1984. 273-74.

---. On Lies, Secrets, and Silence. New York: Norton, 1979.

---. What Is Found There: Notebooks on Poetry and Politics. New York: Norton, 1993.

Rukeyser, Muriel. The Life of Poetry. New York: Current Books, 1949.

---. "The Speed of Darkness." A Muriel Rukeyser Reader. Jan Heller Levi, ed. New York: Norton, 1994. 228-32.

---. "The Poem as Mask." A Muriel Rukeyser Reader. Jan Heller Levi, ed. New York: Norton, 1994. 213.

The Relationship Between Cognitive Growth, Journal Writing, and the Development of Critical Thinking

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Psychology research in the area of cognition shows a transition from concrete to abstract thinking that occurs in late adolescence. A new college student questions old ways, values, and patterns; these questions are a central part of their identity formation process. This shift to abstract thinking manifests itself in authentic and mature writing that demonstrates critical thinking. By researching the cognitive stages and investigating different journaling techniques, we will show that journaling encourages identity exploration and facilitates cognitive growth. In the footsteps of Piaget, we assert that knowledge of cognitive development in late adolescence should impact curriculum. If this cognitive shift is more fully understood, then educators can create curriculum to foster students' critical thinking skills.

The shift from concrete to formal operations, as defined by Piaget, is important because full formal operations enable adolescents to think abstractly. This cognitive transition is significant because it is a prerequisite for writing with authenticity -- an authenticity that demonstrates critical thinking and personal struggle with a topic. How do educators in any capacity encourage the growth of formal operations in new college students and thus foster critical thinking skills? Journal writing is a practical avenue for personal expression that shows students the connection between writing and thinking. Journaling is simply writing down what you are thinking and hence it becomes obvious that writing is a thinking exercise.

"How can I know what I think until I see what I say?" Edward Morgan Forster succinctly captures the purpose for including writing in freshman classes. Journal writing releases students from the perceived pressure of authority and grades that might inhibit their willingness to struggle with a paper topic. Until students learn that their ideas can take the form of words on paper, their essays will continue to regurgitate information obtained from what they consider more credible sources. And professors will continue to be disappointed in the performance of freshman students, whose papers, again and again, fail to meet their expectations.

Information gathered from two Seattle University English professors, Bean and Iyer, confirms that a great majority of freshman papers do not meet their expectations of mature writing. Bean discussed students' fear of actively participating in writing as a learning process. Bean instructs his class through lectures, examples of others' writing, and written assignments expressing his expectations for papers; also, students are encouraged to go to the Writing Center. This format of instruction is very similar to Iyer's instructions for writing papers in her English 110 class. Iyer has experiences that are similar to Bean's; in her current class of 23 students, 2 are mature writers who came to this college course with that skill intact. Unfortunately, her teaching of writing does not seem to be changing the level of mature writing among students in her class. Students' writing does improve by the end of the quarter, but it still lacks authentic voice and conviction -- the content of the paper that shows critical thinking and confidence. Generally, Iyer finds that new students lack negotiating strategies because they are dealing with many acculturation issues: separating from their family, finding their own food, establishing friendships, managing newfound freedom, learning the computer and library systems, and coping with homesickness. Furthermore, most of her students are "empirically oriented." In other words, they process physical reality and have difficulty grasping underlying concepts. They lack the intellectual depth to distinguish fact from fiction and are unable to ask questions themselves. The intellectual growth that is needed to become a mature writer "can't be built in a quarter. It comes from base education" (Iyer). For those students that enter college as mature writers (other than nontraditional students) Iyer asserts that they bring with them depth of experience, deep thinking, and a strong inquiry method. Interestingly, her star writer, "Sarah" (name purposefully changed), keeps a journal.

Iyer's assertion that new students are "empirically oriented" and unable to grasp abstract concepts supports our investigation of cognitive development. An understanding of the cognitive growth of adolescents and young adults will inform our ability to help students. In addition to researching the cognitive stages, we will investigate the different journaling

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techniques explored by psychologists and English experts, with the belief that journaling will promote the thinking and writing process. "Valuing a personal process such as journal writing in education presupposes some dramatic and fundamental reconceptualizations in theories of learning, in notions of thinking, and in the purposes of writing" (Zacharias 265). The process of learning is intertwined with cognitive growth. A well known French psychologist, Jean Piaget, outlined the four stages of cognitive development: sensorimotor (birth to 13-24 months), preoperational (18-24 months to 7 years), concrete operations (7 years to 12 year), and formal operations (12 years and up). In addition to outlining the stages of cognitive growth, Piaget, the founding father of cognitive psychology, recommended changes in school curriculums that were appropriate to each cognitive stage. The curriculums were also intended to foster students' growth beyond their particular stage. Our research is concerned with formal operations as well as a curriculum recommendation that will foster the growth of new college students.

With the advent of adolescence comes the ability to think about abstract relationships, grasp syllogistic reasoning, and comprehend the elements of scientific thought and methodology (Morton Hunt 358, 361). Adolescents can formulate hypotheses, concoct theories, and systematically examine the possibilities in a puzzle, mystery, or scientific problem. Furthermore, adolescents can think not only about the concrete world but about possibilities, probabilities and improbabilities, about the future, about justice, and values (Hunt 362). The new skills brought by formal operations help to foster the broad questioning of old ways, old values, old patterns; this questioning is a central part of the identity formation process. The shift to formal operations enables the young person to rethink many aspects of his life, but it does not guarantee that he will do so (Helen Bee 474). As students mature cognitively, they begin thinking critically; however, transposing this thinking process into writing is a difficult transition that often frustrates educators and writing consultants alike.

"More complex mental activities, such as abstract reasoning, continue to develop into the early twenties" (Glenn Myers Blair 59). The cognitive shift from the concrete operational stage to the formal operational stage is necessary for critical thinking and authentic voice in the writing process. A students' thinking process is confused by the struggle for identity formation, which impacts their ability to write clearly and therefore aggravates the professor and writing consultant. The cognitive stage of formal operations allows students to consider alternatives to their current reality. As college students try out possible roles, they achieve a clearer identity than they had as high school students. In a study by O'Malley & Bachman it was found that, between ages 13 and 23, the self-concept usually becomes more positive. A clearer, more self-affirming identity is forming and with it comes a greater sense of control over one's future. Successful identity achievers are high in both exploration and commitment (Philip H. Dreyer 123). Thus, identity can be fostered by surrounding students with an educational environment that stimulates exploration and commitment. "For most young people a clear identity is not achieved until college age, if then, so the identity process continues" (Bee 473). The opportunity to write in a journal for class provides stimulating exploration that is simultaneously a commitment. Journal writing can help with the process of discernment and ease students into writing with conviction.

Students are undergoing great change in late adolescence. Norma Haan is a psychologist who suggests that early adolescence is a time dominated by assimilation, while late adolescence is primarily a time of accommodation (Bee 470). Assimilation, according to The Developing Child, "...involves the "taking in" of new experiences or information into existing schemes. Experience is not taken in 'as is,' however, but is modified (or interpreted) somewhat so as to fit the preexisting schemes" (485). Contrarily, accommodation is when a "...person modifies existing schemes to fit new experiences, or creates new schemes when old ones no longer handle the data" (485). Faced with a new social structure in college, and perhaps a new city and new home, students are overwhelmed and forced to accommodate in many areas of their life. Accommodation in the classroom as well could leave students feeling completely stripped of the skills that were valuable and useful in high school. Immature writers shy away from struggling with a paper because they are not yet comfortable with the process of accommodation in the classroom; accommodation was probably not needed in high school compositions.

Frank Smith explores the accommodation and assimilation between language and thought in his book Writing and the Writer. He argues that there is an ongoing thought process that is constantly accommodating and assimilating new information and perspectives. This process is unseen; the results are the language and writing that are produced.

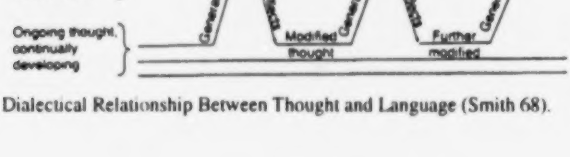

Figure 1: Dialectical Relationship Between Thought and Language (Smith 68).

As Frank Smith's model for the thinking process underlying the writing process suggests, nonconscious elements in writing are important and unavoidable. George Hillocks Jr. suggests that if this model is true, we need to take advantage of it. "Free writing and journal writing as means of generating content and language that helps reveal purposes to the writer are important in this regard" (Hillocks 94). Journaling is one way to bring this thinking process to the student's conscious attention and help them bring the unconscious elements of the writing process under control.

Journaling is writing down what you are thinking. There is most certainly a dialectical relationship between thinking and writing, both enhancing the other and thus fostering a student's cognitive growth. "Specific thinking processes have been found . . . to be demonstrable and teachable and are therefore regarded by many educators as skills" (Zacharias 266). As the need for teaching of thinking processes grows, the implementation of journal writing into curriculum should also grow. "Writing has come to be seen as a tool for learning . . . rather than merely an evaluative measure" (Zacharias 266). There are authoritative statements from educational practitioners that confirm the value of journal writing. In her article, Martha E. Zacharias quotes Strong, who calls journaling an integration of mind and body and "a means -- perhaps the best means -- to make knowledge personal, connected, and accessible to the self" (265). Zacharias elaborates on the relationship between thinking processes and journal writing in three important areas: classifying, criticizing and looking for assumptions, and decision making. These three skills, like Piaget's curriculum suggestions, both rely on and foster cognitive growth. A journal is helpful for "classifying" -- sorting out and grouping to develop order among things -- because: ". . . journals are powerful teaching-learning tools that provide students with opportunities for personal growth as well as language and cognitive development" (267). "Criticizing and looking for assumptions" connects to cognitive growth and identity formation. Zacharias bolsters our assertion about the connection between thinking and writing with specific examples from trained professionals. After all, "...journal writing assists the development of thinking processes. . . . educators believe that this relationship can be enhanced by providing guidelines for specific modes of response in journal writing" (269).

There are many ways to encourage the shift to critical thinking, but including journaling in curriculum has several advantages. Ann Berthoff points out that journaling allows room for ambiguity, while strict academic writing may not. Peter Elbow supports the value of eliminating the audience in writing. Jana Staton argues that a journal can serve as a means of prompting dialogue and communication between teacher and student. Others justify using journals in their classroom by pointing out that writing it down forces students to mull over their own thoughts and lets teachers keep track of this process. Peter Stillman talks about journaling as a private process that offers freedom and multiple purposes to the writer; in contrast, academic writing often limits the writer to a single purpose of informing or convincing.

The most obvious and inherent aspect of journaling is that it is a self-conscious and self-reflective act (Lowenstein 87). This characteristic is possibly the most helpful in aiding the student's shift to critical thinking and mature writing. For many students, writing and thinking are separate processes; writing is a separate, finished product that is distinct from thinking. Journaling gives the student the opportunity to recognize the close link between these processes, and to do so within the realm of their own experience. Pat Belanoff stresses the importance of journaling in the classroom because, "students begin to see them as repositories of their own developing thoughts. In fact, in reflecting on their journals, this is a development they often find fascinating: the way their own minds work" (Belanoff 107). As any mature writer would attest to, this self-knowledge is critical in attaining both depth and clarity of expression. Journaling, whether it is about a specific text or not, helps students nurture their ability to directly express what they are thinking in writing. When students are not overly concerned with performing for an audience, they can ". . . become consciously aware . . . That when they read, they enter into a conversation with. . . themselves about the text" (Belanoff 103). This process is self-interactive and helps the student realize the presence of underlying thought that is continually going into their writing.

One particularly useful method of journaling in the classroom is interactive journaling. While this style sacrifices some of the privacy that a journal can offer, it also promotes dialogue which is one of the most useful tools in a process of self-reflection. The primary purpose of interactive journaling is to give the instructor the opportunity to offer the student thought-provoking feedback about their ideas. Feedback is an essential part of the learning process. However, "the ability to give and utilize feedback, like other measures of communication performance, increases with age" (Asher 191). As students mature cognitively, the feedback and interaction that an instructor gives can be very useful. According to Dr. Iyer, "Journal writing works great for upper division courses because it continues the dialogue of reading."

Jana Staton praises the power of response to student journals as a chance to involve not only the written interactions between the student and the instructor, but their minds as well. Staton says that the value of students writing freely in a journal is understood, but ". . . what needs to be stressed and clarified is the importance of written, interpersonal dialogue as one means for introducing [students] to the open, expressive, thoughtful uses of writing as a mode of knowing oneself and knowing the world" (Staton 47). While dialogue is often viewed as a primarily oral exchange, the activity is easily adaptable to writing. By introducing dialogue to writing, the teacher is taking the monological performance pressure off the student, eliminating the anxiety centered around a solo, graded assignment, and promoting the importance of collaboration in thinking and writing. This approach reduces the authoritarian distance between student and instructor, but at the same time, as Staton points out, " . . . it is the quality of the response . . .that creates endless opportunities for learning" (53). While the college student is at a developmental stage of questioning old ways and ideas, the dialogue journal is designed to create interactions ". . . in which two minds can unite to bring about new understanding, new ideas, new possibilities" (54). A simple question from an instructor can illicit a thoughtful response. Vygotsky hypothesized that writing is more directly connected to internalized thoughts than speech is, allowing closeness of thought and expression to be retained in the written dialogue (124). Research has shown that ". . . teachers who are willing to . . . Make their own writing interesting, quickly draw students into making more elaborate responses" (Staton 56). This process of intellectual growth and self-realization is inherently tied to dialogue in some form or another.

Language and thought are fundamentally dialogical, and are acquired through conversational interaction. Journaling offers a practical way to carry this conversation into the classroom.

While the reasons for journaling are abundant and easy to grasp, the actual implementation of journaling in the classroom is more complex. The implementation of these tools in the classroom can disrupt what may be a comfortable teaching style, and can increase mutuality between students and the instructor. One of the most difficult aspects of implementing a journaling assignment or project in class is the loss of control and authority that the professor may consequently experience. The most staunch supporters of journaling embrace this loss of authority. However, Dawn Latta asks the key question: "How do we instruct students without dominating students' options in writing, and how do we return the control of writing to the students who are doing the writing" (Latta 60)? By implementing journaling in the curriculum, Latta says that the students own their ideas more fully, and are more likely to claim rather than attribute them to some greater authority like the teacher. However, in addition to owning the ideas, students become more conscious writers because, "By using in-process journals students, not teachers, own the problems associated with their writing" (Latta, 62). This ownership of ideas and difficulties does relegate more authority to the students in the classroom. While this idea may be threatening to instructors, it has several positive results -- like increased class discussion and participation.

Other concerns that teachers may have regarding journaling should also be considered. O.T. Kent addresses several of these objections to the method. "Certainly good spelling and grammar are important, but I want my students to take risks in their thinking, and it would defeat the purpose to insist that they perfect their prose first. The appropriate time to evaluate one's prose is *after* one has developed one's thoughts. The journal is a place to do the latter and not the former" (275). Iyer also has concerns about transferring journal writing into good writing; however, the point is not to necessarily create good writing but to develop thinking skills. As the student grows comfortable with thinking critically, they will also grow more confident in their ability to write with conviction. Kent also makes it clear that journaling cannot logically stand alone as a sole evaluative method, but that it should be used in conjunction with papers, tests, and other assessment tools. He admits that in response to the overwhelming amount of time involved in reading an entire classroom's journals, he has had to limit the number of times that students turn them in. Regardless of the time constraint, Kent praises the experience of journaling in his philosophy class: "If I want [students] to experience the joys of critical thinking and to develop their own distinctive responses to the world, then I must help them do philosophy in their own territory. Student journals provide me the opportunity to do this" (Kent 276).

There are precedents for using journals in almost every academic subject, from philosophy to mathematics. Journaling is easily implemented in any class where there is assigned reading in the form of reader response journals. With some additional effort, however, it is possible to implement this method in technical classes, mathematic classes, and science classes. Judy Grumbacher writes about "how writing helps physics students become better problem solvers" (Grumbacher 325), and others write that "journals [in a chemistry class] are a particularly appropriate forum for students' contemplation of the cultural context in which specialist learning takes place" (Meese 346).

There are many different titles that a teacher can give journaling: thinking journal, learning journal (Iyer), learning log, reading journal, reading log, focus log, and topic journals. The journal title can influence a student's perception of the assignment. Teachers also have options regarding the amount of structure that they can use within a journal. Structured journaling was born in the 1970's when psychologist introduced a journaling technique for therapy. The client was instructed to create a three column journal and chart events in their life, their initial thoughts and emotional reactions to that event, and their later, more rational evaluation of the event. This structure was intended to show unhealthy patterns of thought and thus help the client ameliorate them. By applying a variety of columning and sectioning techniques, teachers can get more specific "answers" as well as help students focus their thinking. One student writes: "Sometimes, I notice, I will realize that something is wrong after I write it down. Something about the writing it out makes me realize that it is not so -- like I can see it physically and then mentally know that it is wrong" (Belanoff 107).

This student's insight is a testimony to the value of journal writing. The implementation of journal writing into the curriculum of freshman English classes promotes the interaction between writing and thinking. There is overwhelming evidence from psychologists and English teachers alike that supports journaling as a tool for promoting thinking processes. The evidence from Bean and Iyer suggests that students do not bring fully mature abstract thinking skills to college. Because the transition to college life requires accommodation in almost every aspect of a new student's life, learning how to accommodate new thinking skills in the context of a daunting writing process is difficult. Thus, in the footsteps of Piaget, we recommend a curriculum tool that fosters the shift to full use of formal operations. The variety of journals, such as interactive, personal, and reading journals, coupled with the freedom of structure, allows the instructor flexibility when implementing journaling. The jury is out: there is a dialectical relationship between thinking and writing. Writing in a journal pushes the student to struggle with concepts and ideas (formal operations) that are beyond the empirical realm; simultaneously, a strong grasp of formal operations will inform the writing process. The cognitive connections provided by journaling are valuable and empower the student to discover their own identity, ability, and personal voice. At times, journaling may even be a revelation: "I enjoy finding out what's in my brain, what comes out, because sometimes I don't know what it's doing or thinking" (Kent 331).

REFERENCES

Asher, Steven R. "Referential Communication." The Functions of Language and Cognition. Ed. Grover J. Whitehurst. New York: Academic Press, 1979. 191.

Bee, Helen. The Developing Child. 7th ed. New York: Harper Collins, 1995.

Belanoff, Pat. "The Role of Journals in the Interpretive Community." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 101-10.

Berthoff, Ann E. "Dialectical Notebooks and the Audit of Meaning." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 11-18.

Blair, Glenn Myers and R. Stewart Jones. Psychology of Adolescence for Teachers. New York: MacMillan, 1964.

Dreyer, Philip H. "Designing Curricular Identity Interventions for Secondary Schools." Interventions for Adolescent Identity Development. Ed. Sally L. Archer. Thousand Oaks, CA: Sage, 1994. 121-140.

Elbow, Peter. "Desert Island Discourse: The Benefits of Ignoring Audience." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 19-32.

Gatlin, Leon. "Losing Control and Liking It: Journals in Victorian Literature." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 111-8.

Graybeal, Jean. "The Team Journal." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 306-11.

Grumbacher, Judy. "How Writing Helps Physics Students Become Better Problem Solvers." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 323-9.

Hillocks, George, Jr. Teaching Writing as Reflective Practice. New York: Teacher's College Press, 1995.

Hunt, Morton. The Story of Psychology. New York: Anchor, 1993.

Kent, O.T. "Student Journals and the Goals of Philosophy." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 269-77.

Latta, B. Dawn. "In-Process and Retrospective Journals: Putting Writers Back in the Writing Process." English Journal 80.1 (1991): 60-66.

Lindberg, Gary. "The Journal Conference: From Dialect to Dialogue." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 119-28.

Lowenstein, Sharyn. "A Brief History of Journal Keeping." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 87-97.

Meese, George. "Focused Learning in Chemistry Research: Suzanne's Journal." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 337-47.

Myers, David G. Exploring Psychology. 2nd ed. Michigan: Hope College, 1993.

Santrock, John W. Life-Span Development. 5th ed. Madison: Brown & Benchmark, 1995.

Smith, Frank. Writing and the Writer. 2nd ed. Hillsdale: Lawrence Erlbaum, 1994.

Staton, Jana. "The Power of Responding in Dialogue Journals." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 47-63.

Stillman, Peter. "Of Myself, For Myself." The Journal Book. Ed. Toby Fulwiler. Portsmouth, NH: Boynton/Cook, 1987. 77-86.

Vygotsky, L. Mind in Society: The Development of Higher Psychological Processes. Eds. And Trans., M. Cole, V. John-Steiner, S. Scribner, & E. Souberman. Cambridge: Harvard University Press, 1978.

Zacharias, Martha E. "The Relationship Between Journal Writing in Education and Thinking Processes What Educators Say About It." Education 112 (1991): 265-269.

Images of Health in Health Magazines

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INTRODUCTION

In recent years many individuals devoted their time, energy and money just to make themselves "look good"--healthy and fit. The efforts can be seen in the abundant video fitness programs available for purchase and the fitness centers established; not to mention, the exercise equipment which have become popular advertising items one can find in the media. In the media, one can easily find something that is being promoted that can help all of the so called "unfit" people get into shape in no time flat--from Jenny Craig Fitness Program to Nordictrack. A critical issue embedded in this fitness craze is not if these programs or machines can produce the promised results for the consumers or not, but, more importantly, what is the meaning of "health" that is promoted in the media messages. This critical issue warrants the attention of the communication researchers as well as the consumers, since most of the health related activities or products seems to promote the economic interests of the "health industry." A critical researcher or a careful consumer needs to look into the meaning of "health" been presented in the popular media to determine if this is the "health" that one likes to pursue.

To examine the meaning of "health" in the popular media, one can easily find the presentation of healthy lifestyles or exercises in the television, radio, newspapers, magazines or even in cyberspace. To examine the presentation of health in the media, the researcher studied the health magazines which serve a special population with a strong health and fitness concerns, considering that the television and the radio tend to serve the general public. The health magazines were chosen over the web sites in the cyberspace due to the large amount of visual images offered in the magazines, which allow the researcher to perform an analysis beyond the textual content. The researcher studied the images of health and fitness that are portrayed in the health magazines. The researcher is not intending to argue that these magazines are a fraud, but, instead to reveal the images of health and the underlying meaning embedded in these images.

LITERATURE REVIEW

The cultural studies approach (McQuail, 1984) as extrapolated by Stuart Hall (1973; 1977; 1982) was employed as a theoretical framework for this study. According to Hall (1977) the images portrayed in the popular media are not neutral, instead, they are value laden. More specifically, the media images reproduce the "dominant ideology"--the values and interest of the group of individuals who benefit from the existing power and economic arrangements. The media are believed to serve as a tool of domination for the dominant class by propagating the dominant ideology in the media content (Hall, 1982).

Researchers (Gurevitch, Bennet, Curran and Woollacott, 1982) of the cultural studies examine the media images and how they projected the ideological meanings or the "preferred readings". Students of the cultural studies work to reveal that the media, by being part of the cultural structure, reflect, resemble, and reproduce the dominant ideology of the existing social/cultural arrangements. To uncover the dominant ideology embedded in media products, a critical researcher would perform a close reading of the media images. By performing such analyses, the researcher can uncover a preferred reading suggested in the media text. Guided by the cultural studies, the researcher would be able to reveal a dominant convention or "code" that was placed in the media messages. By offering a preferred reading of the media text, the researcher would be able to demonstrate the reproduction of the dominant ideology in the media.

Utilizing the culture studies as a frame of reference, the researcher hypothesized that the images in the health magazines reproduce the dominant ideology of the society. That is, these images would reflect the values of those who hold the political and economic interest in society today.

METHODOLOGY

In the research, ten health magazines for sale in a supermarket in a Midwest town were randomly chosen to be analyzed. A variety of health magazine were chosen for the analysis; ranging from men's only magazines to women's only, and ranging from magazines of physical body building to ones that deal with the mind. The ten magazines analyzed were: *Men's Workout, Ms. Fitness, Longevity, Exercise For Men Only, Stress Reduction and Weight Loss Workbook, Fitness, Heart and Soul, Diet and Exercise Guide, Slim and Fit Diet and Exercise*, and *Men's Health*. In the close reading of these magazines, special attention was paid to the visual images displayed and the advertisements carried. The findings of the analysis are reported in the following.

FINDINGS

The researcher noted the two most significant areas of investigation in the process conducting the close reading, which are the visual images and the advertisements. By studying the visual images, the researcher noted the target readers of the magazines, the amount of work required to be in shape, and the meanings of health and fitness for men and women. In the examination of the advertisements carried, the researcher noted the products promoted in these advertisements which revealed the economic interests of the magazines and the "health industry."

The visual images

The first item the researcher found to be significant was the target readers that these magazines were produced for. Exactly who is the target reader health magazines are looking for? One would think these magazines are out there for the entire public to enjoy, but they are not. The health magazines seem to be designed for a middle age population only. In the magazines that were analyzed the predominant age group that was being targeted was of people who were in their twenties to early forties. The middle age population was projected in the people that appeared and the products promoted in the health magazines.

The people who appeared in the health magazines all belong to a very narrow age group, which suggests that the magazines are intended for these people. Therefore, one can assume that the middle age group is the population that is most preoccupied with the health concern. Elderly, children, or disabled individuals were not presented in the magazines; therefore one would assume that based on these magazines, these populations do not seem to have a health concern as strong as the middle age population. Also, most of the people that appeared in the magazines are Caucasians. Therefore, it seems that health and fitness are predominantly a Caucasian concern in the American society today.

The next issue that these health magazines seem to suggest is, that with a little work the readers can get themselves in shape in just a few minutes or hours per day. The magazines portray that one can look as good as the model on the front cover of the magazine simply by investing the minimum amount of effort. It was never mentioned anywhere in the magazines that the people presented in the magazines are professionals who trained daily to obtain and maintain the physical shape. What an average reader may not realize is that by exercising on the Nordictrack twenty minutes each time and three times a week will never make him/her look the same as the model he/she saw in the magazines.

The visual images of the models appearing in the health magazines seem to call out an image in the minds of the readers that the goal to pursue of being healthy and fit is a perfect body as portrayed in the magazines. Across the different magazines there seems to be a definite trend forming regarding the meaning of being healthy and fit. The meaning varies based on gender differences. For men, the images of health are represented by the size and the tight muscle tone of the arms and the chest. For women, those are represented by the flat abdominal region and the firmness of the gluten--"Buns of Steel.". One interesting observation is that it seems to be a goal for the men to gain weight and muscle mass by doing various exercises and taking various formulas. The opposite seems to be true for women as women are trying to reduce their weight by doing various exercises and taking various formulas.

The meaning of health and fitness offered in the visual images analyzed seem to be one dimensional for men and women. Only certain areas of the human body are emphasized to represent the meaning of health. This narrow definition and image of health and fitness is not easily obtained by the average Americans. The fact that most of the Americans are unable to look like the models as they see in the magazines, may keep most Americans from trying to be "healthy and fit" as prescribed in these magazines. This common belief may lead to further perpetuation of the one dimensional meaning of health and fitness towards men and women. Mainly, according to this narrow definition of health and fitness, most Americans are "unhealthy and unfit," and many may give up trying to be healthy and fit if they cannot look like the models in a short amount of time. Consequently, many live in the guilt of not being healthy or fit.

The Health Advertisement

When one looked at the products that are advertised in the magazines, the picture of the targeted middle age group is even clearer. The products that are advertised mainly address the health concern of the middle age population. There is a wide range of products advertised in the magazines, ranging from those that deal strictly with the female sex to those that present ways to quit losing the hair. Products such as vitamins, muscle-building supplements and weight-gain formula are targeted for the middle age population.

These magazines carried a considerably large amount of health and fitness products. By targeting the middle age consumer, it is clear that the media and the health industry try to exploit the group of the population that is more likely to spend money on the products than other groups. The magazines and their advertisers are addressing the middle age group of consumers that exhibit the most purchasing power in the society. Therefore, by looking at the target population of these magazines, one can easily see how these magazines serve the economic interest of the dominant class--advertisers and the health industry. The argument which is put forth by the cultural studies scholars (Hall, 1982; McQuail, 1984) that the media are a tool for economic exploitation of the mass population by the dominant class, does have a merit.

The products that were advertised in the magazines seem to suggest that these are the products that a person will have to buy if he/she wants to be healthy and stay in shape. The promotional strategy seems to suggest that in order to get healthy and fit, to purchase these products is necessary. Usually, these are ready made products, all one needs to do is to purchase them and consume them, no extra work is needed. For instance, to obtain a toned abdominal region, one would simply have to purchase an abdominal workout in a jar and just rub it on, as stated in the advertisement of "Vaughn Louise Abdominal Workout Cream." It seems to suggest that by taking these products internally, one can obtain a perfect physical shape. Strangely, these advertisements do not suggest that exercise is needed. Moreover, very few exercise equipment were advertised in the health magazines. Mainly, the products advertised promote a quick and easy way to become healthy and fit in this fast paced society. No hard work is projected in the advertisements, simply purchasing and taking these products, one will be healthy and fit.

All the advertisements promoting health products in the health magazines utilized professional body-building models as endorsers. By associating the products with these "healthy and fit" individuals, these advertisers try to convey to the readers that by purchasing these products, you will be able to look just like these professionals. The promise may be unrealistic, but is embedded in every advertisement. For the consumers who purchased these promoted products, they may not be able to look like these professionals. Instead, by purchasing these products, the consumers approach the feeling of looking like these professionals, and the potential of obtaining the healthy look.

CONCLUSION

One of the effective ways to understand the dominant definition of health and fitness in the current American society is to examine the images of health popularized in the health magazines. When one examines those images, one needs to question the underlying messages embedded. A critical reader has to investigate what is suggested in these images. This study found that the health magazines are the tools for the exploitation of the American consumers by offering one dominant meaning of health to the public. This dominant meaning of health may lead to a false perception that everybody can look as "healthy and fit" as the models presented in the magazines. The perception of health may further lead to the exploitation of the consumers' money and time.

The constant wave of advertisement in the magazines seems to brainwash the public into thinking that they need to buy the products advertised in order to be healthy. By shoving this view on to the public the magazines and the advertisement companies form an impression regarding what it takes to be healthy and fit. The advertisements demonstrate the working of the dominant reading in the media, which serves the interests of the "health industry." This type of advertising exhibits a potential exploitation for the simple fact that there are no information regarding diseases and health concerns such as cancers, AIDS, diabetes. The health magazines studied, sell products and propagate a healthy physical image; they not educate.

There may be many different types of health and fitness magazines for the public to consume, but they are all seem to propagate the same ideal of health--a perfect body, and promote the similar products to obtain the ideal. The visual images and products presented all seem to target the group of people who have the financial means to purchase the product. These magazines all seem to tell the public that anybody can look like the models that appeared in the magazines with just a little time and effort. The exploitation and confusion that are presented in the media warrant the attention of critical researchers and careful consumers. The researcher calls for the construction of alternative meanings/definitions of heath and fitness beyond what is offered in the popular media today. Alternative meanings/definitions that are obtainable, realistic, and addressing to the health interest of the general public, and not the economic interest of the health industry.

Bibliography

Gurevitch,M, T. Bennet, J. Curran and J.Woollacott (eds.), Culture, Society, and the Media. London: Methuen, 1982.

Hall, Stuart, "The Rediscovery of Ideology: Return of the Repressed in Media Studies." In M. Gurevitch, T. Bennet, J. Curran and J.Woollacott (eds.), Culture, Society, and the

Media. London: Methuen, 1982, pp. 56-90.
-----"Culture, the Media and the 'Ideological Effect'." In Curran, James, Michael Gurevutch and Janet Woollacott (eds.), Mass Communication and Society. Beverly Hills: Sage, 1977, pp. 315-348.
-----"The Determination of News Photographs." In B. Cohen and J.Young (eds.), The Manufacture of News. London: Constable, 1973, pp. 176-190.
McQuail, Denis, Mass Communication Theory. Beverly Hills, CA: Sage, 1984.
Men's Workout, (1996, June). Pp. 1-99.
Ms. Fitness, (1996, Spring). Pp. 1-99.
Longevity, (1996, April). Pp. 1-104.
Exercise For Men Only, (1996, June). Pp. 1-146.
Stress Reduction and Weight Loss Workbook, (1996). Pp. 1-66.
Fitness, (1996, April). Pp. 1-114.
Heart and Soul, (1996, May). Pp. 1-96.
Diet and Exercise Guide, (1996, Spring). Pp. 1-82.
Slim and Fit Diet and Exercise, (1996, Spring). Pp. 1-91.
Men's Health, (1996, April). Pp. 1-164.

Blissfully Rude: The Diatribe of ACT-UP

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Since the Greco-Roman era, many groups have resorted to unconventional means in an effort to convey a message. Theodore Windt, a rhetorical critic, defined these bizarre acts as a Diatribe. The Cynics of the Greco-Roman era used the Diatribe, an extemporaneous sermon, to display their dissatisfaction with the public ethics and dominant culture of their time. In modern times, the Diatribe has emerged as a channel for social discontent. The outrageous actions of the AIDS Coalition to Unleash Power or ACT-UP illustrate the power of the Diatribe and very nearly parallel the actions of the Cynics. This paper will explore the genre of the Diatribe, defined by Windt, as it was used by the organization and individual members of ACT-UP. The paper will further examine the rhetorical devices used by the group as well as evaluate their effectiveness.

THE BIRTH OF "DIRECT ACTION"

In Puritan America, the "scarlet letter" was a stigma connected to adultery. Since the early 1980's, it has been connected to AIDS. As the eighties began, the AIDS epidemic threatened to halt the gains made by the gay and lesbian movement in the previous decade. Anti gay forces were quick to take advantage of public concern with AIDS, equating homosexuality with disease. Syndicated columnist Pat Buchanan was in the forefront, "The sexual revolution has begun to devour its children," he wrote in a May 1983 column. He pronounced AIDS to be "nature's revenge...The poor homosexuals: they have declared war on nature and nature is exacting an awful retribution."[1]

But rhetorical attacks from conservatives did not stop in the printed media: the gay community faced a presidential administration which refused to even utter the word "gay" much less address an epidemic which affected them. Ronald Reagan, under whose presidency the AIDS epidemic originated and flourished, had not formally raised the issue until April 1, 1987, in a speech to a group of physicians in Philadelphia--a full seven years after the onset of AIDS in the United States.

As AIDS spread, the government remained impassive, refusing to allocate sufficient funding to the National Institutes for Health to conduct research. While pressuring the government for funds through conventional lobbying efforts during the first few years of the epidemic, gay men in New York and other cities had no other alternative but to raise the needed funding privately. According to Randy Shilts, the only reporter in America on a full-time AIDS beat since 1982 at the San Francisco Chronicle: "No one cared because it was homosexuals who were dying. Nobody came out and said it was all right for gays to drop dead, it was just that homosexuals didn't seem to warrant the kind of urgent concern another set of victims would engender."[2]

A form of group cohesiveness would emerge from this dilemma which proved to be valuable as the gay community sought ways to combat this new disease and continue to fight an old one: homophobia. As time wore on, many in the group began to feel that the normal paths of protest and lobbying were unproductive. They felt that more "direct action"[3] would make them more visible and hopefully taken more seriously in a society that did not. This pattern of thinking evolved into a very vocal and outrageous organization called "The AIDS Coalition to Unleash Power" or "ACT-UP." This organization used a myriad of rhetorical acts to bring its message to the forefront of AIDS policy. Sometimes their methods were reminiscent of the Greek Cynics who had used the Diatribe to convey their messages in the Classical Era.

This essay will explore the genre of the Diatribe, defined by Theodore Windt, as it was used by the organization and individual members of ACT-UP. It will examine the rhetorical devices used by the group as well as evaluate their effectiveness.

ACTING UP: GRECO-ROMAN STYLE

In his essay, "The Diatribe: The Last Resort For Protest,"[4] Theodore Windt traces the history and actions of the Cynics of the Greco-Roman era. He describes them as being concerned with public ethics rather than private morality; as cultural critics rather than politicians. They rejected the strategies of Aristotle to "persuade by drawing on the beliefs of the audience as sources of proof." Instead, they believed that "man's conscience, his logic, and emotions, his perspectives and his attitudes have been corrupted by immoral institutions." To convey their messages, the Cynics incorporated the diatribe, "an extemporaneous sermon"[5] based "on themes drawn from their own doctrines--usually paradoxes which would attract a crowd; and they illustrated them with anecdotes, character-sketches, fables, dialogues against imaginary opponents, topical references, parodies of serious poetry, obscene jokes, and slang phrases."[6]

Windt explains that these tactics of direct action have been resurrected several times in the past few decades: The Beat Generation of the 1950's, the Merry Pranksters of the early 1960's, and by Jerry Rubin and Abbie Hoffman, who formed the Yippies movement of the late 1960's. Indeed, Dr. Martin Luther King, Jr., in his "Letter from a Birmingham Jail,"[7] recognized the need for direct action in certain circumstances because "non-violent direct action seeks to create such a crisis and foster such tension that a community which has constantly refused to negotiate is forced to confront the issue." He continues:

> Just as Socrates felt that it was necessary to create a tension in the mind so that individuals could rise from the bondage of myths and half truths to the unfettered realm of creative analysis and objective appraisal, so must we see the need for nonviolent gadflies to create the kind of tension in society that will help men rise from the dark depths of prejudice and racism to the majestic heights of understanding and brotherhood.

King stated "the purpose of our direct action program is to create a situation so crisis-packed that it will inevitably open the door to negotiation."[8] These types of protests were identical in philosophy to the diatribes of the Cynics. With the emergence of ACT-UP, the traditions of the Cynics seemed to have appeared once more.

ACTING UP: AMERICAN STYLE

The time had come for many gays in America, who were increasingly frustrated with the government's and society's slow reaction to AIDS, to look for other ways to show their disapproval. Their intent was to show that these institutions were hypocritical in their reticence to assist the homosexual community. Radicals within the group had always called for drastic, violent measures to aid the nation in coming to grips with its homophobia, and the AIDS epidemic was no different for them. Others recognized the need for something innovative, refreshing, and controversial that would enlighten the nation to the plight of AIDS infected individuals. One of these people, author Larry Kramer, soon became the voice and driving force behind what would become the organization ACT-UP.

On a Tuesday night in March 1987, the "Decade of AIDS"[9] moved into a new phase. The setting was the monthly speaker's series at New York's Lesbian and Gay Community Center. Onstage was Larry Kramer who started off by asking everyone on one side of the audience to stand up. "At the rate we are going, you could be dead in less than five years," he informed them. "Two-thirds of this room could be dead in less than five years."[10] He went on to criticize the Food and Drug Administration for its slowness in testing and approving experimental AIDS drugs. A billion dollars was being thrown at AIDS, but it was not buying anything that could save the "two-thirds of the people in that room." There were now thirty two thousand cases of AIDS in the United States. Something had to be done. He went on:

> Today's front page of The New York Times has an article about two thousand Catholics marching through the halls of Albany today.... That's advocacy!....Why are we so invisible, constantly and forever?....Did you notice what got the most attention at the recent CDC conference in Atlanta? It was a bunch called the Lavender Hill Mob....They protested. They yelled and screamed and demanded and were blissfully rude to all those arrogant epidemiologists who are running our lives.[11]

The speech was illustrative of Kramer. He was always emotional and always direct. This speech, however, seemed to have caught the popular mood. The audience proposed following up Kramer's rhetoric with action. Two days later, three hundred people met and established a new organization--the AIDS Coalition to Unleash Power. The group decided to focus on one issue--to fight for early release of all experimental drugs that could treat AIDS. Its motto would be "United in anger and committed to direct action to end the AIDS crisis."[12] It was time for action---for screaming and yelling and being "blissfully rude." The politics of anger had arrived.

THE ART OF ACTING UP

Soon after ACT-UP's founding, the new organization got the opportunity to show its mettle. Burroughs Wellcome, manufacturers of AZT, the only drug licensed to treat AIDS, announced that it was pricing AZT at ten thousand dollars for a year's supply. To the ACT-UP members, that price smacked of profiteering. In response, 250 people marched to Wall Street. They hung an effigy of FDA commissioner Frank Young in front of a church in the heart of the financial district. They passed out leaflet condemning Burroughs Wellcome for its pricing of AZT. Then they did something that had not been done before at a gay rights or AIDS demonstration---they sat down in traffic in the middle of rush hour, completely tying up lower Manhattan.

ACT-UP "demos"[13] became renowned for their keen sense of political theatre and ability to attract media coverage and thus an audience. Most famous was its October 1988 effort to shut down the Rockville, Maryland, headquarters of the U.S. Food and Drug Administration, where over a thousand people participated in a series of "minidemonstrations" over a nine-hour period. At one of the day's protests targeting the FDA's refusal to release sixty experimental drugs to people with AIDS, ACT-UP members staged a "die-in" in front of the agency. They lay down on the street and held paper "tombstones" over their heads that read: I DIED FOR THE SINS OF THE FDA; DEAD--AZT WASN'T ENOUGH; DEAD--AS A PERSON OF COLOR I WAS EXEMPT FROM DRUG TRIALS; I GOT THE PLACEBO- --RIP.[14] By the end of the day, 176 people had been arrested.

Sometimes the theatrics of the group turned abrasive, focusing on religious figures in the Catholic church hierarchy. This was particularly true regarding ACT-UP's "zaps" of the Roman Catholic Church. Journalist Michelangelo Signorile describes an incident involving Joseph Cardinal Ratzinger, the German prelate, who was in New York for a speaking engagement at the invitation of that city's John Cardinal O'Connor. Ratzinger had written a paper for the Vatican that described homosexuality as a moral evil. As Ratzinger rose to speak at St. Peter's Church, a group of eight people in the crowd leaped to their feet and began to chant, "Stop the Inquisition!" Someone else yelled "Antichrist!" and "Nazi!" Signorile himself jumped up on a platform, pointed at Ratzinger, and shouted, "He is no man of God--he is the Devil." Then there was the December, 1989 zap at St. Patrick's Cathedral that featured ACT-UP members interrupting an ongoing service and stomping on communion wafers while five thousand others outside the church chanted "You don't say f---, we say f--- you!."[15]

EFFECTIVE ACTING UP?

Whatever the motivations of the members of ACT UP, the effects or results of their actions followed the same pattern as that of the Cynics. Windt points out that the "major weakness of the diatribe is that it is limited in effectiveness." Once the dissenters have spoken, the audience tends to look for "serious remedies" that are "seriously treated."[16] As with the Cynics, "serious remedies" for existing policies in AIDS drug approval were instituted after the Diatribe of ACT-UP. For example, following several years of ACT UP protests, major changes in the FDA's approach to approving experimental drugs took place. Drug regulation was eased, and drugs proven safe but not yet proven effective were made available to AIDS patients. As a result, "ACT-UP is now widely credited for speeding up the drug approval process." One HIV neurologist stated, "The involvement of ACT-UP...has had a very positive influence"[17] on AIDS research. Kramer, who has since left ACT-UP, summarizes the group's accomplishments: "We made AIDS a political issue; we changed the image of gay men from limp-wristed fairies to tough warriors; and we got the drug approval process changed from ten years to, in some cases, less than one year."[18] These changes have not translated into breakthroughs in AIDS treatment; though the drugs have been made available sooner, few have showed much promise. As a result, ACT-UP has lost some of the energy it possessed. Martin Delaney, the head of Project Inform, explains:

> Everybody thought we could jump into AIDS research and make a difference in the short term. Maybe break a boulder that was blocking the path. Well, we did that, but there was always another boulder or we found that there was no path underneath it all along. Everybody's burned out: I am, we all are. [19]

Apparently, the actions taken by ACT-UP had had a positive effect, though the ends to their means were not all they had hoped for.

Conversely, the demonstrators of the ACT UP organization constantly faced negative reception to their rhetorical acts. Their behavior brought about much media attention, but it antagonized the public, and in the case of the Roman Catholic Church, turned strained relations into "permanent enmity."[20] Some called the protests "self-indulgent and counter-productive."[21] President Bush voiced his disapproval of the organization, calling ACT UP protests "an excess of free speech," and told reporters his administration has tried "to be very sensitive to the question of babies suffering from AIDS, innocent people that are hurt by the disease."[22] These attitudes, coupled with the public sphere's reticence to address "private matters" in the public arena, often elicit a negative response to anyone broaching a controversial topic. Perrow and Guillen offer the following analysis:

> AIDS activists...clash with social norms which define matters of sex and sexuality as private. Issues that surround the transmission of HIV and AIDS are among the most forcefully relegated to the private sphere. Early discussions of AIDS, for example, focused almost exclusively on the ties between AIDS and male homosexuality. Even given the increasingly frank public discussion of sex and homosexuality, however, social norms preclude the open discussion of male sexual practices, and especially anal intercourse, the practice most closely linked to the transmission of HIV. Nor do the other modes of transmission of HIV and AIDS lend themselves to public discussion. A large number of cases of heterosexual transmission of HIV and AIDS are linked to intravenous drug use and prostitution, about which public discussion is rare. Thus, social stigmas prevent AIDS from becoming a public issue in any real sense. [23]

It would seem that Windt's ideas proved correct in his theory of the Diatribe.

FUTURE ACTING UP

The diatribe of the group ACT-UP enhanced the public's perception of a private issue, portraying gays to some as courageous, caring individuals and not the sex-crazed pleasure-seekers depicted by the media and certain conservative groups. To others, the diatribe portrayed its participants as extremists and rude fanatics. Just as the Cynics of the Greco-Roman era sought to confront the establishment with its own inadequacies, ACT-UP 's "in your face" tactics mimicked those strategies. But some differences have emerged. Windt states that "the Cynics did not possess power and by all accounts did not seek political influence. They were cultural critics, not politicians."[24] ACT-UP's Diatribe is far from just a mere criticism of society; indeed, they fully intended to gain political influence, and they possessed both financial and political clout from the start. Obviously, the genre has evolved since its inception.

The AIDS decade brought about many changes in the gay and lesbian movement. It created a deeper sense of community and put gays and lesbians in the public eye. The appalling neglect of the Reagan and Bush Administrations helped to mobilize homosexuals as a political force and pushed some groups into a militancy that had not been seen since the early days of gay liberation. No doubt a stronger, more committed gay community evolved poised to face the adversities of the 1990's.

ENDNOTES

(1)Randy Shilts, "The Sexual Revolution Has Begun to Devour Its Children," And the Band Played On (New York: St. Martin's Press, 1987), 371.

(2)Ibid, 95.

(3)Warren J. Blumenfeld and Diane Raymond, Looking at Gay and Lesbian Life (Boston: Beacon Press,1993), 344.

(4)Theodore Otto Windt, Jr., "The Diatribe: Last Resort for Protest," The Quarterly Journal of Speech 58(February 1972) : 1.

(5)Ibid, 7.

(6)Gilbert Highet, The Classical Tradition (New York: Galaxy Books, 1957), 304.

(7)Peter Cranford, Standing Firm: Civil Rights and Non-Violent Protest (New York: Random, 1992), 121-122.

(8)Ibid.

(9)Neil Miller, Out of the Past: Gay and Lesbian History from 1869 to the Present (New York: Vintage Books, 1995), 439.

(10)Ibid, 456.

(11)Ibid, 457.

(12)Ibid.

(13)Ibid, 458.

(14)Ibid.

(15)Ibid, 460.

(16)Windt, 8-9.

(17)"Neurology Funding Good News: Activists' NIH Study Pays Off," AIDS Treatment News (August 7, 1992): 301.

(18)Craig Horowitz, "Has AIDS Won?" New York, 20. (February 1995): 30-37.

(19) Ibid, 37.

(20)Miller, 460.

(21)Blumenfeld, 344.

(22)Mark Thompson, The Long Road to Freedom: The Advocate History of the Gay and Lesbian Movement (New York: St. Martin's Press,1994), 377.

(23)Charles Perrow and Mauro F. Guillen, The AIDS Disaster: The Failure of Organizations in New York and the Nation (New Haven: Yale UP, 1990), 55-67.

(24)Windt, 3.

EYEWITNESS VS. PSEUDO REALITY: A COMPARATIVE ANALYSIS OF STUDENTS' ACCOUNTS AND THE MEDIA REPORTS OF A UNIVERSITY DISTURBANCE

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INTRODUCTION

On Saturday, October 12th, 1996, in Cedar Falls, Iowa, the students of the University of Northern Iowa were celebrating their homecoming. Unfortunately the night did not end on a happy note. On the "College Hill," an area where taverns and restaurants were located, near the university campus, a "riot" broke out; and by Monday, the 14th, television news reports and newspaper articles about the incident were spread around the country.

The author, a student of the University, was out of town when the incident occurred. Like most of the concerned students who were not present when the disturbance took place, the author sought information regarding this incident from various sources. The result of the search, brought conflicting accounts of the incidents. According friends of the author, who were the witnesses of the incident, the disturbance was instigated by the local police. However, from reading the newspaper reports of this incident, one could easily see that the students were solely to be blamed for the disturbance.

A research interest developed as the author compared the conflicting accounts. The author then set out to conduct a systematic study of the accounts of the event from these two sources: eyewitness and newspapers. More specifically, this study is a comparative analysis of students' accounts and the newspaper reports of the incident. The author conducted a content analysis of the news reports regarding this incident on two newspapers. Also, to collect the University students' accounts of the event, the author analyzed the data resulting from interviewing students who were witnesses and non-witnesses of the disturbance.

By comparing the newspaper reports with the witness accounts and non-witness accounts, the author attempted to achieve two goals. By contrasting the media reports with the eyewitness accounts, the author would like to show the different perspectives taken by each party. Also, by comparing the media reports with the non-eyewitness accounts, the author would like to reveal the impacts of the media reports, that is, how the media reports helped shape the non-witness accounts of the incident.

LITERATURE REVIEW

Communication researchers have pointed out that media have the potential for structuring issues for the audience (Lippmann, 1921; Shaw and McCombs, 1977). One of the leading scholars who discussed the structuring impact of the mass media is Walter Lippmann. Lippmann maintained that as a result of the structuring act performed by the media, the audience responded not to actual events in the environment but to a "pseudo-environment" (Lippmann, 1921). As a consequence, the media are responsible for "the pictures in our heads" (Lippmann, 1921).

According to Lippmann, the structuring act performed by the media seems to be necessary to assist the audience to comprehend, manage, and act upon the complex environment. If the structuring act is necessary, then the question is whose views were presented in the media?

This study is an attempt to answer the above question by analyzing the media reports of a recent "melee" occurred near a university campus. To reveal the views and interests adopted by the media toward this incident, the author would contrast the media reports with the witness accounts of the event. The views and interests of the media can be further revealed by studying the views of the non-witness of the event, who mainly obtained the information about the event from the media. The contrast of views between the witness and non-witness serves to intensify the differences between the "environment" as described by the witness and the "pseudo-environment" as presented by the media.

METHODOLOGY

In the research, the news reports of the disturbance on a local and regional newspapers--Waterloo Courier and Des Moines Register--were analyzed. The news reports are news articles written by the news reporters, which do not include editorials, special columns or letters to the editor. The time frame of the news articles studied was set at a week period following the incident. In total, eight news articles were collected and analyzed.

In addition, the researcher utilized the interview data collected by students who were enrolled in a Reporting class at the University of Northern Iowa. In total, one hundred and thirty-two university students who served as the volunteers for this study, were interviewed, which included 66 eyewitnesses and 66 non-eyewitnesses of the event. In the face-to-face interviews, open-ended questions were casted. Volunteers who were the witnesses of the event were asked to describe the incident as they experienced it, and also to contrast their experience with the media reports which they later came into contact with. The non-witness volunteers were asked to describe the incident as they knew it and to recall the sources where they obtained the information about the incident. The interviews were conducted within the week following the incident to ensure the accuracy of the volunteers' recollection of the incident.

EYEWITNESS ACCOUNTS VS. PSEUDO REALITY

In this study, the author examined the eyewitness accounts of the disturbance by analyzing the interview data of the students who were at the scene of the "riot." The author also studied the "pseudo environment" presented on the media by analyzing the news stories on the newspapers. The following discussion presents the eyewitness accounts and the media reports of the incident, which present two drastic different points of view. Also, the author investigated the effects of the media reports by reporting the accounts of the non-witnesses who obtained the information about the incident mainly from the media. By noting how the non-witnesses sided with the media reports, it is easy to see how the media are responsible for the "pictures in our heads."

The Pseudo Reality

By analyzing the two newspapers, the author located two common themes running throughout various reports, which include (1) blaming the students for the disturbance and (2) propagating and defending the institutional standpoint and official conduct during the incident.

First of all, each paper maintained their focus on blaming the students for causing the disturbance. In the reports analyzed, the students were characterized as initiators of the incident, and the police were simply trying to respond to the destructive acts of the students. The incident was reported as "triggered by the overturning of a car about 12:45 a.m." (Des Moines Register, 1996a). "Officers righted the vehicle, and the mob then rolled it onto its roof, overturned a second car and attempted to set one of them on fire" (Des Moines Register, 1996a). The newspapers reported that the police officers decided to disperse the crowd as a response to the crowd's irrational behavior. However, the police's decision was responded to by "lobbing beer bottles and cans" (Des Moines Register, 1996a). "As officers pushed the mob north on College Street, rocks and bricks also were thrown" (Des Moines Register, 1996a). The irrational and destructive nature of the students were communicated by using the "mob," to characterize them.

Each newspaper spent a considerable amount of effort backing the mayor of Cedar Falls, Ed Stachovic, and his controversial decision to ban alcohol sales before midnight of the Homecoming evening, which was two hours earlier than the normal closing hour, 2 a.m. The newspapers showed their support of the mayor by giving the mayor the opportunity to explain his decision. It was reported that, "'We already had a problem well before 12:15 a.m.,' said Stachovic. 'I felt it was prudent and wise to shut off the fuel that was feeding the unrest'" (Des Moines Register, 1996a). The newspapers quickly came to the aid of the mayor by publishing many interviews of him, which allowed the mayor to defend his side of the story. By reporting the mayor's point of view, not the students', the newspapers supported the mayor and suggested that it was not the mayor's decision, which was to be blamed.

The papers also sympathized with the police officers and their efforts. The reports of the action taken by the police portrayed the police as nonviolent or nonaggressive. "Cedar Falls police were setting up skirmish lines and falling back while waiting for reinforcements during a melee Saturday night..." (Des Moines Register, 1996b) On the other hand, the crowd was portrayed as aggressive, unruly and resistive. Paul Hoffey, Cedar Falls Public Safety Director, was reported to say that "We (the police) attempted to move the crowd out of the area and met with considerable resistance. Rocks and bottles and pieces of glass were being thrown at the officers" (Des Moines Register, 1996b). The newspapers continued to state that the "Officers were under orders not to use their batons; they were told to 'use the force of persuasion or pepper spray,'..." (Des Moines Register, 1996b). The newspapers reported that the police officers "showed great restraint" (Des Moines Register, 1996a).

The police took action toward the crowd, pepper spraying the crowd, as the last resort to react to the irrational crowd. The police took action only when the crowd overturned the cars, one officer was assaulted by a brick thrown from the crowd, and several officers were pelted with rocks. It was reported, when the mob began throwing beer bottles, cans, rocks and bricks, "two officers were felled by flying objects; one was treated at a hospital.... Four police vehicles and an ambulance were damaged" (Waterloo Courier, 1996c). During the incidence, the police used the least amount of force as the situation allowed--pepper spray and persuasion.

Newspaper reports mainly described the police action as a means to ensure public safety, not to crack down or retaliate the crowd who were taunting the police. The reports stated several incidences where the police was forced to take action to protect the public. A newspaper reported the accounts offered by Paul Hoffey, Cedar Falls Public Safety Director.

BEST COPY AVAILABLE

Hoffey was reported to had said, "...when crowds began filling College Street, the police blocked off the Hill business area at 11:30 p.m. to protect people from passing vehicles" (Waterloo Courier, 1996c). Also, when the first vehicle was overturned, Hoffey also was reported to say that "Fearing rocking or spinning of the vehicle would injure someone, Hoffey dispatched four police officers to reflip the car onto its wheels" (Waterloo Courier, 1996c).

The newspapers were sympathetic to the danger faced by the police officers in the disturbance. The sympathetic standpoint is revealed in a report about the necessary use of batons in a incident like this. It is reported that, "Waterloo Police Chief Bernal Koehrsen was reported to say that the riot never approached a threat serious enough that officers had to pull out their weapons, but he believed that it reached "a baton response level" (Waterloo Courier, 1996b). The newspapers showed their support to the police not only by giving Koehrsen's viewpoint an extensive coverage, but also reported the injuries and threats the policed experienced. For example, Koehrsen was reported to be pelted with three rocks during the riot, and he said, "a riot is the exact case when you really want the baton with you. We were outnumbered 30 to 1" (Waterloo Courier, 1996b).

The Eyewitness Accounts

Students who are the witnesses of the event began their descriptions of the incident with the initial stage of the disturbance. A male sophomore, Electronic Media major, stated, "There were tons of people in the street, and the crowd got out of control when the bars were forced to close down early, and unleashed the angry drunks on to the street." Another male sophomore stated that people flooded out of the bars and were very angry. A female senior said that after the bars closed early she was mad because she and her friends just got in and had to pay the cover, and they did not even get a drink. A female sophomore, a Marketing major, said, "I was very mad! I had just paid four dollars to get in and they were turning around and kicking me out!" She continued that when she and her friends were outside of the bar complaining with some other people when the pepper spray started to come down without warning.

A male freshman said, "When the bars cleared out, the cops were already out there." And, "There were more cops on the street than I have ever seen in my life," said a male sophomore majoring in Accounting. A female junior, a Finance major, said that the cops were everywhere dressed in full riot gear. She said that it appeared they were expecting "All hell to break loose." A female, junior with a Marketing major, said that the cops were armed with riot gear, desperately looking for trouble or to create trouble. According to her, "This 'pissed' people off." She said that the rage grew once the pepper spray was used to chase the crowd down the Hill.

According to the accounts of several students, it seems to be the police that initiated the incident. A male senior majoring in Business, stated that students were basically peaceful until the police became forceful. A 23-year-old male senior with an Elementary Education major said that he was in the street talking when he suddenly heard shots of the pepper spray cannon. According to him, nothing was going on when the police shot off their cannons. He said that people began to run and "just went nuts." He then saw the officers apprehending students who were too rowdy. A 21-year old male said, "It was all fun and games till the cops messed with us. I got hit in the shoulder with something from a cop and I was just there to have fun."

Students also provided accounts stating that the police used their batons, even though the police department denied the use of such a device. A male freshman with an Electronic Media major, said that he showed up at two in the morning and the police were chasing people all over. He saw the police were pepper spraying and beating others with billy-clubs. Another male student also raised the issue of the night sticks. He said, "The cops say they didn't have them, but I saw people being hit by night stick wielding officers."

Some described in the interviews about the experiences of being tear gassed. A female student majoring in Physical Therapy stated that she was in a group that was directly maced. She said, "...it stung my eyes really bad, and it was hard to breathe for a little while." A sophomore male with a Business major said, "It sucked! The damn police sprayed that pepper spray and it was hard to breathe."

Several students complained that they were gassed even as by-standers. A 19-year-old sophomore majoring in Communication and Computer Sciences, stated, "The tactics that were used by the cops were really unnecessary because innocent people got gassed and hit for trying to get out of the way." A female junior said, "I was just standing on the sidewalk with some of my friends when just out of the blue the police started spraying us with mace for no reason. I wasn't drinking or breaking any laws and I got sprayed. To me, that is not right. I feel betrayed by the police."

Witnesses said that the police didn't handle the incident properly. Some said that the police overreacted which triggered students to become violent. One 21-year-old male junior majoring in Business said, "The cops...were really to be blamed for causing the problem because the riot wasn't really any worse than the riots in years before." A 20-year-old male freshman with a Pre-business major, said that he didn't feel that this situation "was that big of deal" and that "the police overreacted by storming the street..., and fueled the situation by pissing off the students." A male freshman felt that the riots would not have happened if the police did not use, in his words, "excessive force" in trying to keep a handle on the situation.

Generally, the occurrence of the riot amazed the students who witnessed it unfold. Many said that it was just a select group of people that were being violent, and throwing things; the rest, as they put it, "just stood there in awe, because we hadn't ever seen anything like it. It was kinda cool because nothing exciting ever happens here." A male freshman with a Business major said that the cops took off running toward anything suspicious "just like you see on T.V. and in the movie." An amazed sophomore summed up his observation and said, "It was crazy, but hey it's college!"

The witnesses's evaluations of the media reports of the disturbance are unanimously negative. Most of them believed that the media reports had been one-sided, that is, the media sided with the law enforcement against the student body. In the media reports, many believed, more weight was being put on what the city officials had to say, and not the college students who experienced it. Many observed that the media placed most the blame on the students, and not commenting on the mayor's decision or the police's behavior as the the problem. As a Construction Management major said, "The media only focused on the few disruptive students and the "brave policemen," and not on the full spectrum of occurrences that evening." Consequently, the media made it seem as though it was all the students' fault--the students were totally responsible for the riot. One female student said that the media had made the students seem like an out-of-control group of delinquents.

Many students believed that the media blew the incident out of proportion by trying to add drama to the story. One male student felt that the media portrayal of the disturbance was way off base, and said, "Some papers made it seem like the LA riots after the Rodney King trial." "It's not like they (the students) were killing anyone," said a female student.

Some were angered by the false media reports which differed from their first-hand experiences. One female student cited a statement in a newspaper that said the police were being tossed around like rag dolls, which she said was a total fabrication. A male student was upset at the media's reports on the riot as he said, "The media said that the police didn't use their billy clubs, but myself and a friend were clubbed after we were repeatedly sprayed with pepper spray. It was a lie."

The Non-eyewitness Accounts

Of the sixty-six students interviewed who were non-witnesses of the event, some received the information about the incident from friends, but most of them became aware of the incident as a consequence of their exposure to media reports. To illustrate the effects of the media reports on the non-witnesses, the accounts of those non-witnesses who received information from face-to-face communication were discarded, only the statements of those who received information about the incident from the media were examined.

Those non-witnesses who obtained the information from the media which adopted a position sympathetic to institutional conducts, exhibit some common reactions toward the event. Mainly, they were influenced by the institutional viewpoint of the media. Generally, they were angry at the students who caused the riot, they were ashamed of the incident, and they firmly believed that the police were in the right. Needless to say, these common reactions toward the incident are different from the experiences of their peers who experienced the incident first hand.

By reviewing the interview data of these non-witnesses, expressions of anger toward the students who caused the riot were noted. Many believed the incident had given the university a negative image on the media, and the entire university's reputation was damaged by a few students. "I am embarrassed to be a part of UNI right now," said a 23-year-old Business Management major. A male freshman majoring in Mathematics felt ashamed after reading the stories on the newspapers regarding the disturbance, as he said, "I would think people would have more respect for their school, community, fellow students, and themselves to participate in such a demeaning act of drunkenness. I hope that the students who took part in this disgraceful act are severely punished for what they did."

Almost all of the non-witnesses studied believed that the police action was justified. A male, junior, Mass Communication major, felt that the police were justified to retaliate to the mouthy kids with the action they used. Another male student said, "The police did their job as best they could. It sounds like the students were too wild."

Even though the non-witnesses studied generally took a point of view different from those of the witnesses, they did share the same shocking experience regarding the occurrence of the incident with the witnesses. A male junior, an Accounting major, said, "It's a shame people have to do this, but its only happens once a year so I guess it's alright. It would have been neat to see, I wish I could have been there to experience it." A male freshman with an Education major felt that homecoming should be fun and people shouldn't be destructive. "But hey we made it on MTV and CNN," said the male student.

CONCLUSION

In the comparative analysis of students' accounts and the media reports, it was found that the newspapers mainly adopted a pro-institutional standpoint, the eyewitnesses defended the students' viewpoint, whereas the non-eyewitnesses studied were influenced by the media reports and believed that the students were to blame. The author concluded that the pseudo-environment presented on the media is mainly an institutional interpretation of the events occurred, which is different from the eye-witness accounts. What is interesting to note is that within the University community, people may have different perceptions of the disturbance based on different sources via which they obtained the information about the incident. Some students were angry at the police, whereas some others supported the police, and were angry at their fellow students whom they believed caused the incident. For future studies, researchers can look into the media reports not only on the newspapers but in a wide range of media sources such as the television, the radio, the magazines or electronic sources of information, and to determine how these channels of information may generate their own pseudo-environment for their audience/users.

BIBLIOGRAPHY

Des Moines Register (1997a). "Mob's actions condemned by UNI community." October 15, front A1.
-----(1997b). "Homecoming climaxes with major skirmish." October 14, page A1.
Lippmann, W. (1921). Public Opinion. New York: Macmillan.
Shaw, D. and M. McCombs. (1977). The Emergence of American Political Issues. St. Paul: West.
Waterloo Courier (1997a). "Revelers riot on the Hill." October 14, page A1.
-----"Waterloo police felt handcuffed without batons." October 15, page A1.
-----"Council hears community's view of response to College Hill riot." October 15, page A1.
-----"UNI vows to punish students involved in riots." October 15, page A7.
-----"UNI attitudes toward alcohol under scrutiny." October 16, page A1.
-----"Hundreds of callers back C.F. officials' crowd-control decision." October 16, page A1.

Light in the Crevice Never Seen:
The Indigenous Voice and the Rhetoric of Resistance Literature

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HAWAI'I: "PARADISE" OF THE PACIFIC?

The State of Hawai'i, according to travel and vacation guides, is a traveler's "paradise" with exotic people, food, and beautiful beaches. Known as the "Aloha State," Hawai'i has been part of the United States since 1959 and is a playground for wealthy vacationers and home port for the Pacific Fleet of the United States Navy. On the surface this state seems to be a stable and a content member of the Union; however, this is only a facade. Hawai'i (and America) has a dark past which continues to influence the present. On January 17, 1993--one hundred years after the overthrow of Queen Lili'uokalani and the Kingdom of Hawai'i--a Commemoration was held to mark the illegal armed invasion of the sovereign nation of Hawai'i by the United States of America. This event became a flash point in the fight for Hawaiian Sovereignty, which over the years has had little attention from the rest of American society. Expressions of outrage and lamentation marked the Commemoration ceremonies as Kanaka Māoli (Native-Hawaiians) gathered together in solidarity as a colonized and subjugated people. On that day, 'Iolani Palace--former residence of Hawaiian Monarchs--was draped in black and served as a backdrop for the thousands who gathered with tears in their eyes and chants of lamentation and protest on their lips. This is the reality of Hawai'i's history--according to the Kanaka Māoli--the forced colonization and annexation of a sovereign and independent people to the United States.

An understanding of the colonial situation of Kanaka Māoli within their own homeland and their struggle for sovereignty frames our reading of *Light in the Crevice Never Seen* (1994), by Haunani-Kay Trask, as one of the very first literary works by an indigenous Hawaiian to be published on the mainland United States. Trask is a leader in the sovereignty movement as well as an educator and writer. This collection of poetry becomes an example of "resistance literature" akin to the writings of Pablo Neruda and Rigoberta Menchu in Latin America, and Naguib Mahfouz in the Middle East. Each of these writers have become the voice of the colonized and oppressed--a voice that has employed the literary medium as a political tool. Authors such as these have used prose and poetry as a means for both creating cohesion within a group and expressing political resistance. This is a foreign concept to the Western literary establishment which delineates a separation between art and politics. However, this is not an unusual occurrence in the cultures of indigenous peoples and those who suffer under the yoke of colonialism. Barbra Harlow in her study, *Resistance Literature* (1987), argues that "Poetry [literature] is capable not only of serving as a means for the expression of personal identity or even nationalist sentiment. Poetry [literature], as a part of the cultural institutions and historical existence of a people, is itself an arena of struggle" (33). As an "arena of struggle," literature becomes a medium through which opposing ideology and beliefs are juxtaposed to reveal a battle for dominance between these conflicting political discourses. Resistance literature, as discourse, attempts to reclaim a people's history, culture, and identity from their colonizers. The very nature of this kind of writing is rhetorical as it explicitly attempts to persuade its audience to join the battle.

Now, the question is raised: how does literature function to create hegemonic resistance? Hegemony refers to the dominant ideology functioning within a particular society, and thus, is the cause of oppression for those not in power. This hegemonic oppression is what resistance literature attempts to fight against and dismantle. The linguistic tactics and strategies used in the creation of resistance literature functions rhetorically. Thus, the answer lies in the province of rhetoric which discerns the nature of how language functions in the world. Rhetoric, argued Kenneth Burke, is based in an essential function of language, a symbolic means by which cooperation can be induced. The speaker, according to Burke, persuades an audience through the

168

use of symbolic action; drawing upon shared symbols in order to build a rapport with the audience (*A Rhetoric of Motives* 43). This essay will focus on Trask's work as rhetorical discourse, explicating the way language, specifically metaphors, is used to create the sentiment of resistance. I will argue that identity, solidarity, and resistance is shaped metaphorically. The specific objective of this essay is to demonstrate the advantages of metaphoric analysis as a means of articulating counter-hegemonic discourse by a Kanaka Māoli writer. To support my thesis, I turn to linguist George Lakoff and philosopher Mark Johnson's theory of metaphor found in their study, *Metaphors We Live By* (1980). They contend that metaphors are not purely stylistic devices; rather, they are integral to the way in which social reality and resistance discourse are constructed.

Lakoff and Johnson argue that "metaphor is pervasive in everyday life, not just in language but in thought and action. Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphoric in nature" (3). Metaphor functions on the level of an enthymeme, drawing the audience into participating in the completion of the rhetorical construction. Enthymematic argument, according to Aristotle, is a primary form of public persuasion. This kind of argument relies upon shared cultural experiences by the audience to complete the proposed argument and to lend the rhetor credibility. In this study, the key to analyzing metaphor is found in looking at cultural experiences shared by native Hawaiians. For Haunani-Kay Trask the audience is her own people, the Kanaka Māoli, and she draws upon cultural metaphors and experiences in the construction of her resistance arguments.

A METAPHORIC ANALYSIS OF *LIGHT IN THE CREVICE NEVER SEEN*

Light in the Crevice Never Seen illustrates how resistance literature functions on a metaphoric level, creating a participatory, and thus, stronger argument for the reader to accept the case for resistance. Two general thematic metaphors were identified as being exemplary of how ideology can be used to create cohesion within a group and a counter-ideology against hegemony. The two metaphoric themes found were (1) death and destruction metaphors, and (2) life metaphors. Because language is shaped by cultural experience the experiences shared by the Kanaka Māoli are critical in shaping the language Trask uses.

Death and Destruction Metaphors.

Death and Destruction metaphors illustrate the great injustice and harm caused by American colonial oppression; they deal with the degradation suffered by the Kanaka Māoli. Trask uses various metaphors related to the main concept of death, which according to Lakoff and Johnson is an extension of the principle of experiential gestalts. This construction links distinct metaphors with a larger concept, lending to metaphoric cohesion. This occurs when distinct metaphors have similar functions within a particular discourse, supporting the larger category. The "system" of death metaphors includes (1) images of cold/weather, (2) animal images, and (3) images of a personified nature. These metaphors are taken from the Hawaiian cultural experience and are used to create a sense of community and identity within the native population. Trask also uses these metaphors to counter the dominant American ideology.

An example of the cold/weather metaphor can be found in the following passage:

nothing familiar in
the Arctic wind how
did this happen here?
my ill-clothed people
black hair freezing

in the American air
sores and frost on their tender
lungs, gasping for life
in our native Hawai'i (3)

The metaphor functioning here is the "Arctic wind," which represents the American presence in the islands. The "wind" is seen as a cold intrusion into the normally tropical weather of Hawai'i. However, beyond a physical level, the ideology of America is viewed as destructive to the Hawaiian people. This metaphor calls upon the current knowledge of the indigenous group which uses the foreign concept of "Arctic" to illustrate something negative. The use of this foreign term is justified by the fact that all Hawaiians have been taught English in the American school system. This, then, becomes a common term or experience in the cultural repository. White Americans are thought of as intruders who have "driven into the snow / God's justice white / death   white cold / cleansing the land / of blackness   sin" (43-44). The wind is cold and white, leading to the assumption that this wind of "death" comes from white (haole) people and their destructive ways.

The metaphor also functions by creating a community for indigenous people, as they are not equipped to handle the "American air," synonymous with "Arctic wind," both of which bring a "cold" death. The metaphoric allusion is extended to include a descriptive effect of the "Arctic wind" as it causes "sores and frost on their tender / lungs, gasping for life / in our native Hawai'i." This unnatural weather in the experience of the Hawaiian people has caused a form of suffocation, an oppression of their normal way of life. Metaphorically, Trask creates and highlights the experience of victimization within the culture by a colonial power.

Another death metaphor is generated through the use of animals. In particular, Trask uses the metaphor of a kōlea or Pacific golden plover to refer to haole people:

> The kōlea stilts its way
> through drooping ironwoods
> thickened by the fat
> of our land. It will eat
>
> ravenous, depart rich,
> return magnificent
> in blacks and golds.
>
> Haole plover
> plundering the archipelagoes
> of our world. (33-34)

The plover is a migratory bird that arrives in Hawai'i in August and then leaves for Alaska in May. In her notes after the poem, Trask describes the kōlea as "arriving as a thin, almost emaciated stilt [sic] but leaves fattened and beautiful" (38). In the Hawaiian culture the expression haole kī kōlea refers to a "plover-shooting white man," a descriptive expression used to delineate the contrast between the haole way of shooting birds and the Hawaiian way of capturing plovers without killing them. Today, based on the cultural context of the expression, any haoles "who exploit Hawai'i, especially developers and tourists, are referred to as kōlea by many Hawaiians" (38). This metaphor of the kōlea is extremely tied to the land and the culture and is linked with the experience of the Hawaiian community as a whole. Just like the plover who migrates to feed and be "thickened by the fat / of our land," the "Haole plover" ravages the islands of Hawai'i, leaving nothing for the indigenous inhabitants. The plover metaphor clearly counters the accepted impression of the benevolent and civilizing American presence. This metaphor reminds the native community of the loss of their culture, language and identity at the hands of the haole. The creation of both a cohesive community and a counter-ideology is exemplified in this metaphor.

The metaphoric images of cold/weather, animals, and a personified nature are all component parts of how the larger concept of death is structured within this example of resistance literature. Trask uses these death and destruction metaphors predominately in the first two sections of her work, illustrating the complex stages of her anti-colonial ideology. These sections "Chant of Lamentation" and "Raw, Swift, and Deadly" are focused on the destruction of the Hawaiian people and culture through expressions of outrage and anger. These metaphors are embedded in the Hawaiian cultural experience. Therefore, the indigenous audience is able to complete the metaphoric construction, and as a result, gain a sense of ownership over the idea and build a sense of community. The community created is one of shared loss and anger that fulfills the objective of resistance literature--rallying the people. Also, in the process of evoking a sense of community, these metaphors clearly indicate a counter-ideology to the American system, as it has been the cause of so much death and destruction in the Hawaiian community. This reappropriation of old metaphors by Trask serves to build upon shared experience and effectively promote an anti-colonial ideology that attempts to garner support for the sovereignty movement. Death and destruction metaphors ultimately challenge the dominant discourse of American colonialism by attacking the linguistic symbols at the heart of its power base and by creating new symbolic structures for the Hawaiian people.

Life Metaphors.

Trask's work also includes life metaphors, and their use evokes images of hope and renewal for the Hawaiian people. Again, Trask uses a plethora of metaphors related to a major concept. The system of life metaphors includes (1) light images, (2) sexual images, and (3) personification of nature. These metaphors are based in the Hawaiian conceptual system,

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allowing Trask to build a sense of regeneration and rebirth of the Hawaiian land, people, and culture. The creation of hope for the lāhui (nation) is an essential function of these metaphors. However, they also help to spark action--a sense of personal responsibility in overcoming the colonial system.

The light metaphor which is particularly important in this discourse is that of "light in the crevice never seen" (75), which is also the title of the work. "[L]ight in the crevice never seen," is used as a metaphor in the poem "Ko'olau" to describe the hula (sacred dance) in Hawaiian culture and religion:

light in the crevice
never seen mosses
palai kāla'au
bamboo

crescent moon
stones
fragrant clack clack
from the shadows (75)

The hula itself is a metaphor, symbolizing the culture and spirituality of the Kanaka Māoli. "Palai" are ferns, sacred to Laka, the goddess of dance and "kāla'au" is a dance using sticks of bamboo. These images recall the familial structure of the cosmos which is expressed through the hula. "crescent moon / stones" refer to another instrument of dance which are held in the hands of the dancer and used to make clacking noises. These noises (and dance) are described as coming "from the shadows," indicating that the hula is a an example of the hidden culture which exists in the darkness, symbolizing life and spirituality of the people. The metaphor functions here to develop hope for the resurgence of the culture and of the traditional ways. The hula is a powerful cultural symbol which builds within the audience a desire for what has been lost.

Nature metaphors are also important in the development of the larger concept of life. The metaphor of the Taro (a starchy root that is the staple of the Hawaiian diet) is a personification of the natural world in the poem "Ko'olauloa:"

this earth glows the color
of my skin sunburnt
natives didn't fly

from far away
but sprouted whole through
velvet taro in the sweet mud

of this 'āina (80)

The taro is the mythical ancestor of the Hawaiian people who sprang forth from the 'āina (land). Thus, the Hawaiian people sprang from the land. This metaphor is a reminder of where the Kanaka Māoli came from and what claim they have to the land. This illustrates the cosmological bond that the Hawaiian people have with the land that ties them spiritually and historically to Hawai'i, but also, gives hope for the future. The association is made that since the taro still exists, then the Hawaiian people still have a connection to the land and therefore, must work towards liberation.

The images of light, sex, and a personified nature are components in the larger metaphoric concept of life. Trask uses these metaphors in the last section of her work completing the final stage in her anti-colonial ideology. Building on the first two sections that focus on death and destruction metaphors, this final section evokes images of hope and renewal for the Hawaiian people. The progression of metaphoric images in the first two sections rhetorically builds a community which is based on shared loss and anger over what has been done to the Kanaka Māoli and sets the foundation for action to be taken. However, it is in this last section where the images of regeneration and life are used to create a utopian vision of what Hawai'i can be again. Thus, the combination of anger and sadness with hope and renewal, creates a community of indigenous people who have a vision of what their home, culture and people can become. Along with the sense of community and a utopian vision of Hawai'i these life metaphors rhetorically attempt to incite action by the indigenous population to work towards this goal of liberation. Functioning as a whole, the cultural metaphors in Trask's work rhetorically creates a community and evokes action that is the heart of resistance literature.

CONCLUSION

"Metaphors" according to Lakoff and Johnson "create realities for us, especially social realities" and "may thus guide future actions" (156). The function of metaphoric analysis is to uncover the cultural and experiential factors on which the metaphoric construction is based. In this essay, the voice of an indigenous Hawaiian writer was analyzed for her use of metaphor to create enthymematic arguments woven into her poetry. For Haunani-Kay Trask the function of writing is to decolonize the Hawaiian mind and to leave a record of the resistance movement. Her use of poetry in particular lends itself to a metaphoric analysis, as she appropriates cultural metaphors to create cohesion within the native audience and to propagate her own ideological stance of resistance.

Trask's writing falls into the genre of resistance literature, which seeks to undermine the dominant ideology of colonial oppressors. In the case of Hawai'i, America is the colonial power which has subjugated the Hawaiian people and left them destitute both physically and spiritually. *Light in the Crevice Never Seen* is Trask's metaphorical and ideological "declaration of war." Any resistance movement needs an ideological basis from which to act. For the Kanaka Māoli, Trask's work becomes such a foundation, dispelling the myth that art does not have a real effect in the world. This work is both beautiful and powerful at the same time, creating a counter discourse to the dominant American ideology.

When dealing with resistance literature, studying the indigenous voice becomes critical, as they are often the group under colonial oppression. Resistance literature is propagated to oppressed masses and finds its popularity and power within this group. The resistance writer becomes the voice for and to the people. In this role he or she must use stories and experiences from the land in order to connect with the indigenous population. For Trask, the use of cultural metaphors specific to Hawai'i lends strength and credibility to her argument--creating both cohesion and a call to action in the fight for Hawaiian sovereignty. The progression of metaphoric images from death and destruction to life completes the stages of Trask's ideological "war." In the construction of these metaphors, the indigenous audience is drawn into the ideology argued by Trask and makes it their own through their participation. This participation is extended when the sense of ownership of the metaphor underlies the audience's desire for action to be taken. Thus, the audience takes ownership of the struggle and is rhetorically induced to fight for liberation. The ultimate goal of resistance literature is to create a cohesive community and to induce action by its members. Through the use of metaphor, Haunani-Kay Trask has fulfilled these objectives and has made *Light in the Crevice Never Seen* her "spear of memory" in the struggle for Hawaiian Sovereignty.

REFERENCES

Bowers, John W. and Donovan J. Ochs. The Rhetoric of Agitation and Control. New York: Random House, 1971.

Burke, Kenneth. A Rhetoric of Motives. Berkeley: University of California Press, 1969.

- - -. Language as Symbolic Action: essays on life, literature, and method. Berkeley: University of California Press, 1966.

Daws, Gavan. Shoal of Time: A History of the Hawaiian Islands. Honolulu: University of Hawai'i Press, 1968.

Dougherty, Michael. To Steal a Kingdom. Waimānalo, Hawai'i: Island Style Press, 1992.

Harlow, Barbra. Resistance Literature. New York: Methuen, 1987.

Lakoff, George and Mark Johnson. Metaphors We Live By. Chicago: University of Chicago Press, 1980.

Lakoff, George and Mark Turner. More Than Cool Reason: A field guide to poetic metaphor. Chicago: University of Chicago Press, 1989.

Morrison, Toni. Playing in the Dark. New York: Vintage Books, 1992.

Sumida, Stephen H. And the View from the Shore: Literary Traditions of Hawai'i. Seattle: University of Washington Press, 1991.

Trask, Haunani-Kay. Form a Native Daughter. Maine: Common Courage Press, 1993.

Trask, Haunani-Kay. Light in the Crevice Never Seen. Oregon: Calyx, 1994.

Trask, Haunani-Kay. Personal Interview. 17 June 1996.

Trask, Haunani-Kay. "Writing in Captivity." Pacific Histories Association Conference. University of Hawai'i at Hilo, Hilo. 11 July 1996.

Wilner, Eleanor. Introduction. Light in the Crevice Never Seen. By Haunani-Kay Trask. Oregon: Calyx, 1994. xvii-xxiv.

Marketers' Use of Semiotics and Symbolic Represnetation on Childrens' Packaging

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INTRODUCTION TO SEMIOTICS

The world can be viewed from many perspectives. Although people see the same objects, they may still interpret them differently. How people perceive things is influenced by semiotics. From a societal view, Webster's dictionary defines semiotics as "the science or language of signs" (Allee 286). Semiotics has been studied from many views. But, from a marketing perspective, Ferdinand de Sausaurer states that the definition of semiotics is "the science that studies the life of signs within society" (Winfred 174). To illustrate, if a person associates the color pink with girls, then when purchasing a gift for a girl, that person may look for a product with pink coloring.

The semiotics influence can be caused by many variables. One of the most important of these is personal experience or observed example. As people experience life, they are exposed to particular objects and learn how to react. Likewise, learning can also take place by viewing other people's reactions and behaviors in given situations. As a child is growing up, he or she is exposed to many new concepts. By watching his or her parents, the child learns to imitate behavior. But, most importantly to semiotics, the child also will mimick the parents' beliefs and attitudes toward objects. For instance, if a young girl is drawing pictures with her mother, and observes the mother drawing a heart to symbolize the feelings of love, then when the girl sees a heart again, she will correlate it with loving emotions. Based on consumption studies, marketers want one specific question answered: do symbols persuade goods and services purchases? Noth Winfred believes the answer to this question to be "yes." He suggests this example: "If inferences are thus made from goods (e.g., cars) to their users (e.g., their personality type) the commodities are interpreted as *indexical signs* . . . the public discourse *about* the commodity generates meanings which transform the commercial object into a sign. Once the consumer has learned its meanings, he or she is liable, at a certain level of consciousness to rediscover this sign on the marketplace" (Winfred 174). In other words, when the consumer sees the signs or objects in the marketplace that he or she has associated certain meanings to in his or her personal life, the consumers parallel these feelings and the sign takes on the meaning originally assigned to it. This report will focus on the following segments of semiotics: symbols, shape, font, and color. These will then be interpreted to show how they relate to the packaging of children's products and how marketers can take advantage of this information.

Variables in Semiotics

To begin with, different symbols can induce certain reactions or thoughts. Over time, objects can attain specific meanings. The heart (   ) symbol has come to mean "love." For example, there are bumper stickers that say "I   my dog." Marketers could use hearts on their packaging to create a sentiment toward a product. A doll's package could have a heart on it and portray warm feelings. Another symbol that has gained a universal meaning is a star (   ). The connotation with a star is positive. It can be used on a child's homework to show an excellent job has been done, or people often draw a star when they want to highlight an important idea. Some symbols can be used to show danger or be used as a warning. In fact, the skull and crossbones was originally used in pirate ships and on the pirates' flags. Today, the skull and crossbones is frequently utilized as a warning on harmful medicines or chemicals (   ). Since people see the skull and crossbones symbol analogous to that of danger, it is a reliable way to show hazardous materials. Marketers and artists have also used certain shapes to create specific feeling or give meanings to products. Over time, specific shapes have been paired with meanings to create certain moods or effects. The square has become a symbol of strength and masculinity due to its sharp edges and straight lines. The circle, on the other hand, often elicits feminine feelings: the circle may symbolize the "curves" of a woman or the more traditional role of woman as the sensitive and caring part of the species. Next, the triangle is the ultimate shape of stability. The base is wide and the weight is in the middle. The placement of lines on a page has also been paired with meanings due to the feelings the lines create. A vertical line represents strength and substantiality. The columns hold up the buildings and give a dignified influence. Horizontal lines give a feeling of peace or rest. Also, diagonal lines represent action or movement. Moods are also created through different display types, which are fonts, usually over 18 point, used to attract attention. For example, Roman typefaces give a feeling of dignity, austerity, and grace, just like early Roman inscriptions (Craig 137). EGYPTIAN TYPEFACES are forceful and insistent (137). San serif types, those without serifs, or little tails, are modern, and give a contemporary and efficient feeling (137), while serif types, such as the one being used, are more relaxed and flowing.

Other characteristics of symbolic representation also have influential attributes: the use of color has a semiotic effect. For instance, the color red has typically been associated with love, war and battle, danger, and alarm. Blue, on the other hand, has a cool feeling and is often associated with water and heaven. It also can be used to portray sad feelings, hence the phrase, "I feel blue." On the other extreme, navy blue may represent war. When one mixes the two previous colors (red and blue), the result is the color purple which expresses "royalty, self-sacrifice, depth and rage" (Sheet 7). Expressions of these can be used effectively by marketers to influence buyers that their product is superior or royal. Next, the color yellow also has significant meanings. Parallel to the other colors, yellow has positive and negative connotations. Positively, yellow suggests wealth, royalty, prosperity, and harvest. But, negatively, yellow suggests cowardice and sickness. Similarly, green portrays various meanings, and its name stems back to the word "growth or growing" (Spink 34). Since spring is a season where new life begins in plants, trees, and flowers, green has come to symbolize youth and rebirth (Spink 34). Unfavorably, green suggests envy and jealousy or immaturity. Next, black often represents everything that is evil or bad. In western movies, the "bad guys" always wore black attire. Some other places where black is found are as follows: at night, in caves, and in the color of bats. These reflect "death, crime, terror, mourning, dirty, [and] impure" (Sheet 7). The opposite of black is white which represents everything that is pure. The color white can be found in snow, sheets, clean laundry, Easter lilies, sacrificial animals (doves, oxen, lambs) which contain not a speck of color, and a white flag (Spink 40-41 and Sheet 7). Since white is seen as clean and pure, it suggests the following things: innocence, youth, and virginity. Because white expresses this, it is worn by girls who are getting confirmed and by brides. Also, because of the clean and pure aspects of the color white, it has been used extensively in the medical profession. Likewise, "akin to white as the color of innocence is its role as a symbol of friendship and peace" (Spink 41). In order to show peace a truce, or even to surrender, a white flag (as opposed to a black flag as suggested earlier with the pirates) is waved or flown.

History Of Children's Marketing

Now that the foundation of semiotics and some of the definitions are clarified, our attention can be turned to who is affected by semiotics and how they are affected. This paper takes an extensive look at how semiotics influences purchase decisions made by children and how marketers use semiotics on packages of children's toys to elicit certain feelings. To fully understand this, the children's market must be defined and completely understood--starting with a history of the children's market. The role of children as consumers has changed drastically over the past few decades. The 1960s viewed children primarily as influencers of consumption decisions made by parents. The 70s declared children as consumers in their own right when parents let children make their own purchase decisions. By the 1980s, child-based retail flourished as children consumers were placed on somewhat equal ground with adults. Now, marketers are spending a billion dollars a year on marketing communications aimed at children and marketing research is investing millions more a year to further tap this lucrative market (McNeal 4-6). After World War II and beginning with the baby boom, the attitude in the United States changed to "have fun, die young." Along with this attitude change came a certain self-centeredness that has carried into the 1990s and continues to grow stronger (McNeal 4).

Not only have historical events changed the role of children as consumers, but sociological factors also play an important role. The changing structure of the family offers us four main reasons for children to be identified as consumers. The first factor is the fact that there are fewer children per parent. As women became more career-oriented and gained more equality, the size of the family decreased. Thus, with fewer children and less time to spend with them, the children may get showered with attention and gifts. Secondly, there are fewer parents per child. The divorce rate has risen over the past few decades and it is no longer uncommon for single, unmarried individuals to raise children. These children are expected to fill in for absent adults and assume more responsibilities—including shopping. Deciding to have children later in life is another factor that leads to increased spending on individual children. Finally, the number of dual working families in the United States continues to grow. These families often have more money, but less time to spend with the kids.

Marketing Implications

The children's market is not simply viewed as 37 million young individuals (McNeal 14). Children spend over $6 billion annually and save about $2 billion annually. So, not only do they spend an enormous amount each year, but they also save money which will gain interest and be spent in the future. They will become consumers of all product categories as they grow older. Since one out of every five adults is an anti-shopper, it is important for marketers to make the shopping experience for children enjoyable so a positive attitude about shopping will be carried into the future (McNeal 15-16). Because children learn to shop at such a young age, the package is a critical part in identifying the product. In order to target children effectively, marketers must have packaging that children will understand and visually approve. The package must be an honest presentation of the product's features and it should use colors, words, and symbols that match the child's cognitive level (McNeal 194-197).

GENDER DIFFERENCES

Not only is it important to realize the importance and potential of the children's market, but it is important to realize the gender differences within the market. In society, girls and boys are treated differently from a young age, even by marketers. For example, Smith states that "By watching members of their own sex and then copying or modeling that behavior, children can discover how they are supposed to behave and feel" (323). This illustrates that children learn behavioral actions by example. Since advertisements and marketers "play" on these known actions, they can target the genders separately. Also, research shows that "through age four, children's activities were similar, but for the five- and six-year-old children, four significant differences in activities emerged" (Smith 326). The study showed that girls engaged in passive activities, while boys engaged in motor or active functions. If marketers use this technique in their packaging (showing girls in passive activities and boys in active situations), they will better parallel the tendencies of the market and attract a higher percentage of the market.

Gender differences may be natural, not strictly societal. In the article "Boys Vs. Girls," by Nancy Hall, she states that "boys and girls differ physiologically from birth, and such variations in hormones and brain structure probably account for the disparities in early childhood" (64). Research has even shown that boys are usually taller, heavier, and have more muscular strength when compared to girls (Hall 64). This could lead to the difference in children's aggression levels. Boys are more active and "are slightly more likely to engage in large motor behaviors," whereas, "girls engage in more expressive behaviors, such as vocalizing and smiling" (Hall 64). Boys and girls differ in many ways, although there are also many similarities. Children's marketers should utilize this information in order to better relate to the market.

METHODS

In order to determine which semiotic characteristics marketers use to influence children's purchasing decisions, primary research is necessary. By visiting a Toys R Us children's toy store, we will examine different products. To begin with, the population of our study is all children's toys available on the market today at the Toys R Us store in a city of 60,000 people in the Midwest. Due to the colossal number of products accessible today, it is necessary to take a sampling of the most popular products as opposed to studying the whole population. The products that generate a great deal of money from sales are ones that retailers give the most expensive and extensive shelf space (the closer to eye level or the consumer, the more it will cost), thus they are considered (for terms of this study) some of the more popular toys. Therefore, products with at least 10 feet (wide) of shelf space and at least three rows (high) will be chosen as individual examples. By collecting data from every 10th item of the most popular toys in the store, we will be able to narrow our scope and focus on specific items.

In addition to choosing every 10th item among the most popular toys, products will be further separated by the gender who buys the product most often. We will then analyze how marketers attempt to influence girls versus boys in the packaging of the toys. Utilizing the segments of the store, or studying the store layout is one way to decipher which toys are for boys and which are aimed at girls. Another way to choose which gender a toy is targeting is by who is pictured on the package design. Again using Barbie as an example, young girls are featured on the packages rather than boys. When the marketers show girls on the package, they are illustrating who they envision using their product. Also, children tend to imitate same-sex models with greater frequency than opposite-sex models so it would be logical that packages featuring girls in the pictures will be aimed at girls and vice versa (Smith 324).

This project will encompass studying and analyzing 80 different toys from the Toys R Us store. Of these 80, 35 of the toys are marketed primarily to boys, 35 will be marketed primarily to girls, and the other 10 are marketed to either boys or girls. Most importantly, the Toys R Us Chain has 45% of the children's U.S. toy sales. By having such a high percentage of the market, Toys R Us can afford to introduce new toys and products; an opportunity that smaller stores would have to pass up. This gives Toys R Us sales advantage since it has such a large variety in its products. To maintain consistency, all products will be tested using the same semiotic variables: symbols, shapes, font, and color. The literature research has given an informational background, but primary and functional research must be made. From this information we have concluded certain hypotheses:

H_1: Certain action symbols will be associated with boys, such as 💬 (used to illustrate talking) and ⇨ (used to show motion). Whereas, passive symbols will be used for girls, such as hearts.

H_2: The shapes that will be utilized most for boys will be bold squares, as opposed to the feminine circles and curves will be used more for girls.

H_3: The fonts used for girls will be more feminine in nature when compared to those for boys. For example, script may be used for girls. While, something more bold may be used for boys.

H_4: The colors that are used for girls will be softer pastels and pinks, whereas, the colors for boys will be darker colors like black, green and dark blue.

RESULTS AND DISCUSSION

After reviewing our results, we have come to the following realizations which toy marketers can implement in order to target gender groups. To begin with, certain symbols were found to be associated more often with specific gender groups. For example, the heart was found on eight girls packages and no boys packages. Based on our hypothesis, we predicted this to be true due to the association of love and caring with the heart. Females in general have been socialized to be able to express feelings much more freely than males. Therefore, the heart symbol can psychologically influence girls to parallel the product with their caring emotions; this in turn can lead to a purchase because of the effects of semiotics. The flower can be used in a way similar to the heart when marketing a girls' product. Flowers are natural and give off soft smells that convey feelings of peace and harmony. Men typically want to be rugged and aggresive--any association with flowers may contradict this image. Thus flowers can be used by marketers to influence girls, as opposed to boys, to purchase their products. Finally, the flash was determined to have a significant difference between marketing toward boys and girls. Ten boys' packages had a flash (🗨) symbol, whereas girls' packages featured only three of these symbols (in fact, one of the three was actually a sun). The points on the flash give a rough apperance, and the constant flow of the edge portrays motion and activity. In the first hypothesis, we also made reference to the fact that the symbols used for girls would be passive in nature, while boys' symbols would be active. The heart and flower symbols are very passive and had significant use on girls' packages which supports this hypothesis. We considered these symbols passive because they are generally not associated with physical activity. The flash, on the other hand, is active and was used often on boys' packages to indicate action.

In the second hypothosis, we predicted that rounded shapes would be used to target girls and pointy or sharp-edged shapes to target boys. Shapes such as the circle and square were predicted to be targeted towards girls and boys, respecively. However, this was not the case according to our results. We infer this is because the shapes are very commonly used and seen in every facet of life. Other shapes, including the triangle, rectangle, and oval are not as common as the circle and square which is why we feel that they better proved our hypothesis.

First, the triangle and rectangle have defined, hard edges. These both proved to be utilized more frequently on the packages aimed at boys. In fact, the triangle was not used on any of the girls' packages. From the previous shape discussion, the triangle is seen as a sign of stability. This sign may relate to and semiotically influence boys who have been socialized to see themselves as the stable partner or head-of-the-household.

While the diamond has hard edges, we feel that it was used to target girls on four packages and none on boys because of the correlation to jewelry. From an early age many girls hear the phrase, "a diamond is a girl's best friend." This phrase can influence girls to see the diamond as a positive attribute when purhcasing toys. On the other hand, if a boy would see this shape, he may react negatively and not buy the product. Boys have been culturalized to be "macho" and wearing jewelry is often seen as "girly" or "wimpy."

The oval, with its soft curves, gives a feminine feeling which is why is was mainly used on girls' packages. Traditionally, women have been seen as soft and caring, as well as having feminine curves. Even in cartoons and children's shows, children often see the male characters referring to females by making curvy or wavy hand gestures.

Next, the third hypothesis suggested that bold and boxy fonts would be used on the packages for boys; while, curvy and soft fonts would be used for girls' products. In our results, we found that outline (a more bold font) was used much more frequently on boys' products. To illustrate, outline was used almost twice as much for boys' packaging. On the contrary, girls' products put to use the serif type fonts four times as often. This font's tails give a script-appearance. Script was used on five of the girls' packages, while it was not used on any of the boys' products. Script or serif fonts are usually narrower fonts, while san serif vary in size or thinkness. The narrowness has the effect of a lighter, airy sensation which relates to how girls show their free-flowing emotions.

Lastly, color was tabulated with some interesting results!! To begin with, we must allude to the fact that we did not take into account all of the pastel colors, such as light purple. Although, we did include light blue and mint, because we analyzed girls' packages first. We noticed that the blues and greens were much lighter that the blues and greens on the boys' products. The mistake that we made was in assuming that purple would not be used for boys' products at all. So, when we noted girls' products with the color purple in them, we did not classify that most of them were truly pastel purple as opposed to dark purple. For the main product colors (primary color), pink was significance, the likelihood ratio came to .0000 because fifteen girls' products had it and boys had none. See Table 1.0 for exact data figures.

Table 1.0: Primary Color Results

	Pink			Purple			Black		
	No	Yes	Yes (%)	No	Yes	Yes (%)	No	Yes	Yes (%)
Girl	20	15	75.00%	25	10	40.00%	32	3	9.38%
Boy	35	0	0.00%	28	7	25.00%	25	10	40.00%
Unisex	9	1	11.11%	10	0	0.00%	6	4	66.67%

Significance (Likelihood Ratio)	
Pink	0.00000
Purple	0.05358
Black	0.00000

One specific example of this, was in the bicycle helmet section which was in a unisex aisle, located between the girl and boy sections of the store. The helmet that was labeled "Girl Helmet" was hot pink and had flowers on it. But, the boys' helmet was black with dark purple and dark blue streaks. Not only does this illustrate and support our hypothesis for color, but it also goes along with the passive and active aspects of the products. Once again, flowers are passively used to influence girls to purchase products, and active, moving streaks are used to influence boys.

The purple significance level was very close. We wanted to include this to show that had we differentiated between dark and light, the light purple would have probably been used significantly more with girls.

The last primary color that was of great significance was black. This strongly parallels our hypothesis that light colors would be used for girls, and dark colors would be used for boys. Not only did pink have a significance

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level of 0.000 but black did as well. The contrast between these two colors is great, and the fact that they both scored as significant and mutually exclusive enforces the initial hypothesis.

As for secondary colors, red, green, orange, and black proved to be used more often on boys' packages than girls'. To begin with, red may have been used as a secondary color for boys because of its association with danger and war. This also follows closely with the active and passive relationship when evaluated against boys versus girls. See Table 2.0 for data statistics for secondary colors.

Table 2.0 Secondary Color Results

	Red			Green			Orange			Pink			Black		
	No	Yes	Yes (%)	No	Yes	Yes (%)	No	Yes	Yes (%)	No	Yes	Yes (%)	No	Yes	Yes (%)
Girl	32	3	9.38%	32	3	9.38%	35	0	0.00%	21	14	66.67%	33	2	6.06%
Boy	23	12	52.17%	25	10	40.00%	31	4	12.90%	32	3	9.38%	24	11	45.83%
Unisex	5	5	100.00%	6	4	66.67%	10	0	0.00%	8	2	25.00%	8	2	25.00%

Significance (Likelihood Ratio)

Red	0.00491
Green	0.03103
Orange	0.03197
Pink	0.00636
Black	0.01578

The fact that green was used more often for boys' packages than for girls' may be due to the traditional tendency for boys to be more competitive. One of green's semiotic interpretations is feelings of envy or jealousy. The competitive side of a boy may be triggered when viewing products with this color, and may in turn influence a purchase. Also, green may represent nature and the outdoors. Many of the boys' products are intended to be used outdoors and the green may stimulate instinctive outdoor inclinations.

To conclude our discussion, unisex packages are quite different from those of girls or boys. They have a high use of primary colors and had a low use of unique shapes or symbols. They seemed to have a more simple and classy appeal to them. A familiar example to most people is the Crayola package which mostly uses primary colors. The packaging is quite simple and consists mainly of a golden yellow color. Because these products are aimed at both genders, using the primary colors is a marketer's way to avoid packing color conflicts. To further illustrate, the majority of the sporting goods consisted of primary colors. This seems to be the first step toward gender equity in the toy market. Black was infrequently used, and pinks and light blues are emerging. However, we are not of the opinion that this will continue to change drastically or rapidly because boys' sports still get more attention when compared to girls'.

This paper is also a helpful tool for parents to inform their children of marketers' tactics. Not only should children be aware of the influences in their lives, but in order to help them make rational decisions, it is important to be aware and have all the packaging and semiotic knowledge possible. For instance, parents may wish to inform their children that marketers socialize girls to be associated with pink and boys to be associated with black. In order to help children have confidence and make their own decisions, these statistics can help. A situation may arise where a girl would want to purchase a "boy's" product. Instead of making her feel ashamed for wanting a product not meant for her gender, parents can inform their children that these choices are okay.

CONCLUSIONS

Overall, our hypotheses were supported by the statistical results that we compiled. In our opinions, color had the greatest effect and influence on children's packaging. It is apparent that marketers use different semiotic influences to target genders separately and also to target a unisex segment.

Marketers have extensive power over children's perceptions. By using this knowledge to their own advantage, marketers can persuade children to feel certain emotions which in turn will sway them to purchase their products over the competitors. Parents should also be aware of the tactics used by marketers to properly inform their children and make worthwhile purchase decisions.

Because semiotics can be such a strong influence, people need to remain aware of the world around them. Society will be constantly targeted by marketers today and in the future. By staying knowledgable and aware, they can help to ensure that the language of signs and semiotics will not be used against them.

BIBLIOGRAPHY

Craig, James. Designing with Type. Revised ed. New York: Watson-Guptill Publications, 1980.

Hall, Nancy W. "Boys Vs. Girls: Different from the Start." Parents. July 1996: 64-66.

McNeal, James. Kids as Customers. New York: Lexington Books, 1992.

Noth, Winfried. International Journal of Research in Marketing vol 4 (3). "The Language of Commodities: Groundwork for a Semiotics of Consumer Goods." 1988: 173-186.

Smith, Lois J. Journal of Broadcasting & Electronic Media vol.39 n3. "A Content Analysis of Gender Differences in Children's Advertising." 1994: 323-336.

Solomon, Michael R. Consumer Behavior ed. 3. New York, NY: Prentice Hall, Inc.: 1996.

Spink, Reginald. Symbols Around Us: Sven Tito Achen. New York, NY: Van Nostrand Reinhold Company: 1978.

Same-Sex Marriage Politics:
The Politicizing of Sexual Orientation

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The radical feminist statement, "The Personal is Political" was once meant to test the boundaries of political discourse about women's rights by rejecting the present rhetoric and calling for a new perspective. Jean Bethke Elshtain writes in *Public Man, Private Woman*, "there are no neatly defined limits on the boundaries of politics. Boundary shifts in our understanding of 'the political' and hence of what is public and what is private have taken place throughout the history of Western life and thought" (201). The specific rhetoric surrounding women's work, women's role in society and family and the definition of women in general went through profound changes in the last century. The changes in rhetoric coincide with the overall politicizing of private issues into public policy concerns. "The relatively open-textured quality of politics means that innovative and revolutionary thinkers are those who declare politics to exist where politics was not thought to exist before. Should their reclassifications stick over time the meaning of politics – indeed of human life itself – may be transformed" (201). Feminists are one group of revolutionary thinkers whose impact has changed the meaning of politics as well as human life in significant and permanent ways. Today, the private issue of sexual orientation is emerging as another public, political reclassification.

The politicizing of sexual orientation began relatively recently in the United States, and has been seen in *presidential* discourse only within the last two election cycles. Although gay rights advocates have fought for equality for many years, the discussion of these issues on a presidential level indicates a movement into the mainstream political rhetoric of the United States. This paper will attempt to illuminate the politicizing of sexual orientation by examining presidential rhetoric on same-sex marriage. Same-sex marriage became an important political issue during the 1996 election cycle and provides a clear and up-to-date lens for viewing President Clinton's discourse on sexual orientation. Same-sex marriage is a complicated issue because there are many different types of public discourse involved. Judicial discourse can be found in the Hawaii sexual discrimination case. Legislative discourse can be found in the Defense of Marriage Act and the various state laws recently passed. Political discourse can be found in the election year posturing of the two major parties and various political analysts. And presidential discourse can be found in various messages from President Clinton and his surrogates. The common thread among these different types of discourse lies in Clinton's actions, position and rhetoric. The president can influence each area of public discourse, and his patterns of rhetoric can shape the *type* of debate within each sphere. Theoretical literature on presidential rhetoric identifies the president as a key player in the politicizing of sexual orientation because he plays a large role in same-sex marriage politics. Therefore, this paper acts as an initial attempt to summarize, analyze and crystallize the President's role in the politics of same-sex marriage. The research presented is designed to highlight President Clinton's action, position and rhetoric as a shaper of the issue.

Before diving into the analysis of the President, it is important to review the events that led to the election year activities. This issue originally entered the legal scene in 1991 when three same-sex couples sued the state of Hawaii for denying their marriage license applications. Hawaii's state constitution, as well as most other state constitutions, has an equal-protection clause that forbids discrimination "because of race, religion, sex or ancestry" but does not directly protect sexual orientation (Leo 19). The couples claimed in *Baehr v. Lewin* that denying them a marriage license was discrimination based on sex (Harris 106). In 1993, the Hawaii Supreme Court ruled that prohibiting same-sex couples from obtaining marriage licenses may violate this equal-protection clause (Stengel 52). The Court sent the case back to a lower court for trial and directed the State to show "compelling state interest" to justify the ban (Leo 19). The State was ordered to "articulate interests compelling enough to justify burdening the fundamental constitutional rights of due process and equal protection" (Harvard Law Review 118). Legal experts say this is one of the toughest legal standards. It is rarely met except in cases of national security or public safety (Boxall A4). Although the case is not finished, on Tuesday, December 3, 1996, Honolulu Circuit Court Judge Kevin Chang ordered Hawaii officials to stop denying marriage licenses to same-sex couples. Chang wrote that the state had "failed to present sufficient credible evidence... that the public interest in the well-being of children and families or the optimal development of children would be adversely affected by same-sex marriages" ("Judge Rules" A4). Chang put his ruling on hold while the State appeals the decision (Lawton A1). An appeal of the ruling will send the case back to the Hawaii Supreme Court (Dunford A5). This means that it will still be some time before same-sex couples will be able to get married in Hawaii.

In the mean time, legislatures all over the country pursued actions that would protect them if Hawaii ruled in favor of same-sex marriage. "In the heat of a Presidential campaign, an issue that lesbian and gay organizers had planned to advance much more deliberately has suddenly become a top priority" (Dunlap A12). Over 32 states looked at proposals to ban same-sex marriages and to prohibit recognition of same-sex marriages performed in other states (Kaplan & Klaidman 29). Sixteen states have passed laws and two GOP governors have signed executive orders banning gay marriages ("Judge Rules" A4). At the federal level, the U.S. Congress passed, and President Clinton signed, the Defense of Marriage Act which addresses two main issues. First, it says that states cannot be forced to recognize same-sex marriages performed in other states. Second, it defines marriage as the union of one man and one woman only (Barr 27). "Marriage so swiftly became the emblematic gay rights issue of the season that lesbian and gay organizers were left with little time to build political alliances" (Dunlap A12). The issue created a whirlwind of anti-gay politics and caught the gay and lesbian organizers off guard.

Eventually, these legislative measures could be judged unconstitutional due to the "full faith and credit" clause of the U.S. Constitution (Murray 30). Congress does have the power to determine the "effects" of this provision (Barr 27), but the ultimate decision concerning the constitutionality of these laws must be determined by the courts. "The courts will be asked to decide whether other states are obliged to recognize Hawaii same-sex marriages under federal constitutional requirements that states observe one another's official acts" (Boxall A4). So far, only Hawaii courts have addressed the issue as a constitutional right. The U.S. Congress and various states have taken preemptive measures to try to delay the legalizing process, but the real legal battle will continue to be waged throughout the nation, both in the courtroom, and the rooms of public discourse.

As the same-sex marriage issue gathered speed all over the country, the entire nation was interested in President Clinton's position. Bill Clinton has been characterized as the most pro-gay president in the history of the United States. He has "increased AIDS funding by tens of millions of dollars, granted security clearance to openly gay men and women, and endorsed measures such as the Employment Non-Discrimination Act" (Bono 43). Bob Hattoy, one of the openly gay White House aides, told the New York Times that he thinks the President will play an important part in the lasting picture of equality. He said "Bill Clinton has stuck with us through a lot of important issues and is capable of historical progress" (Clines A22). The President has also personally expressed his continued support for the gay and lesbian communities. At an informal press conference in the White House Rose Garden on June 7th, Clinton said, "I don't think any President has ever been as sensitive to the legitimate interests of gay Americans than I have. And I have been roundly criticized for it in many quarters" (Ayres A8). In a late June interview with *Advocate* magazine, a national gay and lesbian publication, he added "My administration has taken more steps than any previous in bringing the gay and lesbian communities to the table. I am proud of my record, and it is a record to build on" (Moss 46). Despite this history of support for homosexual advancement, the President has strongly expressed opposition to legalizing same-sex marriage. George Stephanopoulos, the President's senior advisor stated in early May that Mr. Clinton said in his 1992 campaign that he opposed same-sex marriages and therefore was merely reiterating long-held positions. He maintained that, "It never hurts you politically to stand by your positions, even if it causes some temporary disappointment among your supporters" (Rosenbaum A10). This position did become a controversial political move during the heat of the election.

The republicans were hoping for this controversy and temporary discomfort to throw a wedge in the president's campaign. Howard Fineman, political writer for Newsweek magazine, wrote that "In a distrustful age, a presidential election is less about inspiration than mayhem: locating popular issues that divide the enemy camp and cast your opponent as a cultural extremist" (30). The issue of same-sex marriage fits this strategy. Hattoy says, "To support same-sex marriage at this particular cultural moment in America is a loser" (Clines A22). A June 3, 1996 Newsweek Poll showed that while 84 percent of Americans say gays should have equal access to job opportunities, 54 percent say gay marriages should not be legally sanctioned (Kaplan & Klaidman 26,29). By increasing the visibility of the same-sex issue, republicans pressed the President into a corner where he had to choose either a liberal pro-same-sex marriage stand or maintain the middle ground against the tide of gay and lesbian critics. "Advocates of same-sex marriage maintain that conservatives forced their hand when they initiated a nationwide legislative drive to foreclose recognition of such marriages if they were legalized in any state. The object, these advocates contend, was to close off any meaningful discussion of the issue and to drive a wedge between the President and his gay supporters" (Dunlap A12). The President chose to hold the mainstream position and take the risk that his homosexual constituency would withdraw their support. Fineman asserts that Clinton "knew he could say no to same-sex marriage. Though gays have poured millions into Clinton's campaigns, the movement's leaders understand the numbers" (30). New York Times political analyst Todd Purdum further reported that White House aides acknowledge "their calculation that gay supporters would be unlikely to abandon Mr. Clinton over this issue" ("White House" B9) and "that they were eager to squelch it now" ("President" A1). The best political move for the President was to sign the bill and quickly move on to other, less controversial issues. White House press secretary, Michael D. McCurry, said, "The President believes the motives behind this bill are dubious and the sooner he gets this over with the better" (Purdum, "Gay Rights" A22).

The fact that this issue mushroomed during an election year is critical for interpreting the President's conduct. Purdum argues "the White House soft-pedaled the issue at every turn" ("Gay Rights" A22). This approach upset the gay and lesbian community, and was widely

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criticized for its obvious nature as election year politics. The President's actions were clearly "intended to remove a potential controversy with republicans over a divisive social issue" (Purdum, "President" A1). Elizabeth Birch, executive director of the Human Rights Campaign, expressed her frustration over the Defense of Marriage Act by saying, "The bill is a ploy by the floundering 'Dole for President' campaign to drive a wedge between the gay community and President Clinton, and it's very disappointing and sad that he has felt the need to take the politically expedient way out." David Mixner, a California fund-raiser and old friend of Mr. Clinton's, added: "Both Harry Truman and J.F.K. were reluctantly drawn into the civil rights battle, but when they had to choose between political expediency and the moral high ground, both chose the moral high ground. Regrettably, this President has not" (Purdum, "President" B10). The political battle during this election cycle was a loss for proponents of same-sex marriage. Not only did the legislative battle mentioned earlier catch them off guard, but their most supportive president ever abandoned them in their hour of need.

The support for gay and lesbian issues was further eroded by the patterns of the President's rhetoric surrounding same-sex marriage. As the interview with *Advocate* magazine illustrates, there are two opposing sides of Clinton's rhetoric. For the more politically popular sexual orientation issues, Clinton uses liberal rhetoric. For same-sex marriage and other more controversial issues, he abandons his liberal position for more conservative rhetoric. For example, his answers on the specific issues of appointed positions, workplace equality, and AIDS funding as well as responses to general gay rights questions, repeated words such as "inclusion", "acceptance", "compassion", "tolerance", and "understanding" (Moss, "Interview" 46, 48). He appealed to common American values by saying, "We all want liberty and freedom. We want the embrace of family and community. We want to make the most of our own lives. That is why I've always said that our great diversity is a source of strength to unite – not divide – our country" (Moss, "Interview" 50). This rhetoric is consistent with his usual pro-gay position.

However, on questions concerning same-sex marriage, sexual education and adoption by same-sex couples, he used more traditionally conservative phrases such as "remain sensitive to the traditional values of our communities", "what is taught must be left to teachers, local school districts, parents, and students", and look "first to state and local governments, as well as the private sector, to consider issues like these involving community values and matters of conscience" (Moss, "Interview" 50, 52). These statements seem diametrically opposed to the previous ones and are indicative of a major rift in Clinton's politics on sexual orientation. The President's inconsistent messages about the various gay and lesbian issues renders his support for the gay rights movement as unstable and unreliable. This creates a state of political confusion about the status of sexual orientation in our nation's rhetoric. In a press interview during his 1992 campaign Clinton said, "My own view is that this should be a country that is free of discrimination.... [but] I don't think there should be affirmative steps to promote the homosexual lifestyle" (Moss, "Interview" 46). This inconsistency was further exemplified during the 1996 campaign season. Although he signed the Defense of Marriage Act, the President characterized the bill as "unnecessary and divisive" ("Senate's Votes" A22). Presidential Spokesman Michael McCurry stressed that this issue is a "nettlesome one for the President as he tries to balance the interests of a core constituency with those of moderate voters" (Purdum, "White House" B9). Rhetoric experts Karlyn Kohrs Campbell and Kathleen Hall Jamieson identify the importance of Presidential legislative messages in their text *Deeds Done in Words: Presidential Rhetoric and the Genres of Governance*. They focus on veto messages, but begin with an explanation of the various choices available to a president when presented with new legislation.

> A president can also sign without fanfare. This occurs most often when enactment is politically necessary but distasteful... they are likely to do so unobtrusively or to bury the act in a flurry of ceremonies celebrating the passage of more popular pieces of legislation. A president who disapproves of a piece of legislation but lacks a strong rationale for rejecting it or considers rejection politically inexpedient may allow a bill to become law without his signature.... Presidents also can register a formal protest when signing a bill into law or submit a message to Congress narrowing the interpretation of the act. (77, 78)

Clinton chose to sign the law late at night, therefore with little to no fanfare, and at the same time publicly protested the law. This middle ground position was indeed politically wise, but the White House pressed the issue further by not maintaining a quiet signing. The rhetoric used by Clinton and his surrogates both before and after the signing was filled with conservative messages. Repeatedly the President has been outspoken about his view that "marriage is an institution to be shared by a man and a woman" (Moss, "Wedding" 20). And McCurry said, "[The President] believes this is a time when we need to do things to strengthen the American family, and that's the reason why he's taken this position" (Purdum, "White House" B9). These statements are even more pervasive than the actual bill because they accentuate positions against sexual orientation equality and indicate a pattern in Clinton's rhetoric overall.

The evident transition toward the middle has become a key part of Clinton's politics. "After mocking Dan Quayle in 1992, Democrats have adopted family-values rhetoric with a vengeance.... Instead of advocating family values [Clinton] spoke of a 'government that values families,' then expanded that definition of the American family to include single-parent and homosexual alternatives" (Crabtree 8-9). One general problem with this rhetoric is that the continual use of conservative phrases confuses liberal interests with more conservative values.

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Ed Miller, director of research at the conservative Polling Co., asserts that Clinton's "liberal base realizes that they have lost the rhetorical battle – that they will never get the president reelected by demanding that he talk like a liberal" (Crabtree 9). Hattoy further pointed out that people should not expect such a complex cultural issue to be settled in the flash of a Presidential campaign (Clines A22). This is exactly the reaction that many gay and lesbian leaders had to Clinton's decision to sign the Defense of Marriage Act. "Gay rights advocates have agreed to disagree with him on same-sex marriage" (Purdum, "President" B10). They've let Clinton's rhetoric go largely unattacked so that they can move on to other issues.

This reaction may prove to be deadly for the movement and is problematic for our nation in general because presidential rhetoric has tremendous power in shaping our national identity as well as our federal policies. The president is clearly an important figure in the same-sex marriage issue. His position and rhetoric have tremendous power to shape national opinion and the parameters of legal, political and rhetorical debates. Campbell and Jamieson write that the office of the president entails an important public rhetorical role. "Public communication is the medium through which the national fabric is woven" (6). State of the Union addresses, for example, offer one of many opportunities for the president to define this rhetorical national identity (54). These addresses specifically call for meditations on underlying communal values. "Public meditations exemplify the symbolic processes by which a collectivity of individuals comes to see itself as an entity – a group, a community, a nation – with an identity that unifies its members and distinguishes them as a group" (55).

The political rhetoric surrounding same-sex marriage is not the first issue that has challenged our national identity. As mentioned at the beginning of this paper, the struggle for women's rights also forced our politics to be reevaluated. "From the earliest colonial beginnings, the tenor and quality of politics in the United States have been reflected in the tenor and quality of our national public rhetoric" (Stuckey 27). The national public rhetoric in the case of same-sex marriage has in large part centered around Clinton's position and his decision to sign the Defense of Marriage Act. This is logical given the role of presidential rhetoric in shaping our public images. Whatever the president does will naturally draw national attention and can have drastic implications for the acceptance or rejection of legal and political rights. "The President has become the nation's chief storyteller, its interpreter-in-chief. He tells us stories about ourselves, and in so doing he tells us what sort of people we are, how we are constituted as a community. We take from him not only our policies but our national self-identity" (Stuckey 1). The identity currently being evaluated is possibly one that touches our long-held understandings of American history as one of accommodation, democratic freedom and moral integrity.

The issue pushes the boundaries of our sense-of-self in very specific ways. Edwin Black writes in *Rhetorical Questions: Studies of Public Discourse*, that "the issue of self-definition is commonly manifested as an urgent crisis" (23). The same-sex marriage issue has been called a crisis by many conservatives throughout this entire election cycle. "Conservative groups contended that permitting same-sex marriages would alter one of society's most fundamental institutions" ("House Panel" 447). The political smoke screen they created was intended to circumvent or even halt the evolution of this national identity. American University law professor Nancy Polikoff says "the fight for marriage rights has closed off any critique of the institution itself" (Dunlap A12). Polikoff argues that organizing society around sexually connected people may be the wrong approach entirely (Johnson 48). "The question is not, as opponents would have us believe, will marriage survive the legalization of same-gender partnerships? Instead, the questions are how do society and the state support stable households in a world where the composition of families is changing, and how might same-gender relationships contribute to that end?" (Johnson 50). These, admittedly more difficult questions, are not being addressed at all in the larger social debate about the issue.

This stagnation is undercutting the power of sexual orientation as a defining American issue. Nevertheless, the same-sex marriage issue has created tension throughout the nation and has been successful in sparking meaningful discussions. The current political meditations on marriage and family have produced the rhetorical definition of marriage as Clinton's phrase that "marriage is an institution to be shared by a man and a woman" (Moss, "Wedding" 20). Because of the Presidents' shaping power, Americans are therefore called to value heterosexual relationships – without any discussion on the importance of love, fidelity and lifetime commitment "When we say that presidents constitute the people, we mean that all presidents have the opportunity to persuade us to conceive of ourselves in ways compatible with their views of government and the world" (Campbell & Jamieson 5-6). That is exactly what is happening in the debate over same-sex marriage.

The larger debate about the value of family and marriage in our society has not yet been addressed at a national level. But because of the way our nation was created, it is likely that sexual orientation will eventually force America into the reevaluation process. This country was arguably the only country ever established with a specific purpose in mind. "The United States of America is a social unit that derives its identity primarily from a set of political convictions" (Black 40). Some have said that these convictions led to the most influential constitution in history and the most powerful society in the world. However, because these convictions are based on abstract principles, the particular national identity at any given instant is fluid and capable of evolving over time. "A social identity grounded on conviction may at any moment be the subject of moral choice. It can be relinquished in favor of an alternative social identity" (Black 45).

The issue of same-sex marriage is asking this country to make a choice – accommodation or tradition. "The acquisition of a social identity, then, is not only the relatively simple matter of embracing a term or a set of terms" (Black 50). Terms currently in question include the legal definition of marriage as one person to another person as opposed to one man to one woman. "It is, also, the infinitely more complex act of assimilating whole networks of affiliation, value, and vocabulary" (50). The entire notion of individual rights and familial happiness is up for debate. Black emphasizes the magnitude of this debate by saying that when "a substantial number of people confront together a choice of defining who they are, what they come finally to believe about themselves may leave its mark on history" (21). This is precisely why same-sex marriage and the presidential rhetoric surrounding this issue are so important. They may have tremendous impact on our future, and consequently, our history.

Therefore, when viewing this issue through the lens of rhetorical theory it becomes clear that presidential rhetoric about same-sex marriage is a powerful force in the politicizing of sexual orientation because it has the potential to create a particular national identity. Questionable legislation passed in an effort to forestall a judicial definition of marriage inclusive of same-sex couples was used as election year posturing. The president's response to this legislation and his repeated use of conservative rhetoric has defined the country as a nation concerned about the family and the breakdown of the institution of marriage. Gay and lesbian leaders would like a thorough evaluation of these aspects of society but the identity being maintained is one of conservative and unevolving positions. The tension between these two forces may eventually cause a great change in our society. This will happen only as sexual orientation becomes more and more politicized. As Elshtain demonstrates, the current revolutionary thinkers have already begun this process.

REFERENCES

Ayres, B. Drummond. "Clinton Plans San Francisco Visit Despite Gay Protest Threat." The New York Times 8 June 1996: A8.

Barr, Bob. "No: Don't let homosexual activists subvert the cornerstone of civilized society." Insight 10 June 1996: 25,27.

Black, Edwin. Rhetorical Questions: Studies of Public Discourse. Chicago: The University of Chicago Press, 1992.

Bono, Chastity. "Playing into their hands." The Advocate 1 October 1996: 43.

Boxall, Bettina. "Hawaii may let gays tie the knot." Minneapolis Star Tribune 4 April 1995: A4.

Campbell, Karlyn Kohrs, and Kathleen Hall Jamieson. Deeds Done in Words: Presidential Rhetoric and the Genres of Governance. Chicago: The University of Chicago Press, 1990.

Clines, Francis X. "Weary Aide Is Buffeted In Gay-Marriage Storm." The New York Times 29 May 1996: A22.

Crabtree, Susan. "Politics of family values." Insight 17 June 1996: 8-10.

Dunford, Bruce. "Gay marriage wins round in Hawaii." Saint Paul Pioneer Press 4 December 1996: A1, A5.

Dunlap, David W. "Some Gay Rights Advocates Question Drive to Defend Same-Sex Marriage." The New York Times 7 June 1996: A12.

Elshtain, J.B. Public Man, Private Woman. Princeton: Princeton University Press, 1981.

Fineman, Howard. "Dulling a Sharp Wedge." Newsweek 3 June 1996: 30.

Harris, Elise. "Shotgun Wedding." Out June 1996: 104,106.

Sexual Orientation and The Law. Harvard Law Review, ed. Vol. 102. No 7. Cambridge: Harvard University Press, May 1989.

"House Panel Passes Gay Marriage Ban." Facts on File: World News Digest with Index 27 June 1996: 447.

Johnson, Frenton. "Wedded to an Illusion." Harper's Magazine November 1996: 43-50.

"Judge rules Hawaii may not forbid same-sex marriage." Minneapolis Star Tribune 4 December 1996: A4.

Kaplan, David A., and Daniel Klaidman. "A battle, not the war." Newsweek 3 June 1996: 25-29.

Lawton, Kim A. "Churches split over same-sex marriage ruling." Saint Paul Pioneer Press 5 December 1996: A1, A11.

Leo, John. "Gay rights, gay marriages." U.S. News & World Report 24 May 1993: 19.

Moss, J. Jennings. "Bill Clinton: The Advocate Interview." The Advocate 25 June 1996: 44-52.

Moss, J. Jennings. "Wedding bell blues." The Advocate 14 May 1996: 20-23.

Murray, Frank J. "Battle of the (Same) Sexes." Insight 4 December 1995: 30.

Purdum, Todd S. "Gay Rights Groups Attack Clinton on Midnight Signing." The New York Times 22 September 1996: A22.

Purdum, Todd S. "President Would Sign Legislation Striking at Homosexual Marriages." The New York Times 23 May 1996: A1, B10.

Purdum, Todd S. "White House Is Avoiding Gay Marriage as an Issue." The New York Times 16 May 1996: B9.

Rosenbaum, David E. "Many Disillusioned Liberals See No Alternative to President." The New York Times 27 May 1996: A10.

Rotello, Gabriel. "An aloha state of mind." The Advocate 12 December 1995: 96.

Stengel, Richard. "For Better or For Worse?" Time 3 June 1996: 52-53.

Stuckey, Mary E. The President as Interpreter-in-Chief. Chatham: Chatham House Publishers, Inc., 1991.

"The Senate's Votes on Gay Rights." The New York Times 12 September 1996: A34.

'Do As Little As Possible'
The Transformation of Film Noir's Myths in Chinatown

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> "Hollywood likes to tease the audience, but the law always comes along at the end and kills the bad guy. It's not that way and I didn't want to film it that way."
>
> -Roman Polanski on Chinatown

Roman Polanski's Chinatown belongs to a group of films commonly referred to as the second generation of film noirs. Noir itself was considered to end by 1958 with Orson Welles' Touch of Evil. These films share similar attitudes regarding their presentation of a familiar formula. They do not simply imitate the noir characteristics, rather, they reinterpret these myths as it suits their purpose. Chinatown does this expertly, using the noir conventions to redefine and ultimately dismiss them. Polanski uses the old formulas self-consciously in order to lead the audience to realize his agenda; that of presenting these ideas as false and destructive. He wanted the film to be a look at the world of the 1930's through the technology and camera eye of the 1970's. The film is situated entirely within the genre; he wants to evoke a generic experience from the audience. He needs prior noir knowledge as a backdrop against which he can tear down its conventions.

Whether or not film noir is a genre or simply a style, there are certain characteristics that link all noirs together. As their name suggests, they are generally dark, both in lighting and in theme. Shadow and light play off each other and show contrasts. Noirs generally take place at night (Chinatown's climax). A big city is the usual setting, often Los Angeles (as is Chinatown). The use of a real city creates an open story, one that deals with contemporary social realities. The use of a fake city, that is a set, closes the story up, focusing it more on the festering neurosis of a character (Hirsch, 17). Chinatown incorporates both; the scene at Chinatown was a set, but many other scenes were shot on location, including the scene at the orange groves. Low and high angled shots are often employed in noirs; the former to show one character's power over another, the latter to emphasize a sense of impending doom. Chinatown uses such shots, most notably in scenes of J.J. Gittes (Jack Nicholson) tailing Hollis Mulwray (Darrell Zwerling). These stories are often told in flashback and/or voice over narration. While Chinatown lacks overt examples of each, the movie as a whole serves as a flashback, looking from the present onto the past in order to tell a story.

Noirs generally have three basic character types; the criminal, the femme fatale and the detective. For the most part, they center around a detective, invariably a man, on a quest for answers. He uncovers these truths through his own powers of observation and deduction. The hero has a code of honor that he must abide by, or he will become a victim of fate. Often this code corresponds to society's ideals, but not in all respects.

The motivation for the hero's quest is usually in the form of an encounter with a woman, usually a femme fatale. These women are cold, calculating and mysterious, never giving themselves completely to anyone. They shrink from familial roles such as wife or mother. They use their sexuality merely as a means to an end, usually money and/or power. Their intimacy is purely sexual; they do not need love. The only way these women are able to dominate men is through the use of their sexuality. They will use it without remorse, trapping and controlling men. In the end, these women typically are killed, arrested, ignored, or, realize the error of their ways and are reincorporated into society.

The criminal part of these stories is usually found in a transgressive male. These men are often effeminate foreigners. They are presented as less masculine than the detective and/or other males in the story. Physical presence is often downplayed, the criminal having a noticeable physical deformity; obesity, shortness, use of a cane, etc. Greed for money and power frequently motivate the criminal.

Although the general feeling of noirs is one of defeat and despair for the characters, there is always a sense of justice at the end. The characters have done wrong and deserve the punishment they received. Society rights the wrongs, law and order prevails. The audience leaves knowing that the criminal world they spent an hour and a half inhabiting was not able to sustain itself in the face of society. Criminals are punished, the good side wins. There is always a hint at the characters ability to make a go of it in the real world, outside the life of crime they explored briefly.

This is the aspect of film noir that Chinatown dismisses. It uses noir characterizations to render this transparent and in need of a reworking. Polanski counts on the fact that the audience has seen other noirs. He presents a familiar situation and lulls the audience into thinking that it will be like previous noirs they might have experienced. However, in the end, he demolishes the moral universe that noirs sought to establish. He felt that "the dramatic impact would be lost unless audiences left their seats with a sense of outrage at the injustice." (Polanski,348). It is as if Polanski is chiding the American public for ever having bought into the myths that noirs perpetuate. He says that individuals have no control over or say in their destinies; they are helpless bystanders.

"By upsetting the genre, Chinatown exposes the self-justifying structures through which the popular myths of our culture naturalize ideology" (Wexman, 106). Movies are often used to reinforce or even tell the public what they should think, feel, and do. Noirs did this repeatedly, showing promiscuous women to be dangerous, foreigners to be criminal, and only the lone detective was good. Chinatown shows the audience how not to think, and in doing so shows the audience where their previous ideologies were rooted. The "femme fatale" is not evil, the criminal is not foreign and the lone detective is ineffective. Justice does not prevail in the end. Order is not restored. The evil element is left free, with the hint that he will repeat his actions on a second generation.

Typical noir characterizations allow Polanski to prove the inadequacy of prior noirs. Chinatown involves a very complex, twisting, confusing plot born of one man's extreme greed. The woman is the catalyst for action, and is presented as embodying many characteristics of the femme fatale, while being more complex and human than her predecessors. The detective is almost completely noir, in attitudes and actions, but strikingly differs in his degree of success. However, in the end, the humanized female is killed, the detective is rendered impotent, and evil rules.

Evil is incarnated in the person of Noah Cross. He is the precipitating factor in each crime committed, both in the public and private spheres. Greed for power and money is his primary motivation, not any greater sense of good for the community. He had given up part of his power when Hollis Mulwray, his business partner, forced him to sell the water and power company to the public. When his daughter Evelyn ran to Mexico and married Hollis, Cross lost his power to exert control over her. He will not allow that power to slip through his hands again. Controlling water and his daughter/granddaughter, Katherine, (the product of his incestuous relationship with Evelyn) are his ways of insuring his power for the future.

Cross is reconciled to his past and has no regrets. In fact, he seems somewhat proud that he has done what most men can't even consider. Most people never have to deal with the fact that "Given the right time and right place, they are capable of anything." This could easily serve as a catch phrase for earlier noirs; they implied that all men held potential for criminal activity, that it was just below the surface. It only took an accidental occurrence to bring it to the foreground. Cross has given in to this noir idea and has never sought to escape it as earlier noir characters do. He strives for the reenactment of his earlier crimes.

Dominance is the power of Cross. He is able to dominate society by controlling their water supply. Cross also is able to exert power over the other characters. Evelyn becomes flustered and starts stammering whenever her father is mentioned. Gittes, much as he tries, is unable to dominate Cross. He is constantly pushed to the side of the frame when he is shown with Cross. Gittes, as the detective, goes to the Albacore Club to ask questions. Yet, it is Cross who dominates the conversation, mispronouncing Gittes' name and even ordering him to sit down.

Cross is unable to distinguish between public and private, seeing each much the same way. This duplicity of vision is represented by his bifocals. These glasses are what eventually lead Gittes to the truth. This double vision carries into his attitude about his business and his personal life. He did not want the public to own their own water because it would grant them more power than he had. In California, water is life. He is also able to see both his daughter and granddaughter as his lovers. The incestuous nature of his vision, both in private and public arenas, is represented by the smashed lens of his glasses.

Unlike older noirs, Cross is not depicted as "other" or alien in any way but dress. He helped build the city. He is not a foreigner, but is more transgressive than most noir criminals. This forces the audience to realize that evil dwells in their backyard. It is not just foreigners who deal in crime. It is those they deal with every day.

The portrayal of Evelyn Mulwray, Cross's daughter, also offers a dark twist to noir sensibilities. She is first presented as a typical femme fatale, in complete control of Gittes and the direction their relationship would take. Her observation of him while he was reciting a dirty joke, at the expense of the Chinese (with whom she is constantly aligned) shows her ability to fulfill the role of the gazer as well as being the object of the gaze.

Her next scene shows that, while she is still viewed as a femme fatale, she is becoming a three dimensional person as well. She starts off in control of the situation and Gittes, but ends by meekly saying "call first" to Gittes as he leaves. When Gittes brings up the young girl, she loses her composure.

Evelyn does show many other femme fatale characteristics, but these do not render her as pure black widow. In the end, these items are undermined. She admits to having frequent affairs and not being able to see anyone for very long, showing a freedom in sexuality apparent in previous noirs. However, once her past is discovered, the audience can sympathize with these statements. Her father's incestuous behavior would traumatize anyone. She is cool and reserved at first, but, by the end, she has relaxed and begun to open up to Gittes and the audience, much as is the case in any growing, real relationship.

She dominates Gittes, not sexually but in language and even in action. From the beginning, she ruled their mode of discourse, with Gittes changing his usual mode of speaking when she was around. He either stopped in the middle of a curse word to find a more "appropriate" one or he would apologize to her after using profanity. She had to translate "cherchez la femme" to him because he did not understand French, in spite of his earlier usage of it. She was able to lie to him on several occasions without his knowing immediately; he merely thought she was hiding something. She made fun of him, asking "Do you get it or is it too difficult for you?" and repeating his earlier line "I think I would have remembered" with clear ironic overtones.

She also dominates him several times by saving him. She saves him from a difficult situation by claiming she hired him. She picks him up at the orange groves where he was beaten up and knocked unconscious. At the rest home, he is able to jump into her car to make a getaway from the thugs.

She is complex, not just deceptive. She is a victim, not a victimizer. She has her reasons for keeping secrets and for once they are understandable. However, Polanski does not allow this complex woman to survive. His presentation of her as such shows the limited vision of earlier noirs. The audience, along with Gittes, are not able to see past her outside appearance of a femme fatale. She is three dimensional, not a creature born of evil intentions. She has been caught in a world that she is unable to escape. Earlier noir women deserved their punishment because they were evil. When Evelyn is killed, Polanski shows that the world is not as black and white as used to be thought. She is killed while trying to escape from her problems, problems she did not bring on herself.

The characterization of J.J. Gittes is where Polanski is able to present the ineffectual nature of most of the myths of film noir. Gittes embodies noir detective's values: he aspires to actions on a grand scale; is motivated by his ideals of courage, justice and altruism (when compared to Escobar, Looch, Cross); believes women and minorities and those associated with them are subordinate and often a cause of evil; is on his own to save himself from other's ideals; and is trying to at least resolve an isolated instance of injustice.

Polanski uses this formula and representation to question and ultimately dismiss these ideals as inadequate and destructive. Gittes is a failure; he is doomed to repeated failures in the same areas. He is caught in a cyclical history. He finds little out for himself; instead he is given direct clues by others. His chosen profession dictates that he spend his time observing others, but he is unable to deduce what is really going on.

It is obvious that Gittes has bought into the image of a femme fatale because he continually blames everything on Evelyn. He is stuck on the fact that she is holding back and does not take into consideration the amount of truth in what she did tell him. He cuts Evelyn off as she tries to explain to him and he offers his own solution, to which Evelyn readily agrees. His failure to extricate himself from the stereotypes of noir show it to be a limited vision. He does not believe anyone, much less a woman, could be in possession of greater knowledge than he.

While he jokes about his powers of observation, he does not observe all he should. He is unable to keep others from observing him and discovering truths about his character. Evelyn notices that "no question from you is innocent". The man in the barber shop comments on the derogatory nature of Gittes' work and causes a defensive reaction from him. Cross is able to see what Gittes' relationship with Evelyn will become. While Gittes is easy to figure out, the case is not. This explains his troubles with it. His vision will not allow him to see what he is not directly involved in.

Polanski forces the audience to identify with Gittes and his shortcomings. They travel through the case with him, sit in his back seat, look through the binoculars with him, and share his point of view. The "man with the knife" (Polanski in a cameo part;) speaks directly to the audience. When Gittes beats up Mulvehill, he cracks Mulvehill's head against the camera, making the audience aware of their participation in the movie. In as much as the audience is implicated as partaking in the look, Polanski invites an examination of "what it is like to get caught gawking" (Weschler, 92). The audience catches their breath as Gittes has to jump back to avoid being caught. Because they identify with him on a physical basis, they are forced into identification with him on a mental basis as well. When he fails, so has the audience.

Gittes is a sexist and a bigot, typical failings for noir detectives. However, Gittes' views are invalidated by his degree of dependence on these minorities. Evelyn saves his life twice. She supplies the answers to his questions. When she reveals that the glasses did not belong to Hollis, the audience and Gittes realize that the true source of corruption is not a woman. This invalidates Gittes prior idea that Evelyn was behind everything. To find the solution, he must return to Chinatown, a place where he has no influence on the outcome, where it is outside of his control.

It seems though that the rest of the world shares his views. Escobar believes Evelyn is behind everything. The cut on Gittes' nose could be taken to represent not only his failure as a detective, but also his flaw. In Chinatown, society is just as transgressive as the criminal, but their transgressions are accepted as the status quo. The other men in the film also have physical problems, showing that they share Gittes' beliefs about minorities. Both Lou and the overweight mortician have colds. The "weasel" at the Hall of Records has a boil. Mulvehill appears at the end with a bandage on his head. Polanski's thug and Looch are each shorter than average. Cross is aging and needs bifocals. None make any reference to a serious relationship with either men or women.

In the end, Gittes is impotent. Once again, while trying to save a woman he cares about, he succeeds only in getting her killed. His control over the world, as well as his powers of investigation, are merely illusory. Polanski shows the audience that noir traditions are ineffective and even destructive. He brings his audience into a comforting, familiar generic experience, only to change the formula and force a new ideology on the audience. He undermines the conventions of noir by playing within the genre itself. He destroys it from the inside out.

Bibliography

-Cameron, Ian, editor. The Book of Film Noir, New York: Continum, 1993.

-Hirsch, Foster. The Dark Side of the Screen: Film Noir, New York: Da Capo Press, 1981.

-Leaming, Barbara. Polanski: The Filmaker as Voyeur, New York: Simon and Schuster, 1981.

-Man, Glenn. Radical Visions, Westport: Greenwood Press, !994.

-Polanski, Roman. Roman, New York: William Morrow and Co., 1984.

-Thompson, David. "I Make Films for Adults", Sight and Sound April 1995:6.

-Walling, William. "*Chinatown*", Film in Society, Arthur Asa Editor, New Brunswick: Transaction, Inc., 1980.

-Weschler, Lawrence. "Artist in Exile." The New Yorker 5 Dec, 1994: 87.

-Wexman, Virginia Wright. Roman Polanski, Boston: Twayne Publishers: 1985.

OUTSIDE LOOKING IN:
SACRED SPACE OF TAOS PUEBLO

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The private perspective holds space for the occupant's benefit and holding a surrounding area as part of the occupant's personal territory. Although public orientation sees space as available for anyone's use, the encroachment of personal or sacred space brings decisive action. Preservation of a private realm occurs as one withdraws from the intruder or asks the offender to move. In Taos Pueblo, protecting sacred space is a way of life. Sacred space is revealed in the Tewa's cosmology, symbolism, and architectural design.

The hazard of disregarding the cultural factors of space can be extremely costly. Tewan ancient instruction on the necessity of protecting sacred space concludes with a warning prophesy stating the Tewa tribal territory would be invaded by men who would eventually outnumber the native Americans. The Tewa are alerted to counter the invasion by resisting new ways (Miller, 104). Today, resistance to modern ways is manifested symbolically through adherence to early architectural philosophical ideals. Tribal council approval is required for placement of doors, windows, and any other structural changes (Ortiz, 44-45).

The Tewas' symbolic configurations are elaborate and follow spiritual co-centric circles. Understanding the symbolic process depends heavily upon pattern recognition (Harvey, 205, 209, 212). For example, Alfonzo Ortiz points out that Taos traditionalists use symbolism to delineate boundaries and define the center of their cosmology. Ortiz uses the example of a Taos painter beginning in the center and moving out to the borders to illustrate the necessity of boundaries and sacred center (Ortiz , 143). Through symbolism, Native American philosophy indicates that all things are considered living and united as one being. Nothing is inanimate. Traditionally, belief in natural harmony and relating architecture to sacred, functioning landscapes is an act of respect. There is no discrimination between man and nature. Pueblo natives use language appealing to the intellect, with meanings that cross over between architecture and sacred landscape. For example, *ye makini* means inner room as well as cavern; *te'wi* means set back on a mountain or bench in a *kiva*. There are no abstract terms for space and time. These words are only as valuable as defining the distance between two points (Hale, 104 -110).

Just as language indicates respect for sacred landscape, the manipulation of the watershed by the Tewa's brings reverence to focus. Red Willow Creek bisects the plaza at Taos. Similar to the creek, the Rio Grande River gorge cuts through the Taos plain. Taos Pueblo cosmology is further honored by echoing Blue Lake, found within the center of the Sacred Mountain. The entire watershed is sacred. As the Tribes attorney relates, "The watershed creates the Rio Pueblo de Taos. Blue Lake and the numerous sacred springs are the source of Red Willow Creek. The waters of the Rio give life to the watershed and to the Indians who dwell within. ... Blue Lake, as the principle source of the Rio Pueblo, is symbolically the source of all life; it is the retreat also of souls after death, the home of the ancestors who likewise gave life to people of today... Blue Lake, therefore symbolizes the unity and the continuity of the Pueblo." The Tribe recognized this lifeline centuries ago, prior to their 60 year struggle over returning their exclusive rights to the watershed. It is argued by Howard McCutchan that without exclusive rights, the intricate weave of Taos Pueblo will shred from the inside out by mining, decline of forests and Tourism (McCutchan, 86).

Other threads in the Taos weave concern the buildings themselves. As Suzanne Blier (2) and Alfonso Ortiz (86) agree, it is necessary to look at each building as an active, living organism. Since the Pueblo grows slowly in response to time and outside influences, artifacts are the best illustrations of Pueblo development. The walls surrounding sacred areas of the community are the most obvious example of artifactural evidence. This defense mechanism evolved from the Comanche raids of the 1700's. Its current use is a line of demarcation between public and sacred areas.

To further comprehend the Pueblo as an animate work of art, one must also understand the law of reciprocity as it pertains to pueblo architecture. Reciprocity is defined as a " mutual or cooperative interchange or relationship (Harvey III, 208)." Living within this law facilitates creation of sacred space in structures that mirror nature. Texture, color and shape link the Pueblo and Sacred Mountain and establish a natural reflection.

My first observation in 1994 revealed the pueblo sprawling in front of the Sacred Mountain. The structures appear to always have been there. The architecture echoes the surrounding arid, mountainous landscape. The plaza is within the pueblo as the valley is within the mountains. A wide, clear stream rushes through the center of what seems to be a parking lot. The open doors reveal limited views of shops and dwellings within. Large wooden poles horizontally embed the structure, resembling a tree line on the side of a mountain. Ancient manifestations reveal themselves, ranging from quite subtle to obvious correlation.

Ancient intent is visually implied within the very weave of the pueblo's architecture. Vincent Scully (48) describes the texture as one "of strawed adobe with that of grainy cedar." Hand sculpted clay was replaced with adobe brick walls after the arrival of the Spanish in the 1500's. The understated appearance of brick style changed the less formed appearance of the adobe wall to a coarser, more even appearance. This change also lent strength to the forms and provided a means to more easily modify the architecture. The adobe structures are repaired yearly in the same manner they have always been repaired, maintaining the man-made, soft lines.

The color of adobe compliments the encompassing landscape. The light tan/ beige appearance remains consistent, and visually connects the pueblo with the surrounding elements. At times the Pueblo glows golden against the background of the Sacred Mountain. The structures are established through color from the

189

mountain much the same way the mountain itself is part of the Sangria de Cristos Range. This overall impression is added by the shining windows and bits of green and blue colors from the mountain shadows. The Sacred Mountain supplies an inspirational background to the pueblo's confirmation: one much more dramatic than available photographs reveal (Personal analysis from photographs of Northern Pueblo by Kenneth Clayton).

Analysis suggests four major physical line directions presented within the pueblo configuration; vertical, horizontal, diagonal and round. Wood used for construction was stripped of bark and limbs then, post and lintel framework techniques were used. Ladders and framework, while honoring the trees, reinforce the impact of the grid. Line arrangements are dominated by horizontal pueblo roofs and the implied horizontallity of the mountain tops. Vertical slants of the framework act as a counter balance while diagonal lines of the mountainsides, ladders, and other structures add to the equilibrium. Photographs of the Pueblo suggest a pyramidal or box formation however, there are no absolutely straight lines. The exterior configuration of the community is softened by the roundness of corners, kiva walls, ovens, and natural timbers. Centuries of hand forming and smoothing have maintained a man-made earth from relating to the mountain. While the overall flow of the structure is fluent, photographic views of the North Pueblo expose divisional rock fractures between rooms which create recesses and ledges. Rocks placed around the foundation of the pueblo resemble a talus slope, furthering the correspondence with the Sacred Mountain (Personal analysis of Pueblo architecture by contrasting and comparing photographic evidence by Clayton and Scully).

The interior impression received is three dimensional. Immense logs, darkened by smoke and time, dominate the inner framework. One native artisan reminded me that the room we were standing in, as well as the aged framework, had been there since the beginning of time. I later understood his reference to time as Tewa genesis and not my cultures cosmology as a marking point for the architecture (Personal interview B. Hanson, October 1994).

Taos reciprocal relationship with the church of San Geronimo honors the sacred landscape. Although European in style, the church has adjusted within it's structure and color to resemble a snow capped mountain resting between two peaks. According to Scully (58), the portico is "overtly intended to echo the mountains profile. In this way the intrusive European attitude was deflated by Pueblo culture and drawn by it more naturally inclusive web of divinity." The white portico reflects the sun in much the same manner as the sun glistens off the mountain ridges (Personal analysis of San Geronimo using written and photographic evidence; Clayton and Scully).

From the very beginning of Taos recorded time, living within the law of reciprocity created a home in harmony with the environment. An intricate strategy of complicated symbolism was developed to protect the Pueblo. Manipulated patterns consisting of spiritual co-centric circles and elements of design establish their nature based cosmology. The Pueblo, feeding from the source of all life, grew throughout the centuries. Through persistent adherence to a prevailing philosophy, Taos Pueblo became an animate work of art.

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References:

1. Miller, M.L.: Preliminary Study of the Pueblo of Taos New Mexico, Chicago: University of Chicago Press, 1971.
2. Ortiz, Alfonzo: New Perspectives of the Pueblos, Alberquerque: University of New Mexico Press, 1972.
3. Hale, Kenneth: A New Perspective on American Indian Linguistics, Santa Fe: University of Santa Fe Press, 1982.
4. McCutchan, R.C. Gordon: The Taos Indians and the Battle for Blue Lake, Albequerque: Red Crane Books, 1991.
5. Blier, Suzanne Preston: The Anatomy of Architecture, Ontology and Metaphor in Batammaliba Architectural Expression, England: Cambridge University, 1987.
6. Sando, Joe S.: Eight Centuries of Pueblo Indian History, Santa Fe: Clear Light Press, 1992.
7. Harvey III, Byron: An Overview of Pueblo Religion, Alberquerque: University of New Mexico Press, 1982.
8. Scully, Vincent: Pueblo: Mountain, Village, Dance, Chicago: The University of Chicago Press, 1989.
9. Clayton, Kenneth N.: Photographs, Houston: Taos Pueblo, 1994.
10. Interview by Brenda Hanson of annomous Taos Pueblo artist: Taos Pueblo, 1994.

Directed By and Starring Cindy: Sherman's Performance Photography

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Cindy Sherman has claimed that her work is not a commentary on the masculine gaze, the feminine masquerade, or narcissism, yet all three issues are integral to an examination of her photographs. "...[Her] images are a critique of a world-view which sees the female body as coherent, beautiful, idealized and glamorized"(Day, 271). Whether or not she is addressing issues of gender is disputed by her critics. Ken Johnson claimed that, "becoming the Other, [Sherman] therapeutically releases the contents of psychic disturbance" through her roles of photographer and performer"(Johnson 53). What Johnson has failed to recognize, is that, because she is a woman, Sherman is already the Other. Margaret Iverson accepts this Otherness and argues that Sherman is searching for a means to "represent women without patriarchal precedents"(Iverson 52). Sherman may have this goal in mind, but her images also demonstrate the artist's awareness of the culturally constructed gender roles which are ingrained. Her very act of creation sets up the dichotomy between the active masculine and the passive feminine which recognizes that these constructs persist and must be manipulated.

It is important to recognize from the outset that by undertaking the role of photographer, Sherman has clearly taken an active/masculine position. This alone is not unusual, many women have chosen this active position of creation. Every woman is placed in this masculine position whenever she views any type of art work. The gaze is a power construct which is only applicable to active masculine characteristics.

The power to possess the gaze is formulated on desire for the viewed object. For the masculine, this desire requires a displacement of the primary love-object, the mother. Since it is the mother who is the first object of desire for the boy, he need only shift this desire onto the object of the gaze. For the female, however, desire is not such an easy process. Although the girl also begins with the mother as the primary love-object, the father quickly takes this role. Since the father is the possessor of the phallus, he is not an obtainable object of desire. The feminine recognizes that she is, like the mother, an object of desire. Thus, the feminine has no means of identifying the object of the gaze, except by identifying with that object. In order to possess the gaze, to feel desire rather than desired, the woman must take on a masculine role.

In this first approach to the artwork of Cindy Sherman her photography can be seen as a usurpation of the masculine gaze. In her photographs, Sherman maintains complete control over her medium, composing each photograph as a record of her own femininity. It is through her controlled composition that Sherman utilizes the masculine gaze in the presentation of a feminine spectacle. This is especially apparent in her early series, The Untitled Film Stills (late 1970's) and the Centerfolds (early 1980's) which are images of herself which Sherman composed by referencing depictions of women in the male dominated art of the cinema.

Sherman clearly poses herself in an awareness of the gaze in a number of the Film Stills. She often uses walls and doorframes to direct the gaze and as a frame, further distancing the viewer from the reality of the figure. She makes exceptional use of this device in Untitled Film Still #2 . On the left, the picture is cut by the frame of a door and on the right the viewer gets the edge of a shower curtain. What is most meaningful in this Still, however, is Sherman's use of the mirror. It is the mirror which lends an identity to the figure. Without the mirror, her face would not be visible, and the exaggerated motion of her right hand would not be clear. Sherman placed the pertinent information within the mirror; we understand that this is another woman obsessed and concerned with her own outward appearance. Here Sherman has consciously focused the viewer's gaze, playing it for her own purposes.

The later series, Centerfolds, explores a more psychological representation of the feminine. Attempting to replicate feelings of fear or longing, Sherman places herself in almost empty environments, assuring the primacy of the emotion as well as that of her body. She remains empowered through the masculine gaze, recording the emotional aspect of the feminine.

Sherman turns to the day dreaming figure in Untitled #96. Unlike the image from the Film Stills, this girl is not concerned with her self as a spectacle. Although she is physically there to be viewed, psychologically she is more deeply involved in herself. She may not openly acknowledge the gaze, but ultimately, these early images are created from an understanding that woman is an object to be seen.

It is the masculine who possesses the phallus (authority, action) the feminine is only lack. Nonetheless, the feminine plays an important role to the possessor of the phallus; her lack is a constant reminder that what he has might be lost. Thus, the feminine is appealing because she is subordinate, but at the same time she is threatening because she represents the potential of castration. If the feminine could actively participate in issues of control, such as the gaze, then the phallus would be meaningless, effectively castrated.

The gaze is the primary masculine power at stake in Sherman's art. It could be that she is placing the viewer in a masculine role in order to properly see the photographs. In this case, Sherman would be using the objectification of women to question the manner in which they are perceived in society. Her use of the gaze is foregrounded by her use of the masquerade. Sherman clearly is aware of the gender issues which define her as artist and as woman.

When a woman shows herself to be in possession of the phallus, as Sherman does by using the masculine gaze in her role as photographer, she fears retribution from the Father (i.e. the masculine possessor of the phallus). This is where the concept of the feminine masquerade comes into play. Sherman, at least in her early work, does not remove this masquerade, instead she utilizes it as the other half of her art work; her performance.

According to Joan Riviere, the masquerade is the means by which the feminine veils the phallus. The phallus, the symbol of power and activity is constructed as masculine, but this does not mean that a woman cannot obtain that power. Whenever a woman succeeds in a field which depends on intelligence or creativity, she is empowered with the phallus. Through that empowerment, the woman perceives herself to be a threat to the Father, so she fears punishment for her transgression. In order to hide this transgression, the woman must assume the "proper" feminine attributes. The masquerade consists of the woman's attempt to be sexually attractive to the male. In order to be an object of desire, she must cease to display phallic characteristics, becoming flirtatious in order to protect herself from the retribution.

Cindy Sherman's masquerade reflects her transgression of masculine power. As photographer, she makes use of the masculine power of the gaze and as performer she attempts to veil her transgression. In the majority of the series which Sherman has produced, she uses herself as the figure for each image, transforming her body into representations of many different types of women. In effect, she is offering herself as object of the gaze, using this masquerade to veil her simultaneous appropriation of masculine power.

In her enactment of the feminine masquerade, the artist tries on the various roles of femininity. The Film Stills are the first, timid step; allowing Sherman to experiment with the accepted feminine concerns of beauty and presentation. Film is the ideal place to begin addressing these concerns; cinematic images of women, especially those in Film Noir, consistently present the figure as a glossed over beauty. Sherman begins with the surface presentation, giving minimal attention to the underlying emotions. She focuses on the outer image because it is the aspect of the masquerade which first defines the perceptions of others.

In Untitled Film Still #6 Sherman lies prone on rumpled sheets. The mirror in her right hand represents her vanity, a common attribute of the feminine. She is an attractive figure, and the mirror suggests her own interest in her appearance. The vacant expression added to the skimpily clad figure's placement on the sheets indicates that she is in the midst of a private reverie, dreaming possibly of a sexual encounter. In effect, she has offered herself as an object to be seen and desired, rather than as a threatening, phallic woman.

The crucial question is "how to draw the line between genuine womanliness and the 'masquerade'"(Riviere 38). According to Riviere, there is no difference between the two. To be a woman is to be masked. She may masquerade in masculine or feminine personas, but woman in our phallo-centric culture is only not-male. Obviously, this is not an appealing thought to any woman, and in her later series, Sherman attempts to remove herself from the constraints of the masquerade. As she matured, Sherman continued to masquerade as spectacle in order to make up for her active masculine role of photographer, but she slowly began to erode these masks.

The exposure of the masquerade is evident in the Fantasy photographs and the Portraits. Sherman increasingly incorporates prosthetic appendages in these works, making no attempt to integrate them with her body. These false body parts first appeared in the Fantasy Series, in which Sherman's vision of the world seems to grow much more disturbing. Here she has no desire to masquerade, as though she is tired of the entire game. Instead she goes to lengths to make us notice her masquerade.

The masquerade is made visible in Untitled #216 one of the Portraits. The orb which substitutes for a breast cannot be rationalized away; even if it had been covered, it would not appear to be a normal breast. The masquerade cannot survive when its devices are revealed. Sherman seems to instinctively realize this, and consciously (at least in the Portraits) seeks to expose the accoutrements of the masquerade.

Her more current body of work moves a step further, completely taking her figure out of the issue. In the Mannequin Series, Sherman removes herself from the role of spectacle, thus ending her masquerade while developing statements on the nature of sexuality in general. Untitled #261 is an ambiguous image since the mannequin has both male and female attributes. By offering these confusing images, Sherman is able to reduce desire, and move her art work further from the issues of masculine activity and feminine spectacle.

The Mannequin Series also represents Sherman's move away from the narcissism which characterized her earlier works. Although her role as performer has been interpreted as feminine masquerade, there is also a clear narcissistic character to the Film Stills, the Centerfolds, and even the Portraits. No other figure would be adequate for the images Sherman wished to create. She manipulates her body into hundreds of different roles, but they are all remain pictures of Cindy Sherman.

As both performer and recorder, Sherman clearly focuses on the culturally perpetuated roles of femininity. Her early images seem to encourage voyeurism, allowing the viewer into the world of the subject without her knowledge. Yet, since it is Sherman herself, she is obviously aware of being watched; she has willingly made herself the spectacle.

Freud wrote that "the development of the ego consists in a departure from the primary narcisissism and results in a vigorous attempt to recover it" (Freud 121). Sherman's work is self-reflective; she seems to be searching for that lost narcissism, consistently using herself as the subject, but varying each character. It is not that any one of these images defines who Sherman is, or even who she wants to be. No one of the images will perfectly capture the person, but nonetheless, they are all pictures of Cindy Sherman. Taken as a whole, these untitled portraits serve to demonstrate the many roles of woman in society, while they also depict Sherman's own fascination with herself.

As Sherman's work moves away from the masquerade, exposing it, Sherman herself seems to move away from her narcissistic tendencies. In the _Fantasy Series_ and the _Portrait Series_, Sherman begins to change how she composes her photographs. Instead of direct images of herself, Sherman chose to subordinate her figure in a number of the _Fantasy_ images. At first glance, _Untitled #175_ appears to be the aftermath of a bulimic orgy, without sign of the perpetrator. However, Cindy Sherman is seen as a reflection in the sunglasses that lie among the debris. Unlike her previous works, this image of Sherman does not evoke any sort of sexual desire, instead the image is repulsive. Like a number of other images in this series, _Untitled #175_ is a comment on women's relations to consumer culture. Sherman does not want the image to be attractive; it is possible that she no longer wants to present herself as attractive.

Even when she is the center of the composition, Sherman often uses extreme costume and makeup effects, turning herself into witches, monsters, and mythical figures (female and male). Her body is less the subject of these compositions and has become a means to create an interesting image. This is not to say that Sherman was not always concerned with producing an interesting image, but that her earlier works show a greater interest specifically in her body image and figure.

Sherman began working with mannequins because she was tired of photographing herself and did not wish to photograph anyone else. Thus, the mannequins become Cindy Sherman, manipulating the body far beyond the true capacities of any human. With this definite turn away from narcissism, Sherman abandons her performance of the masquerade, yet continues to utilize the masculine gaze in her role as photographer.

It is at the point that she ends the masquerade and turns away from her narcissism that Cindy Sherman's work moves away from the traditional gender roles which dominate our culture. Clearly, by replacing her figure with oddly arranged mannequin parts, Sherman has also removed the object of desire from her images. This is exaggerated by the fact that the _Mannequin Series_ focuses on far more eroticized imagery than the earlier series. Despite the sexual nature of the subjects, it is not likely that a viewer would desire this collection of parts as he would desire a woman. By altering the discourse on the topic of sexuality, Sherman has succeeded in diminishing the power of the masculine gaze. The gaze cannot be destroyed. It is a cultural construct which is ingrained and when the object to be desired ceases to be desirable the power must certainly lessen.

Throughout her career, Cindy Sherman has struggled with the issues of gender which affect relations between the sexes. Her photographs reflect the position of most women in our society; trapped into feminine and masculine constructs of personality and power. Like many women, Sherman does not seem satisfied with masking her masculine activities with an assumed feminine identity. It may not be possible for anyone to find a set identity which is not limited by culture's gender constructs, but it seems that women are especially disadvantaged. In our patriarchal culture women are only negatives and in order to accomplish change, they must take a masculine position but then immediately redeem themselves in the masquerade. Sherman, like many contemporary women, must find the medium point where she can be accepted as a woman, carrying out the feminine masquerade, while exercising actual power, and moving into the masculine domain.

REFERENCES

Day, Gen. "Cindy Sherman: Theory and Practice," *Art Has No History! The Making and Unmaking of Modern Art*, edited by John Roberts. New York: Verso, 1994.

Iverson, Margaret. "Fashioning Feminine Identity," *Art International*, Spring, 1988, pp.52-57.

Johnson, Ken. "Cindy Sherman and the Anti-Self: An Interpretation of her Imagery,"*Arts Magazine*, November 1987, pp.47-53.

Rickman, John. *A General Selection from the Works of Sigmund Freud*. Garden City, NY: Doubleday Anchor Books, 1957.

Riviere, Joan. "Womanliness as a Masquerade," in *Formations of Fantasy* (ed. Victor Burgin, James Donald and Cora Kaplan) New York: Methuen, 1986.

Sherman, Cindy. *Cindy Sherman*. New York: Pantheon Books, 1984.

Sherman, Cindy. *Cindy Sherman 1975-1993*. New York: Rizzoli, 1993. (With text by Rosalind Krauss and Norman Bryson)

Sherman, Cindy. *History Portraits*. New York: Rizzoli, 1991.

Sherman, Cindy. *Untitled Film Stills*. New York: Rizzoli, 1990.

Reinterpreting Roman Morality

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Modern pop culture and Christian apologists and moralists have traditionally portrayed the ancient Romans as having decadent, excessive, and immoral sexual habits. Taking historical texts at face value would lead one to agree with this assessment, but a closer examination of sources shows many Romans of late antiquity upheld, or attempted to uphold, the moral values of their ancestors.

ROMAN HISTORICAL TEXTS

Traditionally, one of the most revealing sources of Roman sexual morality was histories written by the Romans themselves; for example, the histories of Livy and Tacitus. Both of them wrote their works during the empire, although they also both had a longing for the republic, which is easily noticeable in their works. Tacitus' description of the emperor Tiberius is an excellent example of imperial Rome's immoral image:

> On this island [Capreae] then, in twelve spacious, separately named villas, Tiberius took up residence. His former absorption in state affairs ended. Instead he spent his time in secret orgies, or in idle malevolent thoughts.[1]

Both Livy and Tacitus represent Roman history in general decline since Romulus. Livy depicts the early republic as the pinnacle of Rome, which is evident from Livy's writings on the subject. Livy's and Tacitus' outlook causes them to continually compare contemporary events to past events. They are out of touch with the times in which they lived; they lived in the past, not the present:

> I shall find antiquity a rewarding study, if only because, while I am absorbed in it, I shall be able to turn my eyes from the troubles which for so long have tormented the modern world, and to write without any of that over-anxious consideration which may well plague a writer on contemporary life, even if it does not lead him to conceal the truth.[2]

Their outlook on history was also quite different from our modern concept of an objective history for both believed history should be a means of teaching morals:

> I would then have him [the reader] trace the process of our moral decline, to watch, first, the sinking of the foundations of morality as the old teaching was allowed to lapse...and the dark dawning of our modern day when we can neither endure our vices not face the remedies needed to cure them. The study of history is the best medicine for a sick mind.[3]

The idea of a moral history is not the only factor resulting in Roman historians depicting their culture as base and immoral. *The Politics of Immorality in Ancient Rome* by Catherine Edwards explores a more political interpretation of the historians' motivations. She explains attacks on immorality as a means to keep the elite defined and separate from the rest of society.[4] The Roman morality of the elite was not regulated or

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[1] Tacitus, *The Annals of Imperial Rome*, trans. Micheal Grant (New York: Penguin Books, 1989), p. 190.

[2] Livy, *The Early History of Rome*, trans. Aubrey De Selincourt (New York: Penguin Books, 1960), p. 33.

[3] Above, n. 1, p. 34.

[4] C. Edwards, *The Politics of Immorality in Ancient Rome* (New York: Cambridge University Press, 1993), p. 4.

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defined by an authoritative institution--like the Christian church is today--but was instead internalized by members of the society. Because Roman morality was internalized, morality was arbitrary, and, therefore, needed to be defined often by public figures like Livy, Tacitus, and Seneca. The existence of an arbitrary Roman code of conduct was a means by which one Roman was subjected to the power of another through his definition of the code. Therefore, Roman morality was a power wielded by some Romans to empower themselves and disempower others. The social standing of many Roman "moralizers" attests to this. The most stringent "moralizer" of Roman history--as much mythical as historical due to later "moralizers"--was Cato the Elder. Cato was a *novus vir* or "new man" as was Cicero. They made themselves powerful forces in the senate by redefining the Roman elite and its morality. They did this through aspects other than their ancestry, such as wealth or personal abilities. Others who defined morality had similar low beginnings. Horace was the son of a freedman, the Senecas were from Spain, the Plinys were from Transalpine Gaul,[5] and Tacitus was also from the provinces, possibly France or Cisalpine Gaul.[6]

Overall, the Roman historical texts point to a use of accusations of immorality to empower the authors and to give evidence to the idea of Roman decline, which may or may not be historically correct. The "moralizers," by glorifying the past, made their contemporary world appear inferior. They depicted Rome as such to make the populace aware of themselves as inheritors of a great civilization and as impious children who are unable to emulate their forefathers' high standards. Therefore, the historian held a place in society closer to a social critic than an archivist.

ROMAN PORNOGRAPHY

One medium that gives us an indication of Roman sexuality is pornography. There were different types of pornography in ancient times, but the one that comes closest to out modern conception of pornography are works done by *an-aiskhunto-graphyoi* or "writers of shameless things." The texts were restricted to manuals for sex. The manuals primarily contain schemata for intercourse, although there are parts on seduction and perhaps oral sex.[7] The earliest accounts date from the 3rd and 4th centuries BC from Greece, but continue into Roman times and beyond. During the times in which they were produced and especially during the Christian period, the texts were considered luxurious because they only listed possibilities and did not counsel the reader about moderation.[8] Thus, the guide could only lead to weak, self-indulgent behavior that was characterized as "feminine." Because of this association between these texts and femininity, the material was considered soft and indulgent, and was the base form of pornography by which all others were judged. Although the material content of the "handbook" texts was feminine and irrational/uncontrolled, the existence of the genre--which was read predominately by men--allowed men to rationalize and "masculinize" sex by making it logical as if it were a mechanical process or a baking recipe. This rationalization of sex gave men a logical view and, consequently, the power to understand sex, i.e., the knowledgeable power to overcome the irrationality of sex.[9]

ROMAN MEDICAL TEXTS

The medical records from antiquity are excellent resources for understanding Roman morality. As pointed out in *Porneia* by Rouselle, medical texts gives us an indication of how sex was viewed in everyday life. This is because medicine is a human understanding of the body, not a supernatural or philosophical explanation. The way doctors in antiquity viewed the body functions as a good paradigm for the way in which all Roman society viewed the body.[10] In their thinking, Romans clearly made a mind-

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[5] Above, n. 3, p. 34.

[6] This is according to Michel Grant in the translator's introduction of Tacitus, (above, n.1), p.7.

[7] Seduction: P. Oxy 2891, implied by Aristhenes in Athenaeus 5.220. Oral sex: perhaps implied by Timaeus of Tauromenium in Polybius 12.13.1 and Justin Martyr 2.15.3. Cited by H. Parker, "Love's Body Anatomized: The Ancient Erotic Handbooks and the Rhetoric of Sexuality" from *Pornography and Representation in Greece and Rome*. (New York: Oxford University Press, 1992), p.92.

[8] Above, n.6, p. 98.

[9] Above, n.6, p. 99.

[10] A. Rousselle, *Porneia* (New York: Basil Blackwell, 1988), p. 3. Rouselle's main source is *The Medical Collection* commissioned by Emporer Julian, which includes the collected works of Galen, Soranus, and Hippocrates.

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body split. The body had its wants and needs which were in often conflict with the wants and needs of the mind. The body had to be conditioned so as not to interfere with the high aspirations of the mind. The Romans believed in administering the body only for its own health to release the mind from the body's drudgery. This a-matter-a-fact attitude about the body does not mean that there was not anxiety about desire in Roman medicine and philosophy:

> Passion for another's body disturbed, obsessed, and obstructed reason and the freedom of the mind...it was considered important to dissociate the mind from physical desire. The medical writers of the time echoed this view, and the scholars and politicians, like the philosophers before them, agreed that desire should not be allowed to intrude into intellectual or political life.[11]

This quotation shows how the body fit into Roman morality, i.e., a personalized morality regulated by and centered around the individual. Therefore, one measure of a man's moral worth was how much he regulated his body. The workings of this principle are most observable through sex, which sometimes led pagans like Julian and Sophocles to chastity:

> ...[H]e [Julian] was so conspicuous for inviolate chastity that after the loss of his first wife it is well known that he never gave a thought to love: bearing in mind what we read in Plato, that Sophocles, the tragic poet, when he was asked, at a great age, whether he still had congress with women, said no, adding that he was glad he had escaped from this passion as from some mad and cruel master. Also, to give greater strength to this principle, Julian often repeated the saying of the lyric poet Bacchylides, whom he delighted to read, who declares that as a skillful painter gives a face to beauty, just so chastity gives charm to a life of high aims. ...[T]his kind of self-restraint was made still greater through his [Julian's] moderation in eating and sleeping, which he strictly observed both at home and abroad.[12]

Julian's chastity was based not only on the idea of a personal moral code but also on certain medical principles which mainly concluded that sex was unhealthy. First, ancient doctors believed men to be distinguished by an internal "heat," giving them their masculine attributes. Because men had more "heat" than women, they were more aggressive, intelligent, and able. The ejaculation of semen was though to release this heat, and, therefore, make a man more feminine or "cool." Second, sex was considered dangerous for it involved an orgasm of uncontrolled convulsions. The convulsions were considered necessary for they were believed to have shaken a man's blood up into a white foam or semen. Yet, the orgasm was dangerous because it resembled an epileptic seizure. The production semen gave evidence to this belief since semen was considered analogous to the white foam appearing from the mouth of an epileptic.

Overall, the medical texts suggest sex to be unhealthy,[13] calling on men strictly to regulate their sexual lives, which entails maximum abstention from intercourse but still allows for a great possibility of pregnancy. After all, Rome was built around the family; being completely chaste and not having any children would have gone against an important societal norm. Roman men--especially those of the upper-classes who needed an heir--strictly regulated their diets and instances of intercourse to ensure pregnancy. Men ate certain "cool" foods to retain their sperm for too much heat would destroy it: lettuce, melons, berries, and cucumbers.[14] They also abstained from sex until the most opportune time for fertilization. Soranus believed the ideal time for intercourse was in the evening after a woman's menstrual period. After ejaculation, the woman should have crossed her legs and stayed in bed for a few days to be guaranteed of conceiving.[15] The arduous process the Romans went through to procreate demonstrates to what ends the Romans would go to regulate their lives for a health ideal and a moral ideal.

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[11] Above, n. 10, p. 3.

[12] Ammianus Marcellinus, *History*, books XXV, 4, 2-4. Cited by Rouselle, (above, n.10), p. 7.

[13] Soranus, a Greek physician, disagreed with his colleagues on this point. He argued, in the debate over hysteria, that virginity and continence are unhealthy and sex in moderation could cure this disease. Galen, on the other hand, believed chastity to be the highest good. He went so far as theorize that an athlete would be superhuman if he castrated himself for this would cause all his internal "heat" to be kept within himself. See Galen, *de semine* 1.8, Kuhn, p. 571. Coincidently, Artemidorus, who wrote *The Interpretation of Dreams* alluded to the same idea, quoted by Michel Foucault in *The Care of the Self*: "[H]e dreamed that he cut off his genitals, bound his head and was crowned [as a victor]...As long as he remained a virgin, his althletic career was brilliant and distinguished. But once he began to have sexual intercourse, he ended his career ingloriously (p. 16)."

[14] *Medical Collection*, XIV, 66. Cited in Rouselle, (above n. 10), pp. 18-19.

CONCLUSION

The Roman patron was the target of "moralizing" throughout the Roman republic and empire because he held the only "active" or "autonomous" role in Roman society; he could alter his situation if he chose to do so, whereas women, slaves, and children were "passive" in that they could not. The individual morality of the patron gave not only himself but also all these "passive" members of his household their individual character. The character and morality cultivated by the patron defined his household's level of respectability and success. Therefore, it was logical for a patron to follow the "moralizers" example.

Also, the "passive" characters in Roman society, and many of the "active" members as well, were not in the practical position to be immoral. Only the Roman patron had a position from which he could take advantage of others; it was perfectly legal for a Roman man to do what he wanted with his "property," which included all those who were part of his household. Yet, in a world Peter Brown has referred to as "a society that was more helplessly exposed to death than is even the most afflicted underdeveloped country in the modern world,"[16] only a fraction of men could be part of the elite. Only a fraction of men had the time and the wealth to be immoral.

The evidence and theories presented in the paper do not prove the Romans were moral people. It is impossible to prove that the Romans followed all the advice of the doctors and exhortations of the "moralizers." Instead, this paper simple shows that the Romans had an acute concern about moral issues and about upholding the moral "greatness" of their ancestors.

REFERENCES

Brown, Peter. The Body and Society: Men, Women, and Renunciation Early Christianity. New York: Columbian University Press, 1998.

Cohen, David. Law, Sexuality, and Society. New York: Cambridge University Press, 1991.

Edwards, Catherine. The Politics of Immorality in Ancient Rome. New York: Cambridge University Press, 1993.

Foucault, Michel. The Use of Pleasure. Trans. Robert Hurley. New York: Pantheon Books, 1985.

Livy. The Early History of Rome. Trans. Aubrey De Selincourt. New York: Penguin Books, 1960.

Richlin, Amy, ed. Pornography and Representation in Greece and Rome. New York: Oxford University Press, 1992.

Rousselle, Aline. Porneia. Trans. Felicia Pheasant. New York: Basil Blackwell, 1988.

Sissa, Giulia. Greek Virginity. Trans. Arthur Goldhammer. Cambridge, Mass: Harvard University Press, 1990.

Tacitus, Publius (or Gaius). The Annals of Imperial Rome. Trans. Micheal Grant. New York: Penguin Books, 1989.

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[15] Soranus, *Gynecology*, I. 36 and 46. Cited by Rousselle, (above n. 10), p. 20.

[16] P. Brown, *The Body and Society* (New York: Viking Press, 1988), p. 6.

Edna St. Vincent Millay: A Feminine Perception of Love

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Edna St. Vincent Millay presents her version of the love sonnet in "I, Being Born a Women and Distressed," but it is far from being a Shakespearean backslide into obsessive idolatry. Shakespeare's sonnets represent two separate states of love - bliss and misery. From Shakespeare's point of view, life is not worth living if you are a single person without sexual love and offspring, "Make thee another self, for love of me,/That beauty still may live in thine or thee" (Sonnet 10); any state of being, whether in bliss or in misery is all worth it when you are with the one person you love, "but if thou live remembered not to be,/Die single, and thine image dies with thee" (Sonnet 3). A love is supposed to be the center of your world, making it revolve, change seasons, determine the weather, sustain all that matters in life. These five aspects of love are presented in Shakespeare's Sonnet 14:

> Not from the stars do I my judgment pluck,
> And yet methinks I have astronomy-
> But not to tell of good or evil luck,
> Of plagues, of deaths, or of seasons' quality;
> Nor can I fortune to brief minutes tell,
> 'Pointing to each his thunder, rain, and wind,
> Or say with princes if it shall go well
> by oft predict that I in heaven find.
> But from thine eyes my knowledge I derive,
> And, constant stars, in them I read such art
> As truth and beauty shall together thrive
> If from thyself to store thou wouldst convert
>   Or else of thee this I prognosticate
>   Thy end is truth's and beauty's doom and date.

The world is perceived through the eyes of two lovers. The entire universe revolves around two people, a man, a woman, and the love that they share. Love is the largest object in their universe. Smaller entities like seasons, weather, and time only provide for the material well-being of these two people. These elements merely fade into the background when compared with the romantic relationship. It is as if the lovers are metaphorically living on the love they have for each other rather than on the world that is supposed to provide them with everything they need to realistically stay alive. Love is all that matters. Love means everything because there is nothing else. This idea falls nothing short of the fatal Romeo and Juliet scenario in the last line, "Thy end is truth's and beauty's doom and date." In other words, all that comes from perpetual loneliness and loss of love, is a bleak death.

Does love really need to go to such desperate ends? No. At least it doesn't if you can save your life by reading the opposing Edna St. Vincent Millay. Millay, in contrast to Shakespeare, establishes her independence by examining the reality of her situation. As a woman, she questions society's rigid and idealistic expectations of the love two people are supposed to give to one another. The idea of giving up her individuality by blending herself with another does not appeal to her. The poem is uplifting in a personal sense because it shatters the image of the fatal, sacrificial lover. Millay takes on the challenge of a more modern perspective of love in which partners are separate and equal individuals. Neither could be considered a slave to the other. In the early twentieth century, society was becoming more open to equality, and in the process of these changes, perspectives on the age old concept of love also change. Edna S. Vincent Millay becomes a poet beyond her time, and possibly beyond the time that we are presently in. Millay challenges her readers and her critics as she rebels against unrealistic standards of love and poetic art in her society.

Critic Jane Stanbrough believes that Millay's sense of independence is captivating as it, flows through lines that do not fail to take liberties. In the early twentieth century, Millay took certain freedoms in expressing somewhat controversial feminist and socialist ideals. At this time, people were uncomfortable with such expansive new ideas on how men and women should be governed, and thus uncomfortable with Millay's poetic belligerence on these subjects. This is a woman who became a notorious figure, a legend in the making. She published poetry, was an impressive actress, and a dramatist of growing reputation. In all her pursuits, she impudently flaunted her independence, establishing a reputation even before she entered Greenwich Village in New York. At Vassar, her almer mater, Millay had distinguished herself as a defiant public figure, smoking against the rules, cutting classes that were boring, earning a severe reprimand from college officials, one that nearly bereft her of her graduation ceremony (213).

Critic John Timberman Newcomb cites that some of Millay's critics were clearly opposed to her use of the traditional sonnet. They attempted undermine her work by trying to homogenize and control definitions of "modern poetry" in two ways: by questioning a female's comprehension of personal or serious issues, and by denying the use of poetry as a source of political power (270-71). In questioning women's knowledge about personal and social issues, the critics reflect the social inequality and oppression of women that Millay most criticizes. By denying the value of Millay's poetry, the critics parallel the typical historic public perception of women. In the 1920s and 1930s, women were denied the right to vote for the very same reasons Millay was denied as a poet. Millay's critics rendered her poetry politically powerless because they could not see women, her possible readers, as politically motivated, intelligent, or concerned about serious political issues.

The persona of Millay's love figure, in "I, Being Born a Woman and Distressed," is exemplified in the word distress, which defined by Webster's Dictionary, means: "considerable mental or physical discomfort from pain." The woman feels discomfort as she is controlled, against her will, by the standards of society. The lines that read, "I, being born a woman and distressed/By all the needs and notions of my kind," may mirror not only the expectations of her society, but the "needs and notions" reinforced by other members of her sex. She feels driven, despite her own feelings, to care about love in the same way that other women do. Other women feel a sense of security whereas the rational poet finds her lover too close for comfort, "I..., am urged by your propinquity to find your person fair, and feel a certain zest/To bear your body's weight upon my breast..." an image obviously sexual, revealing a metaphorical oneness in love and sex. The image expresses the closeness or "propinquity" the woman feels as the man is bearing down upon her, possibly too heavily. As he closes in on the woman with feelings of love, he does the same in the sexual sense. This experience may involve feelings of inferiority on the woman's part. As she writes, "bearing your body's weight upon my breast," she alludes to the common practice of sexual intercourse where the man is above the woman, an image that may represent a hierarchy in control of her.

The woman either speaks for a particular experience or from reflecting on a past incident in which she felt "undone, possessed," following a sexual experience. According to Patricia A. Klemans, the author most likely reflects upon past experience. Klemans conjectures that the poet of "I, Being Born a Woman" was not only a woman of perception, as all poets must be, but also of experience. She had, by the age of thirty-one, led a life of personal and sexual freedom generally reserved for the men in her society. Her poetry presents a new viewpoint to literature - the liberated woman's view (201). The portrait of the woman is one of tousled hair, no makeup, clothes on the floor, a look of wonderment at what she has just done and why, but the persona shatters the controlled feminine image of herself as she meticulously displays reasons why she is a woman "distressed." The distress comes not from following the "needs and notions" of her kind, but from not wanting to follow them. A social and biological plan is already assumed for her - one that she resents, "So subtly is the fume of life designed/To clarify the pulse and cloud the mind." The "fume" is continually fed by a society that supports it in a way that no one can see its process or its effects. This design of society's is supposed to sustain the momentum or "pulse" of life. But instead Millay writes, "Think not for this, however, the poor treason of my stout blood against my staggering brain..." She fights inner conflicts between biology and reason. Reason tells her that she is unsure of her love for the man, while biology accounts for her irrational lust for him. As lust overrides her more rational sense of uncertainty, she seems to speak to him as she writes these lines, expressing the guilt of her false devotion.

Millay examines her own perception of love - not society's. Klemans determines that the terse conclusion, "I find this frenzy insufficient reason/For conversation when we meet again," characterizes a woman who refuses to conform to society's dictates (201). A confused love for a man has caused the persona of the poem to delve into a state of "frenzy" or panic, one that might not exist without the man's presence. The use of the word "conversation" in the context could express her desire to communicate in a different manner, one where she would be rational, not frustrated, indecisive between thoughts of love and lust.

According to Klemans, Millay's skill and message of feminine individuality is timeless. Her poetry, which may have been pushed to the back shelf many times, will appeal to the men and women of today. Millay belonged to that generation of women who gained the right to vote and who looked up to Amelia Earheart for crossing the Atlantic Ocean in a plane (211). As she integrates herself into the thoughts and feelings of lovers, she concentrates on something so universal and timeless - sexual love. In most cultures, it is a feeling held superior to all others.

In a world of couples, the individual perception becomes clouded. No one really wants to hear about it because it really should not exist, never mind that "the fume of life designed," referred to by Millay may be inefficient. While separating ourselves into couples, instead of individuals, brings much joy and happiness to many, it may bring tragedy to others. In a world where the individual is valued, women may find courage to leave husbands who abuse them and girls may not feel that they have to have sex with their boyfriends just to hang on to a partnership. Millay's perception is not "angry feminist," nor it is a threat to traditional family values, but it is a force that strengthens these high priorities.

Love is wonderful, but often the pressure to find or sustain that love overshadows the happiness it is supposed to bring. Lack of love causes much of the trouble in the world. Not only must it exist between two people, but it must exist within communities of people in order to be truly effective. Community is the core area in which love has failed. As couples, people sometimes forget that they are two unique individuals. Millay, despite circumstances, has managed to overcome the pressure she faces from her society, one that refuses to accept her uncoupled. She has rejected a love she finds senseless, one that jeopardizes her happiness. In her refusal To accept society's plan, she finds independence ant the strength to be a woman, and most importantly - an individual:

I, being born a woman and distressed
By all the needs and notions of my kind,
Am urged by your propinquity to find

Your person fair, and feel a certain zest
To bear your body's weight upon my breast:
So subtly is the fume of life designed,
To clarify the pulse and cloud the mind,
And Leave me once again undone, possessed.
Think not for this, however, the poor treason
Of my stout blood against my staggering brain,
I shall remember you with love, or season
My scorn with pity, - let me make it plain:
I find this frenzy insufficient for conversation when we meet again

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REFERENCES

Bevington, David, ed. The Complete Works of Shakespeare. New York: Harper Collins Publishers, Inc., 1992

Klemans, Patricia A. "Being Born A Woman: A New Look at Edna St. Vincent Millay."Critical Essays on Edna St. Vincent Millay. Ed. William B. Thesing. New York: G.K. Hall, 1993. 200-12.

Millay, Edna St. Vincent. Collected Sonnets of Edna St. Vincent Millay. New York: Harper & Row Publishers, 1988.

Newcomb, John Timberman. "The Woman as Political Poet: Edna St. Vincent Millay and the Mid-Century Canon." Criticism. 37.2 (1995): 261-79.

Stanbrough, Jane. "Edna St. Vincent Millay and the Language of Vulnerability." Critical Essays on Edna St. Vincent Millay. Ed. William B. Thesing. New York: G.K. Hall, 1993. 213-28.

The Romantic Paganism of Niccolò Ugo Foscolo: Infancy, Greece, Venus, Exile, Pain, and Death in the Foscolian Artistic Sensibility

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That Foscolo's paganism was a motivating force in his artistic philosophy has long been recognized, but his veneration for childhood, ancient Greece, exile, and death have rarely been ascribed to it, although careful study of his works, especially his sonnets and early poems, reveals this crucial connection. Foscolo derives from conventional paganism that life is but exile from fame and that death is a new childhood awaiting the exiled man.

PURPOSE

Foscolo's philosophy is consistently expressed throughout all of his works, yet confusion has persisted with regard to its specific tenets. The famous critic Giuseppe Cittana wrote, in fact, "Foscolo, as we shall see, was not a true love poet. The sentiment of love never found in him an adequate poetic expression." Yet in a letter in which he dedicated the poem *To Beauty* to his friend Costantino Naranzi, Foscolo asserts, "Love, that divinity most beneficial to man, that animates our existence and fills us with the images of our will and hope, love delegated these verses to me, which I offer to you my sensible friend, the dearest companion of my persecuted and afflicted days." Here Foscolo establishes the position of love as one of his most important artistic deities, placing criticisms such as those of Citanna in a dubious light. Clearly this illustrates the need for a more comprehensive analysis of the poet's philosophy than has been undertaken thus far. Yet hardly does there exist a significantly large enough number of variations from his central philosophy thoughout his works to warrent this confusion. Foscolo consistently proves how crucial his philosophy was for him and his art.

His more famous works, such as The Final Letters of Jacopo Ortis and The Sepulchers contain all of the elements of Romanticism and paganism which were tenets of his artistic ideology. While these masterpieces clearly deserve even more study than they have recieved, many observers have erroneously overlooked the importance of entire sections of his early poetry because of normative and stylistic reasons. Citanna is among that group, having written, "If Foscolo was, as Carducci observes, "a precocious master of verse," he didn't show in the poems of his adolescence true poetic qualities. His first verses, the hymns and elegies, are yet the nursery rhymes of a child who has been exposed to a little classical culture and lives in the time of the Arcadians." He goes on to say of Foscolo's early verses that they are "nothing more than rhyming words, intonated in a tedious and archaic fashion." Yet even if Citanna's criticisms were true, they would still not lessen the importance of Foscolo's early poetry in any meaningful analysis of his poetic philosophy. Such normative analysis only obscures that fact that, regardless of anyone's opinion of a particular work, it's importance alone warrents study and analysis. Furthermore, Foscolo's veneration of his youth magnifies the importance of his early poems tenfold, so to exclude them from any study would be a perilous route for the researcher to take.

Not only are they beautiful, but his poetic works, especially his early sonnets, provide an especially useful vantage point for analysis because of their concise and intricate structure. Thus, the purpose of this study is to illustrate the connection between those works and Foscolo's artistic philosophy.

INTRODUCTION

At the root of Foscolo's philosophy is a veneration of infancy and youth, including Romantic and paganistic elements. Infancy is seen as the time when man is closest to innocence, purity, beauty, and the fertility of nature. The Romantic substructure of such a veneration is clearly evidenced when Foscolo is juxtaposed against contemporaries such as Wordsworth, whose *To Laura* is a testament to his veneration of childhood.

Converse to this view of childhood as a moment of peace and eqilibrium is Foscolo's view of the life of mortal man. Life is clearly the antithesis of infancy for the poet, comprised of hardship, pain, and affliction. In his letter to Naranzi, Foscolo clearly expresses this feeling of affliction and exile. This accompanies his view of the world as a place incapable of appreciating greatness until it is gone. From this view, and the hard exiled life which prompted it, comes his veneration of death as a means of achieving the fame of which he felt deserving and escaping from the life that is the antithesis of the beauty of childhood. Foscolo's Romantic ideology also puts him at odds with the methodical dogmas of the Enlightenment, and he affirms passion above reason as the guiding force of his actions. Included also in his philosophy is the affirmation of the individual. All of these elements comprise the Romanticism which Foscolo shares with poets such as Leopardi, Keats, Wordsworth, and Shelley.

In addition to Romanticism, Foscolo incorporated his paganism into his poetic philosophy. His romantic veneration of childhood espoused his paganistic veneration of ancient Greece, which he saw as the infancy of civilization. Foscolo saw civilization as necessary for art to thrive, especially the poetic art that he saw as the idealogical apex of human development. Since ancient Greece was the first civilization, it was, to the poet, the most sacred, and since Homer was its greatest poet, Foscolo took him as his artistic idol. Included in this philosophical reference frame is a veneration of Venus as love's most beautiful protector.

The result of this conglomeration of ideas and artistic values is a consistent veneration of infancy, Greece, Venus and Death in all of his poetry. But, this veneration is equally accompanied by an acceptance of the pain and exile that comprised his mortal life. The only hope that Foscolo held within his heart was that with death his greatness would be vindicated by the fame that would thereafter prove his greatness and the world's foolishness.

THE SONNETS

While Foscolo's philosophy is distinct because of the elements of paganism which it espouses, nevertheless he was also a romantic. All of the major elements of Romanticism are evidenced in his poetry, but they are most succinctly expressed in his famous sonnet, the *Self-Portrait*. In the first eight verses, Foscolo gives a physical and psychological description of himself unprecedented in Italian literature except for one letter written by Petrarch. Even this description, however, conveys the romantic philosophy. His lips are "slow to laugh," he writes, illustrating the somber reality that romantics experienced as a reaction to the trials of life. These trials and the poets reaction to them are eloquently surmised by the verse, "{I am} hostile to the world, events are hostile to me." The melancholic, solitary, and pensive components of the romantic composure are clearly expressed in the ninth verse, "Melancholy most days, and alone; thoughtful always. . . ." Anger, also an important poetic sentiment of such idols of Foscolo as Dante, makes the poet "brave," and although the logic of the Enlightenment cautions him, Romantic passion "raves" within and is his ultimate guide. In the end, death alone gives him "fame and rest," symbolizing not only the peace which for pagans is the closest approximation to divinity but also the glory which is the pagan substitute for the immortality of the Christian paradise. Thus, along with some paganistic sentiments we find here a clear expression of Romantic philosophy.

"Never again shall I touch the sacred shores; where my infant body lay; my Zante. . . .," begins the famous sonnet *To Zante*, illustrating not only the close connection Foscolo felt to his infancy and the Greek island which fostered it but also the sense of hopelessness brought on by his inability to ever regain the youth and the home that he lost. While his youth was lost as a consequence of time's passing, his home was lost as a consequence of his exile. He implies that Zante's shores are also sanctified by the ocean which surrounds it and from which Venus was born, who represents all beauty, fecundity, and purity. In turn, her fecundity sparked the growth of and sanctified ancient Greece. The civilization of ancient Greece produced Homer, who in turn venerated Ulysses and made his painful exile praiseworthy. In the end, the mother earth who herself is a deity for pagans shares the mortal fate of the poet, for to both of them is "preordained by fate an unwept sepulcher." The poem begins with the veneration of birth, and ends with an equally forceful veneration of death. Ultimately, it is death, or more specifically the poet's mortality, which prevents him from returning to Zante and his infancy. Thus all of the Foscolian elements are present, and the sanctity of youth and Zante begins a chain of

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veneration, making of his philosophy a logical acceptance of the reality of beauty.

Death is further venerated in the sonnet *To Evening*, where Foscolo compares night to that "fatal quiet" that was the peace that his life so much lacked, and which so "gently" followed the "secret paths of {his} heart." Only with the hope for death, symbolized by the evening, does the "evil time go, and with it go the swarms of cares, where, with me, both of us it destroys." His Romantic "warrior's spirit" raves, but his hopes of paganistic immortality in the form of death allows that spirit repose.

Conversely, love replaces Death as the object of hope in the sonnet *To His Distant Love*. "Love, amid the infernal shadows, will follow me, immortal, omnipotent," he concludes, thus allowing him comfort from his "long exile among accursed peoples." His exile is further reiterated in *Upon the Death of His Brother John*, in which he laments over "always fleeing from people to people" and the inability to even approach his native land without sensing "the hostile Gods and the secret cares which to your life were a tempest." Of his youthful hope, the only hope remaining is that the foreigners among which he is exiled will "return {his} bones then to the bosom of {his} mourning mother."

Thus, although we have seen the elements of infancy, Greece, Venus, exile, pain and death consistently throughout his sonnets, some historical analysis is useful in putting this philosophy into perspective.

ANALYSIS

Niccolò Ugo Foscolo, commonly known as Ugo Foscolo, was born on the island Zante, then a Venetian possession but originally one of Greece's Ionic islands, February 16, 1778. His father was of an ancient Venetian lineage and his mother was Greek. The exposure to those two cultures coupled with his childhood on an island rich in history and nostalgia for Greek antiquity, producing a strong hold on the Foscolian imagination. Mario Pazzaglia says of the figure of Zante in Foscolo's imagination, "In that he saw the symbol of beauty and harmony which the great poetry of antiquity had expressed and which he continually sought as the supreme ideal of his life."

Foscolo's painful and tumultuous life further caused him to fantasize about his childhood, and what began as an admiration of youth developed into an obsession that ignited his idealization of the Greek antiquity that he associated with it and furthered his desire to somehow regain his "Greek youth." Clearly, he inherited his artistic sensibility from the Greek Homeric poetic tradition which he so eagerly sought. The morbid tinge on his works was further darkened by his mother's tragic life, who was the elder of two brothers and one sister, all three of which had committed suicide.

Foscolo expresses his paganism in an extremely pragmatic sense, venerating his most cherished pagan gods at every opportunity and making of the others the source of his difficulties in life. "I feel the hostile Gods, and the secret cares which were a tempest to your life, and I too pray for quietness in your haven," he wrote in the sonnet, *Upon the Death of His Brother John*, clearly illustrating that the Gods for Foscolo, unlike the Judeo-Christian God, can be as unjustly vindictive as equally as they can be venerable. Yet even though Foscolo felt some of the Gods were hostile to him, in Venus he saw a symbol of beauty and perfection that he personified into a virtual heroine. Venus was born a virgin out of the Ionian Sea that surrounds the Greece that the poet so much loved, and her famed beauty played on the strings of his romantic sensibility. But, even though Venus was a virgin, her beauty was not limited by abstinence in his imagination. Lacking the stigma placed on sexuality, Foscolo venerated her also for her fecundity, from which ancient Greek civilization had grown. Her birth was the birth of perfection, and even though she had the powers of a God, her youth went hand in hand with Foscolo's idealization of infancy to further increase the degree to which she was venerated. The ode To Venus is a beautiful expression of his veneration of Venus "above all other Gods."

Unfortunately for Foscolo, in the world of the living the hostile Gods seemed to have more power over his life than the venerated ones. The "Italy" of Foscolo's day was not a nation but rather a culturally linked group of city states, often ruled by the papal state or foreign potentates and too often at the mercy of foreign mercenaries with loyalties only to themselves. As an artist, Foscolo was quick to take a role in the tumultuous political life of the land he loved so much. The Lombardy in which he lived changed hands between the French, Austrians, and others several times. Eventually, Foscolo was exiled and after a short time in Switzerland made his way to England and spent what remained of his life there.

Foscolo did not simply accept his exile, but took his romantic pagan philosophy and made of his own life an icon. Homer venerated exile in his works as an obstacle that proved the worth of man when it was overcome, and the character of Ulysses in *The Odyssey* clearly obtained his greatness in that way. But Foscolo didn't have to search among the remnants of his literary cultural history to find a model of the exiled man, because he had in more recent Italian history a sufficiently venerable model: Dante Alighieri. Dante was exiled from his native Florence at a young age, but he wrote all of his masterpieces while in exile, and Foscolo expected the same of himself. Setting aside theology, in a purely artistic sense Foscolo took Dante as his modern model of the exiled man. He demonstrates this in poems such as his ode, *To Dante*.

Foscolo took the view of exile as an obstacle to greatness a step further and derived that he was great almost as a cause of his exile. In sonnets like *To Zante* and *Upon the Death of His Brother John*, Foscolo repeatedly expressed that the pain of exile was as much a part of his philosophy as the beauty of youth.

Exile's pain was a reality of his life, and in England he undertook "a tiring editorial work load which slowly but surely his health could no longer take" (Binni). The pains of day to day life were very real for him, and he writes of them just as frequently as of his artistic symbol of exile. Despite his taxing work load, Foscolo was never paid more than a pittance. Thus, not only was his health a source of constant worry, but he lacked the means by which to correct it, and his financial worries were quite often even more taxing. Darkness was certainly a reality of his life. After being in exile from Italy for 11 years, he died at the age of 49, still hounded by creditors, and living in one of London's poorest quarters. The pain of his life continually made Foscolo look further to his childhood and to Greece as the symbols of beauty and perfection that pervaded his art.

Interestingly enough, after death Foscolo's fame did increase tremendously, though still not to a level of which a writer such as he proved himself deserving. Nevertheless, even if he didn't achieve the fame which he deserved, at least he acquired the peace which he so much desired.

CONCLUSION

Foscolo's sonnets, though often overlooked, are among the most intricately composed expressions of artistic philosophy in world literature. Careful study of them affords tremendous insights into his other works. It also makes possible a comprehensive study of the semantics and structure of the sonnet, since Foscolo's genius is in being able to convey in poetry what it would take volumes to convey in prose. While the most perfunctory analysis affords insights, any legitimately comprehensive analysis would necessarily have to be undertaken in the original Italian. Nevertheless, regardless of the language in which they are studied, the sonnets provide an inlet to the highly complex philosophy of one of literature's most underappreciated artists.

In a very real sense, infancy is the ideal moment for man in Foscolo's philosophy, because it is the moment when, in his innocence, man is closest to the ideals of purity, innocence, and beauty which were so prized by romantics and which Venus so completely represented. Ancient Greece was seen as the infancy of civilization, and this myth is coupled with the image of Foscolo's own infancy in Zante, the beautiful Greek island to which he could never return. Foscolo was in his philosophy a romantic in the most all encompassing sense, and his insistence upon the individual evidences this. But along with the traditional elements of Romanticism, such as passion, sadness, solitude, thought, love and beauty, death and the fame which it brought were equally venerated due to his paganism. While in and of themselves pain and exile are never venerated, they are valued by Foscolo because they are essentially the obstacles which he felt all great men had to surmount. From this he derived that he was great as a result of his exile, not just because he overcame it. He saw himself as a great writer in the tradition of Dante and Ovid. In fact, the first project he undertook when exiled in London was to write a book on Dante. In addition, the ode written by him in his youth, *To Dante*, illustrates how greatly he idealized a poet whose theology was so much at odds with his own.

The consistent veneration of infancy and death create such a powerful cornice around the painful exile of life that life itself becomes but exile from fame and death is but a new childhood awaiting the exiled man. As children know nothing of life, men in Foscolian philosophy know nothing of death, and thus only by surmounting this ultimate obstacle may their innocence and purity be renewed.

208

REFERENCES

Bertoncello Artigrafiche. Vestigi della storia del sonetto italiano dall'anno MCC al MDCCC. Padova. Cittadella, 1993.

Bezzola, Guido, ed. Tragedie e poesie minori di Ugo Foscolo. Vol. 2 of Edizione Nazionale delle opere di Ugo Foscolo. Firenze. Felice le Monnier Editore, 1961.

Binni, Walter. Introduction. Ultime lettere di Jacopo Ortis. By Ugo Foscolo. Milan: Garzanti Editore s.p.a., 1989.

Citanna, Giuseppe. La poesia di Ugo Foscolo. 3rd ed. Bari. Giuseppe Laterza & Figli, 1947.

Dionsiotti, C. "Foscolo Esule". Lezioni sul Foscolo. M Berengo, D Isella, C. Dionsiotti, D. De Robertis, G. Orelli, M. Luzi, eds. Firenze. La Nuova Italia Editrice, 1981.

Espinosa, Mark Anthony. La Grecia, la Venere, e l'infanzia nella filosofia artistica e nella sensibilità romantica di Niccolò Ugo Foscolo. unpublished paper, Studi Independenti nella Letteratura Italiana. Rutgers University, 1996.

---------La vita come esilio e dolore, e la morte come salvezza nella filosofia artistica e nella sensibilita' romantica di Niccolo' Ugo Foscolo. unpublished paper, Topici nella Letteratura Italiana. Rutgers University, 1997.

Franzero, Carlo Maria. A Life in Exile: Ugo Foscolo in London, 1816-1827. 1st ed. London: W.H. Allen & Co. Ltd, 1977.

Paparelli, Gioacchino. Storia della <<lirica>> foscoliana. 2nd ed. Naples. Società Editrice, 1976.

Pazzaglia, Mario. "The Life of Ugo Foscolo". Letteratura Italiana. 3. L'Ottocento. 3rd ed. Bologna. Zanichelli Editore, 1992.

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Subject Pronoun Usage in Mexican Spanish in South Texas

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In the United States prolonged contact between Spanish and English has led to the creation of a large group of bilinguals whose capabilities in each language vary. One of the most obvious differences between these two languages is the requirement of English that every sentence have an overt subject. Unlike English, Spanish speakers have the option to eliminate overt subjects. This absence of overt subjects is coupled with other linguistic characteristics into what has come to be termed the "Pro-drop Parameter."

(1) (a) *We* went to the store.
(b) Ø fuimos a la tienda.
Nosotros fuimos a la tienda.

The presence of unnecessary overt subject pronouns in Spanish creates a "heaviness" which native speakers often feel upon hearing an abundance of subject pronouns which is attributable to their special contrastive function.

(2) (a) *They* think that they can do whatever *they* want (to).
(b) *Ellas* piensan que *ellas* pueden hacer lo que *ellas* quieren.
(c) *They* think that Ø can do whatever Ø want (to).
(d) *Ellas* piensan que Ø pueden hacer lo que Ø quieren.

Their usage or lack thereof is not merely a stylistic difference amongst speakers, but rather may correspond to differences in syntactic structure (Cf. Lipski 1991). An increased usage of overt pronouns has already been observed in the Mexican and Mexican-American populations of Los Angeles by Silva-Corvalán and Gutiérrez. The Spanish-English bilinguals of South Texas provide a similar population which has not been studied previously although it is one of the largest in the United States. Furthermore, it will furnish empirical data for future comparative studies.

The central hypothesis of our study is that there is a positive correlation between a decreasing ability in a bilingual's oral Spanish and an increasing number of obligatory subject pronouns in his Spanish which we can attribute to a superior ability in English. As the speaker's ability in Spanish diminishes, the use of certain structures such as obligatory overt subjects in environments where they are absent from the speech of monolingual Mexican Spanish speakers increases. Although pro-drop in Spanish is optional, except in the case of obligatory null subjects, insecurity in Spanish allows the English patterns to serve as defaults for these bilinguals.

The main focus of our study is to determine whether second and third-generation Mexican-American bilingual speakers in South Texas are employing overt subject pronouns more often in syntactic environments where they were previously either missing or optional. By second-generation bilinguals we mean Spanish-dominant bilinguals who are persons who are more comfortable speaking and have a better grammatical grasp of Spanish. We define third-generation bilinguals as those participants whose primary language is English and who express themselves more easily in English than in Spanish. Our

210

population sample consists of a group of thirty individuals chosen at random from the area in the immediate vicinity of the city of Kingsville in South Texas. We carried out the study by means of a written questionnaire which asked monolingual Spanish-speakers to make grammatical judgments on a series of thirty Spanish sentences in order to establish the basis for comparison with both Spanish-dominant and English-dominant bilinguals, who were asked to provide acceptability judgments on the same thirty Spanish sentences and on an additional sixteen English sentences which contained or lacked the same traits present in the Spanish examples. Let's examine a few of the sentences:

(3) (a) *Yo* creo que *yo* soy muy inteligente.
I believe that *I* am very intelligent.
Yo creo que Ø soy muy inteligente.
I believe that Ø am very intelligent.
Ø creo que Ø soy muy inteligente.
*Ø creo que *yo* soy muy inteligente.
(b) En el canal 3 Ø dicen que Ø va a llover.
On channel 3 *(they)* say *(it)* is going to rain.
(c) Ø Les digo a mis hijos que Ø se porten bien.
I tell my children to behave themselves.
Ø Les digo a mis hijos que *ellos* se porten bien.
I tell my children that *they* should behave.
(d) En la biblioteca Ø hay unos libros de poesía interesantes.
In the library *there are* some interesting poetry books.
*Ø Lo hay unas películas buenas en la televisión esta noche.
There are some good movies on TV tonight.

Among the types of obligatory null subjects in Spanish can be found the expletive subjects of weather and existential sentences:

(4) (a) Ø Llueve mucho en la primavera.
It rains a lot in the spring.
(b) Ø Hay muchas personas aquí.
There are many people here.

Arbitrary or indefinite subjects are exemplified by sentences such as:

(5) (a) Ø Dicen que va a llover.
They say that *it* is going to rain.
(b) Ø Lo anunciaron en un programa de televisión.
They announced it on a television program.

And finally we have sentences referring to non-human subjects as found in the answer to the following question:

(6) (a) ¿Dónde están mis zapatos?
Where are my shoes?
Ø Están en tu cuarto.
They are in your room.

We must keep in mind that overt subject pronouns must only refer to persons or personified subjects. There are also situations where the pronouns replacing human subjects must be null, as in some subjunctive structures and quantified sentences.

(7) (a) Les digo a mis hijos$_i$ que Ø$_i$ se porten bien.
I tell my children$_i$ that (they)$_i$ behave.
(b) Les digo a mis hijos$_i$ que ellos$_j$ se porten bien.

I tell my children$_i$ that they$_j$ behave well.

(7) is an example where the presence of a pronoun in the subordinate clause indicates disjoint reference rather than referring to the indirect object of the independent clause. Disjoint reference means that the subject of the subordinate clause is a person other than the ones referred to in the main clause.

We conducted and tape-recorded an interview with each participant to determine the characteristics present in his conversational Spanish. The sessions took place at a location chosen by the respondent so that he would be the most comfortable. Each interview lasted between twenty and thirty minutes during which time the individual spoke on the topic or topics of his choice.

The results of test utterances as well as our analysis of unmonitored speech reveals great variation in the actual production of these forms. As shown by our study samples, we observed that none of the speakers interviewed completely failed to use null subject pronouns nor employed overt ones exclusively. The data indicate that some of these Spanish speakers are approaching a stage where the only distinguishing feature between null and overt pronouns is the presence or absence of phonetic substance.

The data appear to support a modified version of our hypothesis, that is: Any level of proficiency in and prolonged contact with English by bilingual Spanish-speakers, increases the incidence of redundant overt subject pronouns in syntactic contexts where they do not appear in the speech of monolingual Spanish-speakers. Support for our revised hypothesis is provided by our qualitative analysis of both the sentences contained in the questionnaire and the speech samples contributed by the recorded interviews.

As we progress towards the determination of definitive results, we must keep in mind that certain characteristics of Spanish which have come to be considered categorical by prescriptive grammarians are not categorical at all as evidenced by the lack of agreement among the monolingual participants in our study as well as by the Spanish-dominant bilinguals who took part in both Lipski's (1991) and Baumel-Schreffler's (1995) investigations. We cannot lose sight of the fact that communication is the primary function of language. In addition, we cannot ignore the place which grammar occupies in the communicative process, for if the grammar is ignored, the speaker cannot effectively deliver the message nor the listener decode it. Furthermore, we must dispel the notion held by many Spanish-speakers that their speech is simply "bad" or "incorrect" Spanish. The fact is that they are in the process of developing a new Spanish dialect native to the Southwest region of the United States.

Bibliography

Lipski. "Bilingual Spanish as a Pro-drop Language: Patterns of Pronominal Evolution". Unpublished work, 1991.

Schreffler, Sandra. "Mexican Spanish in Houston, Texas: A Study of Language Contact and its Effects on Overt Subject Pronouns." PhD. Dissertation. University of Florida, UMI. 1995.

I, Tituba, Symbol Of The Antilles

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To the naked eye the Caribbean looks like the picture perfect model of cultural synretism, but how did this cornucopia of peoples come about to create such distinct cultures? What makes the Caribbean so unique a place? Language and exile are themes I will be examining as cross currents throughout the archipelago -Francophone, Anglo, Spanish, Portuguese -in order to examine that question. Many scholars have used Shakespeare's Caliban as a symbol, a yardstick by which to look at colonization and its effects on culture, language and psyche. I propose alternative symbols in the use of language and exile as subthemes in order to arrive at a deeper understanding of linguistic exile. I posit the thesis that the literary and historical character, Tituba of Maryse Conde's I, Tituba, Black Witch of Salem given her syncretic characteristics and the novel's Caribbean origins, is a more authentic and viable symbol of the island's complexities than the oft-used Caliban.

The Antilles is the picture perfect model of cultural syncretism. The literary and historical character Tituba of Maryse Conde's I, Tituba, Black Witch of Salem, given her syncretic characteristics and the novel's Caribbean origins, is a more authentic and viable symbol of the island's complexities than Shakespeare's oft-used character in The Tempest, Caliban. Alternative symbols when looking at language and exile as sub-themes are necessary in order to arrive at a deeper understanding of colonization and linguistic exile within the the region. Tituba's Yoruba or Santeria practices inspires the Salem witch trials, she is Helen in Derek Walcott's Omeros, the grandmother figure (conquistador) in Gabriel Garcia Marquez's short story "The Incredible Sad Tale of Innocent Erenderia and Her Heartless Grandmother," who becomes her granddaughter's hustler because the young woman accidentally burned down their home. Erenderia was in debt to her grandmother. Tituba is characterized as Jamaica's national revolutionary heroine Sister Nanny, and the recent Haitian boat women who fought for democracy and justice on that troubled island until they were forced into exile. Tituba, who also wears the guise of the Santeria, Candomble, and Yoruba goddess Yemaya, represents this cornucopia of people who have come to create one of the most unique places on earth -the Antilles. Tituba practices a syncretic religion, and speaks the language of the Anglo-Caribbean in the novel.

In a post-colonial cultural context, Tituba, symbol of the Antilles is the voice of the oppressed slave population in Conde's creation. It can be assumed that Tituba in life must have been quite a woman, after all, didn't she create an historical event which now has its own chapter in history books -the Salem witch trials? She is not referred to as a symbol of women's oppression when one might read or hear about the Salem trials, therefore Conde's powerful and testimonial version of Tituba, woman of the Antilles. Tituba knew that her life would have been ignored by histortical writers. She tells us before all this happens that:

> I had already regretted having played only a minor role in the whole affair and having had a fate that no one could remember. "Tituba, a slave originating from the West Indies and probably practicing 'hoodoo'" A few lines in the many volumes written on the Salem witch trials. Why was I going to be ignored? This question too had crossed my mind. Is it because nobody cares about a Negress and her trials and tribulations? Is that why? I can look for my story among those of the witches of salem, but it isn't there (149).

Like modern day Caribbeans, Tituba lived in exile, away from her native Barbados, but practices and pulls from her diverse cultural background of African, Indian and European ancestry when she was sold and then taken to Boston by a Puritan family.

> How strange it is, this love of our own country. We carry it in us like our blood and vital organs. We only need to be separated from our native land to feel a pain that never loses its grip welling up inside us. I could see Darnell Davis's plantation, the arrogant Great House with its columns at the top of the hill, the black shack alleys seething with suffering and life, children with bloated stomachs, women wizened before their time, crippled men, and those cheerless surroundings I had lost suddenly meant so much that tears streamed down my cheeks (48).

The issue of Tituba's race could be debated for centuries, but African, Arawak or Carib Tituba represents the voice of the people who today make up the Antilles. She is a proud, strong, vocal warrior for a social cause -slavery. Tituba is cinnamon colored Gabriela in the Brazilian writer, Jorge Amado's Gabriela, Clove and Cinnamon. Tituba is a sensuous woman who embraces her sexuality. She lives despite her and her people's condition, and she loves freely. Tituba tells us, "I have loved men too much and shall continue to do so. Sometimes I get the urge to slip into someone's bed to satisfy a bit of leftover desire and my fleeting lover is delighted with his solitary pleasure (178)." In Walcott's version of Tituba in Omeros, Helen is "sprawled on the unmade bed/ brown/ and naked as God made her. The hand was not hers/ that crawled like a crab, lower and lower down/ into the cave of her thighs, it was not Hector's/ but Achille's hand yesterday. She turns slowly round/ on her stomach and comes as soon as he enters (153)." In I, Tituba, Tituba herself embraces love and sexuality within the complex world of slave society where love and lovemaking are hard to find.

Shakespeare does not give us a description of Caliban's world as one that is surrounded by mangoes, guava, tamarind, unending rivers, silk-cotton trees, and Santeria sacrifices. Tituba's world is seeped in what is today the syncretic cultural core of the Greater and Lesser Antilles from the "Yucatan and Florida peninsulas southeast to Venezuela, with the Greater Antilles (Cuba, Hispaniola, Puerto Rico, Jamaica) in the north and the smaller islands, or Lesser Antilles, generally to the southeast (Richardson 1995: 6). Tituba is a strong figure where Caliban conjures a more humble, elf-like image; Tituba tells us her own story, her image is bold and powerful. Anne Armstrong Scarboro says that "The emphasis on Tituba's religious/spiritual powers in the narrative enhances Tituba's status as a folk heroine and makes the useful point that there are different ways of interpreting the world (218)." It is through Tituba's eyes that we get an intimate glimpse of the slave's environment, pyshche, religion, torture, pain, and daily yearning for freedom.

The name Caliban is an "anagram of cannibal," followed by Carib-cannibal, Caribbean. Tituba is no one's "savage." In his book Lost Tribes and Promised Lands, Ronald Sanders adds that

> the underside of the colonial experience is above all represented in The Tempest by Caliban (the name is an anagram of "cannibal"), who is Shakespeare's summary vision of the colonized savage, and the last of the eminent racial outsiders in his plays. Shakespeare's sentiments went out to men and women of the Old World, and not to the exotic beings -whether fancifully or realistically conceived -who inhabited faraway places. Indeed, his view on the colonization of such places seems to be that one should, in the end, do precisely what Prospero does and get out of them, leaving behind for good all the problematical even if profitable relationships that they entail. The poet shows no fondness for Caliban, and no faith whatever in the spiritual capacities of this savage who latches on to a pair of drunkards in his clumsy strivings for freedom (254).

Tituba says her name was given to her by her African step-father, Yao He "was as tall as a silk-cotton tree" when he committed suicide after her mother was hanged She lived under force here in the United States longing for the beauty and sunshine of her Barbados She explains how she imagined her island home

> "I filled a bowl with water, which I placed in the kitchen and imagine my Barbados The bowl of water managed to encompass the entire island, with the swell of the sea merging into the waves of the sugarcane fields, the leaning coconut palms on the seashore, and the almond trees loaded with red and dark green fruit Although I had trouble making out the inhabitants, I could see the hills clearly, the cabins, the sugar mills, and the ox carts whipped on by invisible hands And all that moved silently at the bottom of my bowl of water (62)

One day after she had returned from America, fresh out of a Boston prison where she was being accused of being a "witch," the slaves brought a young boy who just received "250 whiplashes on his legs, buttocks, and back, and his body weakened by a spell in prison had collapsed (159)," to her for care She informs us that "the slaves were carrying him to an unmarked grave in a field of Guinea grass when they noticed he was still alive " Tituba was a healer, a mender of wounds -a wise woman She was the healer of the bruised and bleeding souls around her on many Barbados plantations

Jamaica's national motto, "Out of many, one people" embody Tituba, not only because she is of mixed race and is a practitioner of a religion which resembles Santeria, Obeah, and Candomble, but because she exudes the very essence of what is Caribbean She is a product of the violence of the slave trade, and she tells us of her conception

> Abena, my mother, was raped by an English sailor on the deck of *Christ the King* one day in the year 16** while the ship was sailing for Barbados I was born from this act of aggression From this act of hatred and contempt (3)

On the other side of the Caribbean, along the Colombian coast, Marquez conjures up Tituba's spirit in the character of Sierva Maria, in his novel. Of Love and Other Demons The half mestiza and Spaniard practices Yoruba with the slaves and speaks their many languages Sierva Maria "sang in Yoruban, Congolese, and Mandingo A short while later two black slave women came by, recognized the Santeria necklaces, and spoke to her in Yoruban The girl's reply was in the same language (64) " The novel's syncretic elements are at the root of the narrative, and ultimately the elements that make up the Antilles The novel speaks to the heart of what is Caribbean Indian royal palm, Bedouin djellabas, Spaniards, English, Portuguese Jews, Abyssinians, a chair from China, Africans, Yoruba, Catholicism, and Islam

Sierva Maria is Tituba in an abundance of guises According to Marquez "She could dance with more grace and fire than the Africans, sing in voices different from her own in the various languages of Africa, agitate the birds and animals when she imitated their voices the younger slave girls would blacken her face with soot They hung Santeria necklaces over her baptism scapular (12) " Tituba travels the Antilles, where she passes on her wise woman traits to so many others, Antillean women writers are products of this grandmother wisdom of Tituba

In her book Postcolonial Representations Women, Literature, Identity, Francoise Lionnet looks at several novels written by women from the Antilles and North Africa Tituba is in all of them She says that

> Women writers living and writing in Africa and in the new worlds of the United States, the Caribbean, and the Indian Ocean, as well as those who emigrate to various European countries for personal, educational, professional, or economic reasons, have given us unique insights into what Renato Rosaldo has called 'border zones' of culture (6)

These women writers "all share one important characteristic they belong to an increasing number of astute interpreters of the postcolonial condition whose works, published in the

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1970s and 1980s, have been redefining traditional conceptions of history and culture, literature and identity. They create new paradigms that represent, through innovative and self-reflexive literary techniques, both linguistic and geographic exile, displacements from the margins to a metropolitan center, and intercultural exchanges (7)."

Tituba, it can be argued, thanks to Conde's "dreams" has become the black, brown, and yellow woman's Caliban. It is through the character of Caliban that male scholars have been able to analyze the impact of colonialism and European hegemony, using such themes as language, culture, and exile. Tituba now stands as a testimony to the plight of women and their resilience under slavery, religious oppression, colonialism, and male dominance. Tituba, our new symbol of the Antilles lives today somewhere in the reality of what has become Antillean postcolonial and neocolonial culture.

Works Cited

Amado, Jorge. Gabriela, Clove and Cinnamon. New York: Alfred A. Knopf, 1988.

Conde, Maryse. I, Tituba, Black Witch of Salem. Trans. Richard Philcox. New York: Ballentine Books, 1994.

Lionnet, Francoise. Postcolonial Representations: Women, Literature, Identity. Ithaca: Cornell UP, 1995.

Marquez, Garcia Gabriel. Of Love and Other Demons. Trans. Edith Grossman. New York: Alfred A. Knopf, 1995.

"The Incredible and Sad Tale of Innocent Erenderia and Her Heartless Grandmother." Collected Stories. New York: Harper, 1991.

Richardson, C. Bonham. The Caribbean In the Wider World, 1492-1992: A Regional Geography. Cambridge: Cambridge UP, 1995.

Walcott, Derek. Omeros. Canada: Noonday, 1995.

A Profound Cultural Exchange
The Mexican Muralist Movement and the
Harlem Renaissance and its Modernist Descendants

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ABSTRACT

In examining the Mexican Muralist Movement and the Harlem Renaissance of the 1920s and 1930s, one cannot deny the dramatic cultural exchange flowing between these two movements. The Mexican muralists and the Harlem Renaissance artists depict the people's victory over the repression and inequities of their time, while radiating pride in being Mexican and African-American. The works of African-American artists, such as Langston Hughes, manifest a strong identification with the black working class; the powerful paintings of Diego Rivera, also, portray the oppression of the indigenous Mexican peasants. Emerging from the thrilling Harlem Renaissance movement, the African-American Modernist artists of the 1940s and 1950s captured the techniques and messages pursued by the Mexican artists to arouse pride in their African heritage and express the concerns about the status of African-Americans in the United States. The movements reflect a deep artistic connection between Mexico and the United States.

The Mexican Muralist Movement was a direct result of the Mexican Revolution of 1910-1917. Maria del Carmen Ramirez states, "...the Mexican mural painting movement became a paradigm of the cultural regeneration of Mexico brought about by the Revolution" (Ramirez 104). Artists emerged as the intellectual leaders of the post revolutionary period in Mexico and the murals were a new way of expressing Mexican culture. The murals reflected cultural pride, but raised social awareness at the same time. The muralists aided in the creation of a national art that expressed their social realities. The murals served as an instrument of social justice on the part of the campesinos (Mexican peasants) because they reflected the campesinos' burden: a laborious lifestyle, little pay, no land, and exploitation by the Mexican government. One of the most famous Mexican muralists, Diego Rivera, was known for depicting the difficult social conditions the peasants endured. In his powerful painting, *The Flower Vendor* (1935), the peasant's emotional and social burden is allegorically reflected by the huge basket that he is carrying on his back. The peasants were forced to carry the brunt of Mexican society. Rivera has ingeniously manipulated the dimensions of the figures in this painting by making the peasant smaller in size and exaggerating the magnitude of the basket, to where it jumps out at the audience, as to make a bold statement regarding that period.

The exploitation of the peasants is, also, depicted in Rivera's mural, *Repression*. A rebellion in the background between the militia and the peasants is brought to the foreground by the soldier attacking a campesino with his sword. Standing between the soldier and the campesino, a peasant woman with her child in her arms, is fiercely grabbing the arm of the soldier. The crying baby serves as a witness to this atrocity. In David Alfaro Siqueiros' mural, *From Porfirismo to the Revolution*, the campesinos are literally depicted as the masses- their personal identity is lost. The campesinos are dressed in white military uniforms with yellow sombreros and the first three men are distinguished as the leaders of this rebellion. The faces of these men become lost with each increasing row. However, their identical physical appearance is symbolic of their common goal, which is to unite and demand their rights from the Mexican government. Rivera's and Siqueiros' murals celebrated "the peasant leader who becomes the seed of a

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nation" (Monsivais 74). The muralist movement challenged those in power and at the same time, affirmed the values inborn to Mexico's history.

Even as early as 1923-1929, photographers, Tina Modotti and later, Lola Alvarez Bravo captured the daily lives of the dispossessed of Mexico in an attempt to present the reality of their social conditions at that time. However, although, the Mexican Muralist Movement was a reflection of the social conditions plaguing Mexico before and after the Revolution, the muralists also became "agents for forging a new national identity" (Ramirez 104). The paradox of this "new" national identity, however, is that it manifested itself in two contradictory manners- through a new political ideology, *yet* a retreat to Mexico's past. In reference to the "new" Mexico, the new revolutionary state reflected a fresh political ideology and the muralists were responsible for linking their art to the political development of the state. Hans Haufe refers to this new man as the Mexican Prometheus: "In this hymn to the birth of a new man, the Mexican Prometheus, the hopes of the Revolution were realized in an earthly paradise" (Haufe 94). But, at the same time, historical themes soon became a main preoccupation for the muralists and a new appreciation and understanding rose for their Aztec roots. Rivera believed he could link Mexico's present state to his indigenous past. On the walls of the Cortes Palace, Rivera painted the *Conquista* (1929-1930), in which the Spaniards are depicted as the destroyers of pre-Hispanic world peace. It is clear that Rivera sympathized with his Aztec ancestors and glorified their achievements. According to Haufe, "Rivera's identification with Mexican culture and history was chiefly aimed at strengthening the national consciousness" (Haufe 94-95).

Frida Kahlo, who was married to Diego Rivera, is perhaps, the most powerful Mexican female artist. Kahlo was greatly influenced by Mexican folk culture and her Aztec roots. She incorporated rich colors and expressive combinations of folk art in her paintings. Kahlo was proud of her Mexican roots and even though her father was German, she identified entirely with her Mexican heritage. In her self-portraits, Kahlo's Mexican appearance is emphasized through her bronze Indian complexion and her hair, which she wore in the style common to the Mexican women of Tehuana. Maria Izquierdo, another female artist during Kahlo's time also reflected her Indian roots and appearance in her paintings by using bright colors. Izquierdo incorporates her Indian ancestry with Spanish culture, as we see in her painting, *Good Friday Altar*. Both artists, together with Tina Modotti and others, formed an indisputable force that energized the Muralist movement.

Diego Rivera, as did other muralists, painted on the National Palace, the National Preparatory School and the Secretariat of Public Education. These public buildings, which exhibited the murals, functioned as symbol of hope for the post-revolutionary state. But in 1935, Siqueiros criticized Rivera, saying that the muralist movement was reflecting the interests of the Mexican government more than the interests of the people. In a discussion that resulted, in which a nine-point accord was reached, one of the criticisms that was made about the mural art movement of 1921-1925 was that "Mexican mural painting...served the demagogic interests of the Mexican government more than the interests of the working class and campesinos"(Ramirez 108).

> Mexican painters began to proclaim the values of a new society. These artists embraced the pre-Hispanic past not only as a symbol but also as the aesthetic of indigenous culture...The Mexican muralists engaged themselves in the social, economic, and political conditions of the common man. They expressed and encouraged communal interaction toward the shared goals of fighting oppression and celebrating their cultural heritage (Amador, 1997).

By 1934, the Mexican mural painting movement had expanded beyond national borders and was making major contributions in the United States. From both sides of the border, governments promoted a remarkable exchange of artists, bringing into contact Rivera, Orozco, Siqueiros and Kahlo with Hale Woodruff, Elizabeth Catlett, Langston Hughes and Charles Alston- powerful artists of the Harlem Renaissance. The Harlem Renaissance artists of the 1920s and 1930s were among the first artists to celebrate Black history and culture. Before the Harlem Renaissance, Black Americans did not have the option of pursuing painting, writing and sculpture as professional careers. Most Blacks were discouraged from participating in American society, whatsoever, and were restrained by the Jim Crow laws in the South. Blacks were separated from whites in all aspects of public life. The Ku Klux Klan, race riots and lynching were a common reality among the black population in the United States at that time (some would argue that much has not changed even today). Out of this oppression, however, Black Americans found something to celebrate- their existence. Their African heritage, though quite fragmented, was a common element that united them and by the 1920s, a "New Negro" had evolved (Campbell, 1987).

The work of many African-American artists was paralleled in the art of their Mexican neighbors. The most important link between the Mexican muralists and the Harlem Renaissance artists was that they sought to establish a distinct cultural identity. Instead of being ashamed of their African roots and their history of slavery, the Harlem Renaissance artists radiated cultural pride throughout their works- in fact, the Black artists "focused on their ethnic disenfranchisement as topics for their artwork" (LeFalle-Collins and Goldman, 1996). In addition to emphasizing their cultural roots, black artists, also, depicted the social injustices plaguing the African-American community. Even Siqueiros dedicated one of his paintings to the discrimination that tormented African-Americans in the United States. In his painting titled, *Cain in the United States* (1947), Siqueiros depicts Cain as a black man. Cain is lying down on his back with chains, and naked white people, howling, around him are pulling his arms and his legs apart. Cain is portrayed as the lynched body of a black man whose head is bleeding to the ground- extremely symbolic.

There are four main factors that influenced these Black artists: the aesthetic theories of Alain Locke, the social realist movement in the United States, the rise of American socialism and communism, and of course, the work of the Mexican muralists, themselves. Alain Locke promoted the concept of the "New Negro" and he supported the establishment of a national cultural identity. He held the belief that African-American artists should reflect their African heritage and Southern expressions in their artwork. Social realists believed that it was impossible to separate art from its social and political context- this of course, is true of the Mexican muralists, as well as of Langston Hughes and the other Black artists. African-American artists sought to interpret how existing conditions affected the lives of Black Americans. Regarding the political arena of that time, many African-American artists supported socialist, communist, and nationalistic viewpoints that the social realists depicted (LeFalle-Collins and Goldman).

Perhaps the greatest Harlem Renaissance muralist is Hale Woodruff. Woodruff studied under Henry O. Tanner and Diego Rivera. Woodruff was awarded a grant from Columbia University and spent the summer of 1936 studying in Mexico with Rivera. His influence is quite evident in Woodruff's art. Woodruff's most famous murals are the *Amistad* murals (1939), which decorate Talladega College in Alabama. According to Zoe Ingalls, the *Amistad* murals "tell succeeding generations of students a story of enslavement and freedom and daily teach them the redemptive value of courage and hope" (Ingalls, 1996). *La Amistad* was a Spanish ship containing slaves headed for the New World. The first mural is called *The Mutiny Aboard the Amistad* and depicts the rebellion that took place in 1839 on the ship, the mural shows the slaves holding knives to the Spaniards necks' and there is chaos on the ship. The second mural, *The Amistad Slaves on Trial at New Haven, Connecticut* shows the slaves in the courtroom on trial in 1840. John Quincy Adams fought on the behalf of the slaves and won. The same men who had fought for the slaves' cause raised money for the slaves to return home to Africa. The third mural, *The Return to Africa*, shows the Africans returning to their native land in 1842, accompanied by two Christian missionaries.

The *Amistad* murals are a testament to the courage and strength the slaves displayed. Today, the murals continue to serve as a hope and encouragement to the many students entering the library of Talladega College. The murals, also, provide Black Americans with a piece of their own history. Rivera's murals, *Mexico Through the Centuries*, which decorates the National Palace in Mexico City, is similar to the *Amistad* murals in that they tell the history of the Mexican people. The mural, *Mexico Through the Centuries*, which took twenty-two years to complete (1929-1951), starts off with the Zapotec Civilization, one of the native tribes of the Mexican people. It shows the natives, cooking, making crafts, and laboring. The other two murals, tell of the arrival of the Spaniards in Veracruz and the political strife plaguing Mexico in the 20th century during the Revolution. The murals are painted with such detail and precision, so as to capture every moment. These murals represent that part of the Muralist Movement that sought to promote cultural pride and offer the Mexican people pieces of their own history.

Charles White has, also, offered African-Americans pieces of their history they can reflect upon. Charles White once remarked, "Paint is the only weapon [that] I have with which to fight what I resent. If I could write I would write about it. I f I could talk, I would talk about it. Since I paint, I must paint about it." White painted three historically influential murals from 1939-1943. One of these murals, *The Contribution of the Negro to Democracy in America* (1943) shows the contributions of African-Americans to American society. White borrowed many compositional structures from Rivera's "Mexico Through the Centuries," and the two murals bear striking stylistic similarities. White's two main themes in his mural are African -American resistance to white oppression and black contributions to the development of the United States. In the mural, on can see heroes including, Frederick Douglass, Nat Turner, Harriet Tubman. Also evident are Civil War soldiers, a chemist, a blues singer, and an anonymous mother and her child- all representative of the cultural, moral and scientific contributions African-Americans have made to American society. Hale Woodruff and Charles Alston collaborated in a mural, *The Negro in California History*, a project similar to that of White's (LeFalle-Collins and Goldman).

Along the same lines of reflecting history, Charles Alston painted a two-part mural reflecting an integration between African and American culture in the field of medicine. It reflects the history of African medicine in combination with the advances of modern medicine. The murals, *Magic and Medicine* (1936), were first exhibited in Harlem Hospital. The first mural, *Magic*, illustrates the origins of medicine in Africa. This is represented by African-American individuals standing in a cotton field and witnessing a baby being baptized. The suggestion of spiritual healing is further enhanced by a drummer playing over a sick woman who is dying, while African dancers perform dances below a large Fang statue from Gabon. Fang sculptures represented guardians of ancestral remains and here it is evident that Alston was influenced by Alain Locke's discussion of African art in The Negro in Art. The second mural titled, *Medicine*, Alston depicts men and women involved in contemporary medicine. A large microscope is seen in the central part of the painting, which suggests that modern medicine has replaced the traditional, "magic" medicine from Africa. A huge image of Hippocrates stares down upon the whole scene, perhaps suggesting his dissatisfaction that scientists have turned their back on primitive medicine completely (LeFalle-Collins and Goldman, 1996).

Another major theme of the Harlem Renaissance artists was the plight of the black working man and class struggles, a theme very much in contact with the Mexican muralists. Blacks did not have much opportunity for social mobility and were for the most part, what the campesinos were in Mexico- the manual labor force of the country. Blacks worked in the fields, women were house cleaners and very few landed white-collar jobs. In White's *Sharecropper* (1947-1948), the viewer sympathizes with the sharecropper, whose appearance is humble and sad, and whose shoulders are hunched over. Elizabeth Catlett's, *Working Woman*, also tells the sad story of a black cleaning woman who looks weary. *I Have Always Worked Hard in the Fields* is another testament from Catlett of the hard labor black farmers endured. In spirit of black resistance, however, Catlett painted powerful inspirational works, including *In Sojourner Truth, I Fought for the Rights of Women* (1947) and *In Harriet Tubman, I Helped Hundreds to Freedom* (1946). In relation to class struggle, Charles White painted, *Hear This*. The painted depicts an excited, blue-collar black worker attempting to convince a black man in a tie (suggestive of his class) of the importance of what is listed on that piece of paper. The man in the tie, however, appears indifferent and does not seem to care what the blue-collar man is telling him. This suggests the gap that exists between the two man as a result of their class, even though they are both black.

> The murals, easel paintings, and prints of African-American artists and the poems of Hughes and others provided visual, historical, and literary reinterpretations of the history of the black experience in the United States, with special emphasis on unequal treatment blacks had experienced under the capitalist system. For this reason they were particularly interested in the works of the Mexican muralists. Diego Rivera felt that the suppression of subordinate cultures was one of the main links

> between the oppression that workers experienced in Mexico
> and that which blacks endured in the United States
> (LeFalle-Collins and Goldman, 1996)

Although Langston Hughes does not necessarily fall into the category of painters, he was certainly a very powerful *artist* of the Harlem Renaissance. Through writing, Hughes discussed issues of racism, issues of injustice and issues of inequality. In his poem, "Scottsboro," Hughes assures the young black Scottsboro boys that they are not alone in their battle- the boys are condemned to die. The boys are a part of a larger, international fight for freedom and justice that includes the people listed in the poem. Like those martyrs, the truth and memory of the Scottsboro boys will live on (LeFalle-Collins and Goldman, 1996).

REFERENCES

Billeter, Erika. "Frida and Maria." Images of Mexico. Schirn Kunsthalle Frankfurt: Switzerland, 1987.

Haufe, Hans. "Muralism, Self-Made Art." Images of Mexico. Schirn Kunsthalle Frankfurt: Switzerland, 1987.

Ingalls, Zoe. "If You Set Your Mind to Something." The Chronicle. Alabama. September 4, 1996.

LeFalle-Collins, Lizzetta and Goldman, Shifra M. In the Spirit of Resistance. New York: The American Federation of Arts, 1996.

"New Traveling Exhibition Explores Profound Cultural Exchange Between Mexican Muralists and African-American Modernist Artists." Mexican Notebook. October, 1996.

Ramirez, Maria del Carmen. "Nationalism and the Avant-Garde: Ideological Equilibrium of Mexican Muralism 1920-1940." Images of Mexico. Schirn Kunsthalle Frankfurt: Switzerland, 1987.

The Issue of Status in Puerto Rico
Internal Strife in the Search for Status

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Puerto Rico has had, throughout their history, a government determined by someone other than themselves. Since the discovery of the island, and the invasion of the Spaniards, the island has had to abide by someone else's rules. The native people have had opinions on their situation throughout this period, but now *they* have been given the choice. The United States has determined that the island should have a say in the type of government they are being ruled by. This has led to extensive conflict in opinion. Opinions have exploded on the effects that this choice will have on the country. The concerns of what is occurring in Puerto Rico range from the effects on cultural history to the economic stability of its people. Statehood, independence, or the status quo as a commonwealth are the options available to the islanders. Which will be chosen, and the consequences of that choice are yet to be determined. An in-depth study of the present situation, and how the different options could affect that situation may give the reader a more thorough understanding about this determination, and further, give them a clue as to what to expect from the struggle for identity that is occurring in Puerto Rico.

The people and their values are a strong presence in Puerto Rico. Without an understanding of the people on the island, it would be very difficult to understand why emotions are so strong over the present situation. The Puerto Rican people have a strong heritage. Their history and their culture are important aspects of their lives. In other words, where they came from is as important, if not more so, than where they are going. The pride that is exemplified by *every* Latin American demonstrates the intense sense of heritage and soul for the culture.

History is also a vital part of the island's culture. Depending on the status chosen, there is a widespread belief that the island will lose part of its history to another culture. Therefore, it is a worthwhile effort to establish the island's history and understand the people that belong to it.

Christopher Columbus encountered the island on his second voyage in 1493, and claimed it as part of the Spanish empire. In 1898, at the conclusion of the Spanish-American War, Puerto Rico was ceded to the United States. After Puerto Rico was taken over by the United States, the island was considered a poorhouse, dependent on only one crop, sugar (Puerto 28). In 1901, the Foraker Act Amendments established a civil government on the island as opposed to the previous military establishment. United States senators were given the authority to assist with the island's government, and the languages on the island were expanded to two. Then, in 1952, commonwealth status was chosen to be a new type of government that encouraged a partnership between the two countries. The United States occupation was a turning point for the islanders as their situation became less bleak with economic interventions to help boost Puerto Rico's standard of living.

The United States has taken a strong stance in only one aspect of Puerto Rico's present situation: that they should have a say in their government. From the Presidential Notes of George Bush in 1992, the President noted: "As long as Puerto Rico is a territory, the people should periodically be allowed to vote on their political status by means of referendum" (Office of the Press Secretary 2324). This leads us to our present dilemma: if Puerto Rico has the ability to choose their political status, then what should they vote for? Most of the Puerto Ricans are confused. They are not sure what each status represents; further, they are unsure what consequences, pro and con, are involved with the choices they have. Patrick Marshall, author, makes note that in this type of situation, "Voters anywhere tend to vote with their pocketbooks..." (84). It seems the Puerto Ricans, in their uncertainty, vote for what they think will bring the most economic benefit to the island. However, I would argue that they are not looking beyond the short-term effects of the status issue. Therefore, what follows will be an in-depth study of each status available to the island, and what advantages and disadvantages each status brings with it.

The idea of commonwealth status was introduced in 1952 by the governor at that time, Luis Munoz Marin (Puerto Rico 28). The idea took flight, and on July 25, 1952, Puerto Rico declared "Constitution Day". Constitution Day was the day proclaimed by the island when a new precedent was set forth: from hence forth, the island became a commonwealth of the United States. This commonwealth was considered a "...voluntary association with the United States approved by the Congress of Puerto Rico through a plebiscite" (Gelabert 14). Further, the structure of the commonwealth agreement allowed for flexibility from both parties: Puerto Rico was permitted self-government in internal affairs and administration so long as they were subject to United States' laws (Office 2324). This agreement provided a mainframe for what was later to be called "The Union that Works" and "The Best of Two Worlds" (Passalacqua 104). It seemed that this union could establish for both parties benefits that outweighed the consequences. There was economic benefit to be gained, as well as political advantages: it has worked up to recently. There has been dissension on the island as people look towards bigger and better lives. The people that are dissenting argue that there are many disadvantages. That they lack the right to vote in presidential elections, and further, that the Puerto Rican people are not eligible for the same amount of welfare assistance as the people on the mainland are the disadvantages usually targeted by the opposition. Others argue that the island is becoming too dependent on the United States, and that they need to learn to stand on their own. However, extensive research suggests that the benefits that come to the island are much greater.

Several advantages that have been gained by the commonwealth are that the islanders are considered American citizens, and are able to travel freely into the mainland executing the same rights as any average American citizen. Also, the island has gained economic support from the United States government. The island is eligible for some welfare assistance, and the government supplies the island with a budget by which to disperse these benefits. However, the biggest benefit that has been gained by the island through United States intervention is the Section 936 tax break.

In 1947, the United States created a new policy to assist the economic situation of the island. The program was named "Operation Bootstrap". This program was based on industrial development through tax incentives and tariff rebates. This agenda was created with the intention of enticing American companies to move some of their business to the island to cut costs, and increase bottom line profits while providing Puerto Rico with new employment opportunities. In 1976, this operation was renamed to Section 936 of the Internal Revenue Service Code (Marshall 86). The Section 936 tax break states that there is a "100% tax credit to Puerto Rican corporations for income from a trade or business and from qualified investment income derived from Puerto Rico" (Donlan 28). It worked. The amount of business done in Puerto Rico today far exceeds the situation the island was faced with in 1898. An article from The Economist states that "Now, it is rich by Caribbean standards, with a strong industrial base" (29).

Another option has recently been introduced on the island; the option of "enhanced commonwealth status". This option would include an improved version of the 1952 commonwealth agreement, while maintaining the basic "union" structure. "Enhanced status" would include several key elements: first, there would be a provision for additional self-government on the island (still subject to United States laws). This would give the island the "enhanced" sense of autonomy in the governing body, an option that many Puerto Ricans desire. Also, the island would retain all incentive benefits provided through Section 936 and all programs for the poor that are currently in use while gaining several others (not yet determined). Enhanced status would provide for these additional programs through a new law that would make the island's population subject to Federal taxes. However, as a majority of Puerto Rico's population lies below the United States' poverty line, this seems like more of an economic gain than loss (Tochlin A12). If looked at as a whole, the "enhanced commonwealth status", as a recent article states, "...would give Puerto Rico the powers of a state with the exception that they would lack representation in Congress (A12). It seems to be that this plan, if it can be agreed upon extensively throughout the island, would best benefit the country. They would not have to give up their autonomy nor their culture, and yet the island would be gaining almost all of the rights of a state. The Popular Democratic Party, led by former Governor Rafael Hernandez Colon contends that "only an 'enhanced' status can protect the economy as well as the Hispanic culture" (Barrett 19).

The greatest opposition to the enhanced commonwealth status is statehood. The supporters of statehood argue that if the island is so close to being a state, the best thing they can do is to vote in favor of statehood so as to be on equal footing with the other fifty states. If the majority of the Puerto Ricans choose statehood, "Upon the issuance of said proclamation, the Commonwealth of Puerto Rico shall be declared to be a state of the United States of America, and shall be admitted into the union on an equal footing with the other states" (Kilpatrick np). Supporters of statehood emphasize two key advantages to becoming a state. If Puerto Rico were to become the 51st state, the island would acquire representation in Congress, with two senators and five or six members of the house. The island would also gain the right to vote in presidential elections (Tochlin A12). The New Progressive Party, led by former governor Carlos Romero Barceló argues that statehood would mean political equality and more food on the table through assistance programs. Other supporters highlight the fact that federal assistance programs will be instantly gained as opposed to waiting for the budget allotted them from the mainland to determine what help they will acquire (Barrett 19). For the supporters of statehood, these advantages outweigh those of enhanced commonwealth status. However, they will have much more difficulty attaining their goal than maintaining the status quo. This is due to the fact that in order to present a valid case for statehood to the United States, Puerto Rico needs approximately 70% agreement on the island (Dumas 4076).

Superficially, this all seems well and good. However, the case against statehood shows that it is not really the best option for the island. First, [statehood] is irreversible. If Puerto Rico chooses statehood, they are stuck; they will be a part of the union throughout their existence. In an air of such uncertainty, does it seem logical to do something one can't undo? Next, English now co-exists with Spanish as the official languages of the island. Statehood would seem to favor the use of English as a primary language on the island (38 Aniversario np). As one opponent to English as a primary language says, "[teaching English is] the latest effort as a not-so-veiled attempt to assimilate Puerto Rico, or at least portray it as assimilated" (Navarro np) Although English is a strong second language, there are islanders who do not know English, and to force upon them a new language that they do not understand would raise resentment toward the mainland, as well as anger and sadness for losing an important part of the Latin American culture they treasure. This leads to the next point: Puerto Rico would have to assimilate the North American culture. This includes losing much of their history to United States history. They would lose their culture as the prioritized language changed, politics change, and economics change. With so many changes facing the island, the only refuge they could seek is to assimilate, to "go with the flow". Unfortunately, they would be losing over 500 years of valuable history and culture in the process. Another valuable argument against statehood is the fact that although the island would gain instant welfare assistance, many islanders may not qualify for food stamps, Medicaid, or welfare under United States' new policies. With the budget included in commonwealth, the island is guaranteed a certain allotment; however, with statehood, each individual must fare for themselves. By far, the biggest disadvantage for statehood is something that would send the island into economic tumult. If Puerto Rico were to decide to become a state, the island would lose all special tax benefits for investment incentives (Tochlin A12). What this means is that the industries that came to the island to increase profit through tax incentive would lose that benefit. Although the incentive would only be gradually phased out, it is probable that most large companies would leave after the exemption is gone (Barrett 19). What this means for the island is that statehood would cause the loss of more that half of the 300,000 jobs that have been created through Section 936 (Puerto Rico 29). This would double the unemployment rate on the island to more than 30%. Not only does this type of tumbling effect affect the island, it would also affect the United States. It is estimated that to make Puerto Rico the 51st state, it would cost the treasury nearly $25 billion by the year 2000. And this is only the actual process; if tax incentives are lost, and unemployment rises, it will also increase cost in welfare and assistance programs (Barrett 19). This raises another important issue: even if Puerto Rico votes for statehood, would the United States accept them? They are not bound to accept the island if they choose statehood. There have been rumors similar to one found in the Economist that says, "Washington questions whether they want to admit to statehood (which involves two senators and up to seven House members) a Spanish-speaking island of 3.3 million people, more than half of whom live below mainland

America's poverty line" (Puerto Rico 28). There has been mention of initiating a "self-executing" provision in Senate committees, which would mean automatic admission to the states if the majority of Puerto Rico is mustered for statehood. However, this provision in still in the working, and may not even make it to the floor of Congress (Puerto Rico 28). It seems that statehood is more hassle than it is worth. There are several *key* losses to the island, including language and tax incentives, and only superficial gains (i.e. representation in Congress). So long as the United States continues to assist the island as they have done, it seems the most truth can be found in the old adage "If it's not broken, don't fix it."

There has been one other opponent to the status quo, although its presence on the island is minuscule. Independence is an option to the island, and there are radicals that would like to see this option chosen. However, up to 1952, these groups usually expressed their opinions with guns and terrorism; therefore, general sentiments on independence tend to be negative. Although the support for independence is small, supporters are convinced that America will never accept Puerto Rico as a state, and when the island is turned down for statehood that their own ranks will begin to swell (Puerto Rico 28). The obstacle toward independence is that the island would be required to be self-sufficient economically, and it is very unlikely the island could accomplish this feat. Further, Section 936 will be deleted under this option, posing similar problems to those of statehood. Without the industrial base that is so strong, independence seems a long shot in all practicality for the island.

November 14, 1993 marked only the second time in Puerto Rico's history that people were able to freely express their opinion on the island's political future (Passalacqua 104). 80% of the 2.1 million registered voters practiced their right to vote (Dumas 4075). It is interesting that the Puerto Ricans refer to "celebrating" an election rather than just having one. It shows the importance they place on their right to express their opinions. The 1993 plebiscite showed the following results:

48% of the voters voted for commonwealth status
46% of the voters voted for statehood
05% of the voters voted for independence (Aleinikoff 16).

The plebiscite shows the relative closeness of the vote. It seems that most people were very confused by the overabundance of campaigning that occurred before the election, and many votes were not based on actual understanding of the island's options. It could be argued that if education on the real issues of each status would have been fairly distributed throughout the island, the vote would have shown more prominent results. Therefore, a new focus on education needs to be implemented to ensure well-informed voting in the future.

A new movement has sprung up on the mainland, and depending on the outcome of this movement, it could drastically affect the status issue. In December of 1995, Congress voted and *passed* a new law, the Omnibus Budget Reconciliation Act of 1995. What this act consisted of was a complete phase out of Section 936 for future investment, with a grandfather clause for existing 936 corporations. Fortunately for the island, this law was vetoed by the president, and no new actions have been disclosed at this time (Griggs). Surprisingly, the pro-statehood governor of Puerto Rico, Pedro Rosello, was not opposed to this repeal, but did propose an alternative plan. The alternative plan, named 1397E of the Internal Revenue Code, said that any state or territory meeting certain criteria would be eligible for tax breaks. One eligibility factor was that the business had to derive at least 80% of their gross profit from active conduct of a business or trade within certain jurisdictions (Griggs). The new proposal is difficult to understand in context; however, any repeal of Section 936 would create atrocious repercussions throughout Puerto Rico.

The status debate comes down to an argument between national dignity versus economics. Supporters of independence and statehood argue that Puerto Rico must "rid the shackles of colonialism"; supporters of the commonwealth argue that there is more money to be had where they are while maintaining identity (Puerto Rico 28). One thing is certain, "all of the parties are exhausted, financially and otherwise" (Dumas 4078). Further, it seems that the people are overwhelmed with propaganda and publicity. The island needs to step back and remember that they are brothers and sisters, and no matter the status chosen, they must stand tall as Puerto Ricans The struggle for identity has the capability to bring disaster to the island, but if the people educate themselves, they will see above all the talk that their identity remains As Carlos Romero Barcelo says, "Something that all of us know to be true in our hearts and in every fiber of our being that we who are Puerto Ricans are not about to give up our identity for anybody" (Kilpatrick np) The cultural history of the island will hold them together While statehood and independence parties fight with the supporters of commonwealth, the people will continue to listen Commonwealth has been shown throughout this discussion to hold the most advantageous position for the entire island Although there are drawbacks, it seems that the benefits outweigh the shortcomings Further, if looked at on a long-term basis, as opposed to short-term benefits, it is obvious that commonwealth has the most to offer It is a struggle for a country to ascertain its situation and make educated choices without being subjective in their decisions However, the island is in good position to maintain economic prosperity while holding onto the culture they so dearly cherish The struggle goes on, but if one looks at where the island has come from, it seems that victory has already been accomplished

REFERENCES

Aleinikoff, Alexander. "Puerto Rico and the Constitution: Conundrums and Prospects." Constitutional Commentary v.II, Winter 1994: 15-43.
Barrett, Laurence I. "Puerto Rico, the 51st Estado." Time, Mar 26, 1990: 19.
Donlan, Thomas G. "The 51st State? A Fateful Choice Looms for Puerto Rico." Barron's, Sept 3, 1990: 17, 28.
Dumas, Kitty. "Practice Makes Puerto Rico a Force Heard in Congress." Congressional Quarterly Weekly Report v48, Dec 8, 1990: 4074-4078.
Gelabert, Blanche. 1989 San Juan Shopping and Restaurant Guide, San Juan, Puerto Rico 1989
Griggs, Robert. "Proposals in the U.S. Congress, by the President and by the Governor of Puerto Rico, relating to the Future of the Section 936 Credit." Http://www.mcvrp.com : Dec 14, 1995.
Kilpatrick, James J. "Statehood for Puerto Rico ?" The Cincinnati Enquirer, Dec 15, 1990: np.
Marshall, Patrick G. "Debate Over Puerto Rico's Political Status" Editorial Research Reports, Feb 8, 1991: 82-94.
Navarro, Mireya. "Puerto Rico Teachers Resist Teaching in English." The new York Times, May 18, 1997: np.
Office of the Press Secretary. "Memorandum on the Commonwealth of Puerto Rico." Weekly Compilation of Presidential Documents v28, Dec 7, 1992: 2324-2325.
Ortiz, Gilberto Rivera. "38 Aniversario E.L.A." Portavoz de la Mayoria Senado de Puerto Rico, 25 julio 1990: np.
Passalacqua, Juan M Garcia. "The 1993 Plebiscite in Puerto Rico: A First Step to Decolonization?" Current History v 93, Mar 1994: 103-107.
"Puerto Rico: Still Star Gazing." Economist, Dec 9, 1989: 28.
"Puerto Rico's Referendum: 'Salsa with Fries'." Economist, Nov 13, 1993: 28-29.
Tochlin, Martin. "Legality of a Status Change in Puerto Rico is Challenged." New York Times, Feb 8, 1991: A12.

Multinational vs. Global Organizations: A Case Study of the Corporate Culture of IKEA

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In the mid-1980's, IKEA was a successful multinational organization. As they continued expansion to include Canada and The United States, they encountered problems with their employees within the host countries. These problems reflected the domineering approach to training employees and the ethnocentric tendency of the company and its management team.

Based on a case study of the IKEA Corporation, we found these to be symptoms of a multinational organization. In our research, we found that IKEA needed to focus on becoming a global organization. We explain the difference between multinational and global organizations and how that relates to the problems experienced by IKEA. Also, we offer steps on how to make IKEA a global organization and solve the problems they encounter with host country employees.

INTRODUCTION:

As the twenty-first century quickly approaches, the business world is experiencing rapid changes and opportunities on a global scale. However, as global markets open up corporations are faced with many new challenges. IKEA is one of many corporations facing these challenges and overcoming these challenges. The purpose of this paper is to identify areas of improvement and offer solutions to IKEA, based on The Harvard Business School case study published in 1988.

BACKGROUND:

IKEA was originally founded in 1943 by Ingvar Kamprad. It had a humble beginning as a mail order company, but quickly expanded by fulfilling a basic market niche. In Sweden between the years of 1935 and 1946, the price of furniture rose 41% faster than other household goods (Bartlet, 1996). With this in mind, Ingvar developed IKEA with a single objective to, "offer a wide range of home furnishing items of good design and function at prices so low that the majority of people can afford to buy them (Bartlet, 1996)." All aspects of IKEA today reflect this basic notion of providing low cost furniture. There are no sales people on the floors. The stores are built with cost in mind. Assembly is completed by the customer not IKEA.

Ikea's corporate culture is based on Swedish traditions and philosophies. The corporate executives are mostly Scandinavian to create a homogenous group. IKEA prefers to hire younger people, who have not, yet, had the chance to experience corporate life. This keeps their (IKEA) costs low and makes it easier for the managers to adjust to the corporate culture. The culture is very ethnocentric in its tendencies. The Swedish dedication to your job is expected of all employees, along with being very casual at work, always being cost-conscious, and being independent. Promotion within IKEA comes very quickly to those who have the Swedish trait, "odmjukhet" or have modesty, humility, and respect for people (Bartlet, 1996). It is felt that the purchasers should remain Swedish to promote the cost-consciousness, that is believed to be inherent in natives to the Smaland area. Distribution and design are, also, controlled locally despite international expansion. The rest of operations are divided into geographical areas and controlled by regional managers.

The current policy for opening international stores involves two phases. The first phase is involved in finding land and building the store, as well as hiring employees. After about a year of putting the system in place, the second phase starts, in which the operations group takes over permanently. The only guidelines for the expansion group is Ingvar's "Furniture Dealer Testament," which basically outlines the core philosophies that Ingvar found most important. He went so far as to train ambassadors to teach and convey this philosophy to other parts of the company.

Ingvar started expanding into Europe in the early 1970's, despite attempts by local retailers to stop IKEA. By 1976, IKEA's success lead to expansion in Canada and Australia. In 1986, Ingvar made the decision to break into the world's largest retail furniture market, the United States, estimated at $35 billion annually (Kelley 1987). As of 1989, IKEA had a total of 69 stores, 57 outside Sweden and 12 within.

ANALYSIS:

IKEA's rapid expansion into the US markets is changing the dynamics of the corporation and they are encountering many problems with the way the current business operates. IKEA is having problems integrating US employees to the Ikean way. This is due to the fact that both rapid growth and additional employees from expansion into new geographical areas, cause corporations to evolve, specifically corporate cultures (Irwin, 1995b).

Also, this change is putting pressure on IKEA's traditional system of ethnocentric policies. IKEA currently follows the practice of keeping the corporate levels dominantly Scandinavian. While this is successful and often necessary in some areas, it "can lead to 'cultural myopia,' the firm's failure to understand host-country cultural differences that require different approaches to marketing and management (Irwin, 1995a)." This is already a problem, as is evident in the statement by IKEA's head of North American operations, "it has been hard making the IKEA way their way of life here in the US (Bartlet, 1996)." IKEA does not recognize that the US has a very distinct culture and that it is completely different than any previous cultures they have encountered, nor do they see the need to change their own corporate culture.

The above mentioned complications of IKEA's US operations are just that, complications of a bigger problem. IKEA's rapid expansion has brought them to a global level in the furniture retailing business, but the corporation itself is not prepared for this level of business.

According to Stephen Rhinesmith, organizations go through four stages in the process of becoming global organizations. These stages are "domestic, export, international/multinational, and global (Rhinesmith, 1991)." IKEA is currently at the multinational level and is encountering problems because their markets are rapidly becoming global in scale. They will lose their competitive advantage in the US market, if they don't take immediate steps to adopt the characteristics of a global organization. Rhinesmith defines a multinational organization as one that equally distributes manufacturing and technology throughout the company. Also, they have a centralized view of strategy, technology, and resource allocation. IKEA's operations are still run out of Sweden. Another aspect of multinational corporations is how they adapt resource allocation based on international competitiveness (Rhinesmith, 1989), just as IKEA has relocated their furniture supply when different nations have offered low cost options. However, despite having stores in locations around the world, IKEA is not a global corporation.

A global organization's "structure is used to unify the operations in each country (Irwin, 1995c)." A global organization's strategies are not just domestic models changed to fit local markets and cultures, but are, "integrated wholistic strategies(Rhinesmith, 1991)." Rhinesmith re-enforces that global organizations are organized, so that, national boundaries and cultures are not barriers to potential business or manufacturing opportunities. Unlike multinational corporations, global corporations have the mindset of being world citizens.

A global corporation has specific characteristics. There are three areas that must be addressed and changed in a multinational corporation to make it a global organization, strategy/structure, corporate culture, and human resources (Rhinesmith, 1991). Rhinesmith points out for this to be successful, change in all three areas must be addressed.

SOLUTIONS:

IKEA needs to start taking steps towards becoming a global corporation, now. An organization cannot change overnight, especially when traditions and cultures are involved. It will be a slow process to make IKEA a global corporation, but a necessary move for them to remain competitive in the future, where technology will quickly lower cultural and geographical barriers. IKEA needs to address the three areas outlined by Rhinesmith, simultaneously, with specific steps to be taken and goals to be obtained.

First, IKEA needs to put together a task forced designed to study their global strategies and structure. This task force needs to be a cross functional and cultural team. The task force needs to learn to work as a team to identify changing conditions and make decisions on what courses of action need to be taken. Their study should involve becoming "globally centralized." This means looking at the feasibility of keeping operations like distribution and purchasing located in Sweden. Also, re-evaluating strategies in local markets and deciding, if certain tasks would be better centeralized or, perhaps, decenteralized. The new strategies need to include a global vision to meet the competitive needs of the future.

Second and most important for IKEA, is they need to evaluate their corporate culture and take steps to make it more globally oriented. IKEA must focus on retraining top executives to transcend cross-cultural barriers and diversify their homogenous group. They need to develop a mission statement outlining their commitment to becoming a global corporation. Specific goals should be developed so that their progress can be evaluated.

Another area IKEA needs to start making changes in is human resources. Despite growing sales and profits, dissatisfaction among foreign workers indicates a need for change. This change needs to occur within all management levels, top, middle, and low. They need to adjust their staffing policies to promote managers from foreign countries to bring in new ideas and viewpoints. IKEA needs to diversify their executive team to include managers native to the host countries of their stores. The group in charge of opening new stores needs to be educated on the local culture, through training and orientation programs. This will allow IKEA to be able to meet the needs of foreign employees.

CONCLUSION:

IKEA needs to reevaluate and change its corporate culture to reflect globalization. As the company stands now, it is successful internationally, but lacks the diversity, culture, and the mindset of a global organization. These skills are needed to respond effectively to changing global needs from all regions within the company. The managers in charge of opening new stores require more training within the host countries. They need to completely understand the local culture and be willing to adjust IKEA's culture to fit it. Another aspect necessary for IKEA to become a global organization is to develop cross-cultural teams. These teams need to be involved in global and strategic planning and focus on the idea that all members are equal. Most of all, IKEA needs to focus on becoming "world citizens" by adjusting their attitude toward cultures and the differences between them. In doing so they will remain in the global market and be prepared to deal with the growing changes in the world economy.

If management does not recognize this weakness now and start planning to develop a global corporate culture, they will jeopardize their prosperity for the twenty first century. Trade barriers are dropping and world markets are opening up. Therefore, corporations are striving to be the best suited to adjust to every culture and market. These are qualities that take time to develop and if IKEA hesitates they will be left behind.

REFERENCES:

Bartlet, Christopher. (1996) Ingvar Kampard and IKEA. Boston, Harvard UP.

Irwin, Richard. (1995). "International Business Global Human Resource Management-Staffing." Irwin Multimedia Business Reference Library. Compact Publishing.

Irwin, Richard. (1995b) "Strategic Management Implementing Strategy: Culture & Leaders." Irwin Multimedia Business Reference Library. Compact Publishing.

Kelley, Bill. (1987). "The New Wave from Europe." Sales & Marketing Management vol.135.

Rhinesmith, Stephen. (1991) "An Agenda for Globalization." Training and Development Journal.

Rhinesmith, Stephen. (1989) "Developing Leader for the Global Enterprise." Training & Development Journal vol.43, no.4.

The Creation of Christianity:
Exploring the Role of Women in the Development of the Ancient Church

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INTRODUCTION

If someone asked you to list the three most important events in the history of the United States, your list would probably include some of the following: the European "discovery" of the Americas, the Revolutionary War, the signing of the Declaration of Independence, the writing of the Constitution, the abolitionist movement, the Civil War, World War I and II, the civil rights movement. And almost all of these -- in fact every one, with the possible exception of the civil rights movement -- were organized or led by a select group of men who were in power at the time.

In an attempt to cover what they consider the most significant, or at least the best known, pieces of our history, historians are forced to focus on a few isolated individuals. They cannot tell the story of everyone. Feminist scholars argue that historians have consistently neglected the role women have played in societies, but in fact, the histories have neglected much more than just women. Traditional history is not the history of the common person; it is the history of major events and the few people who were intimately connected to those events. For every example of a woman leader in early Christianity, someone could probably recite over one hundred examples of male leaders. But that does not mean that the women were unimportant. To learn the significance of these women, to realize the effect they had on the early Christian communities, we must study them as we would study any other historical figure -- with depth, precision and skepticism. Only after we have done this can we form an educated opinion on the roles of women in the early Christian tradition.

PHOEBE: DIAKONOS AND PROSTATIS

Concept: Paul

Paul was a Jew, a Pharisee, who experienced the revelation of Jesus Christ circa 33 CE and decided to devote his life to spreading Jesus's teachings across the Mediterranean world. He traveled to many different communities, where he would live and work among the people. Many of the people, Gentiles at the time of Paul's arrival, would become followers of Christ. Paul would build up a local community of believers, train individuals as leaders, and then move to another city.

Paul continued to monitor the religious communities long after he had left, via his letters, which now comprise a significant portion of the New Testament. In one of those letters, a letter from Paul to the Romans, he mentions a woman named Phoebe, whose case will be examined by this paper. Phoebe has a connection with a church near Corinth, and the confusion and discussion lies in what exactly was her role.

The Text: Romans 16: 1-2

> I commend to you our sister
> Phoebe, a deacon of the church at

233

> Cenchreae, 2 so that you may
> welcome her in the Lord as is fitting
> for the saints, and help her in
> whatever she may require from you,
> for she has been a benefactor of
> many and of myself as well.
> (Text from the NRSV, the New Revised Standard Version of the Holy Bible, 1989)

Our Thoughts:

Within the Hebrew Bible or the New Testament there are many examples of women taking leading roles in the early Christian churches. But there are also many examples where women are relegated to menial roles. So how come no one knows about these women? What did the original authors mean? As we have already discussed, no one can know for sure what the authors intended. The texts were written so long ago and have since been translated into so many variations, that it is virtually impossible to get unanimous agreement from an individual church, let alone a denomination or the religious world as a whole.

So what is our recourse? Our only option is to return to the primary evidence. When we are confronted by unclear passages, we must cross reference them with other passages from the New Testament or historical evidence from the time when the texts were written. This is not merely the process of translation and historical research, it is the search for women in early Christianity.

Romans 16 from the New Testament is prime material to illustrate how the understanding of the role of women has been affected by translations. In Romans 16:1, Phoebe is commended as "a deacon of the Church at Cenchreae." In the original Greek manuscript, Phoebe is referred to as *diakonos*, which, when translated into English, means "one who serves or ministers to." Thus far, this translation by the NRSV is accurate. However, other translations--the Revised Standard Version, for example--translate *diakonos* as deaconess. This suggests that the original word Paul used was *diakonissa*, the feminine form of *diakonos*. There is a problem with that suggestion; the word *diakonissa* was not used in the time Paul wrote. The role of deaconess, which evolved at a later period, was the ministry to other women. In referring to Phoebe as a deaconess instead of as a deacon, her position as a woman of authority in the church becomes clouded. Paul, in writing this letter, did not give any indication that Phoebe's position was inferior to others he had referred to as *diakonos* (Timothy, for example in 1Thessalonians 3:2)

Why would this change occur, if the word *diakonos* has such a clear, unambiguous meaning? The answer to that question constitutes the very essence of the translation dilemma. To understand the problem with translations one must first recognize the fact that no written text is entirely objective. Authors bring a particular bias to their work based on what they have learned and experienced in their lifetime. An honest and experienced writer seeks to minimize the effect of the bias on his/her work, or, at the very least, owns up to it. The same is true for translators and copyists; people who worked on translating the original Greek manuscripts brought to the texts their own preconceived notions of the religious authority of women. If a detail in the original manuscript appeared to be untrue, it could be altered to better represent what was believed to be factual. We do not believe that this was done as a vengeful act upon women; more probable is that the translators were doing their job based on what they knew. It is unfortunate that by the time many of the translations were done, women had lost much of the role they had previously held in the church. Now, it is left for scholars to attempt to uncover what the reality was concerning women in the early Christian church.

Another example of this translation problem occurs in Romans 16:2. The same woman, Phoebe, is described as "...a benefactor of many and of myself [Paul] as well." The word benefactor was somehow derived from the Greek word *prostatis*. *Prostatis* is the feminine form of *prostates*, which is translated as a leader or chief of some kind. The original word, *prostatis*, describes Phoebe as a leader of many. The word "benefactor", while indicating wealth and some degree of power, takes away Phoebe's position as a leader and religious authority. One problem that surfaces in discerning the true meaning of this word is the fact that the feminine *prostatis* appears only once in the New Testament.

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Thus, we cannot look to other passages to see what position this word previously referred to. However, the main point is still evident; the role of Phoebe is understood differently when the translations stray from the original meaning of the word. The evidence assures us that Phoebe was a woman of importance in the early church. Although many translations have downplayed her role, she still surfaces as an active woman in early Christianity.

CONCLUSION

When researching the role of women in the early Christian tradition, one is often confronted with many pieces of evidence from which individuals could draw drastically different opinions. The greatest source of confusion when working with biblical texts is differences in translations. To combat this problem one must refer to the original manuscript and examine the historical context of the evidence.

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For Better or For Worse: The Case For Gay Marriage

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Baehr v. Levin, a state Supreme Court case in Hawaii, challenged a Hawaiian law defining marriage as limited to unions of a man and woman. The U.S. Constitution's full faith and credit clause would have made forty-nine other states recognize a new Hawaiian marriage law prior to the *Defense of Marriage Act*, and so the issue of gay marriage was thrust into the public spotlight with the speed of a runaway freight train this past year. Some have even argued that the gay marriage debate will be to the 1990's what the abortion debate was to the 1980's. While some see gay marriage as a threat to one of society's most fundamental institutions, I believe the real debate hinges on exactly what "marriage" is, who defines it and the role of marriage as both a public as well as private institution within society. This paper seeks to explore the seemingly changing definition of marriage and the issues involved in marriage's public and private realms. From there I will set up my arguments in favor of gay marriage, lay out the objections to gay marriage and then refute those objections. Extending marriage rights to gays would hardly be a threat to one of society's most fundamental institutions. Instead, recognizing marriage as a right to all couples regardless of sex would force marriage laws to take into account such issues as equality and separation of church and state and would reflect in its new definition the fact that social institutions are not carved in stone but must adapt to changing times.

At the heart of this debate is the question of what marriage is. I will outline briefly the most common-thought purposes of marriage. The state has a vested interest in the role of marriage for procreation. "A family is not an association of independent people; it is a human commitment designed to make possible the rearing of moral and healthy children. Governments care- or ought to care- about families for this reason, and scarcely any other" (Rauch 21). Others hold that marriage provides a "ready-made" caretaker in the event that one spouse becomes sick and in need of care. Marriage is also about more than the couple. It is a public declaration of commitment in which friends and families are thought to have a role (Graff 93). Last of all, marriage is a legally binding commitment for consenting adults with enforceability (unlike domestic partnership agreements).

The gay marriage question also raises questions about the role of the state in defining marriage. "There is obvious tension between the states' power to define marriage and their obligation not to interfere substantially with decisions to enter into a marital relationship" (Hohengarten 1505). Two Supreme Court cases in particular address the question of the state's role in defining marriage. In the first, *Loving v. Virginia*, Virginia's antimiscegenation statute was struck down based on the Equal Protection Clause. The Court held that, despite long-standing tradition to the contrary, the state had no right to deny the Lovings marriage based on race and that they not only had the right to marry but that it was a fundamental right.

The case of *Zablocki v. Redhail* attacked a Wisconsin statute making it illegal for a person to marry if he or she could not pay preexisting child support obligations. The Court reaffirmed the *Loving* decision that marriage is a fundamental right, and also took it a step further, defining it as a privacy right grounded in the Constitution. "Under *Zablocki*, the state's power to define the legal relationship of marriage does not encompass the power to exclude persons from it" (Hohengarten 1507). The question then becomes whether marriage as an institution excludes same-sex couples or whether it is the state which has done so arbitrarily. *Loving* puts into question whether the distinction between same-sex marriage and marriage in general is any more constitutionally (and morally) relevant than was the distinction between couples of the same race and those of differing races (1511).

Gay marriage also tears apart traditional notions about gender roles within the institution. Gay marriage is about more than homophobia; it's about the changing definition of family. Surely, if gays were to marry it would be impossible for there to be any division of labor within the marital relationship solely on the basis of sex. In this way, "hostility toward homosexuals reinforces traditional sex roles, which have worked to the great disadvantage of women" (Koppelman 23). Any person exhibiting behavior which is not deemed appropriate for their sex have for ages been subject to the accusation of being a homosexual. "Indeed, the two stigmas- sex inappropriateness and homosexuality- are almost interchangeable" (23).

I have discussed the definition of marriage: its purposes, the role of the state in defining those purposes as well as the players and roles of the players within a marriage. I now turn to the notion of marriage as both a public as well as a private institution. First, the public side of marriage. "Marriage is not something that exists apart from the law or state. Marriage is a legal relationship, entered into through a legal framework, and enforceable according to legal rules" (Hohengarten 1496). What is inherently wrong with this is that marriage has been exempt from such legal principles as equality and freedom (Ketchum 264). More specifically, marriage has been traditionally held to social contract theory contending that there is a state of nature where everyone is equal. It has been assumed by some philosophers, however, that in nature the "authority of husbands over wives is a natural authority" (Ketchum 265). There are other inconsistencies, as well. Take the issue of the economic and legal "rewards" that come with marriage. These are not general rights bestowed upon everyone, but special rights reserved for those within the marriage bond (265). In this way marriage violates the principle of equality by denying these rights to homosexuals.

Another facet to the public realm of the gay marriage debate is legal recognition in and of itself. As a people we tend only to recognize issues on a legal level that we collectively agree with on a moral level. Legal recognition is often interchangeable with moral approval (Frame 73). As always, the question becomes "whose morals"? What makes my morals any better than those of the next person and why do I have the right to impose my morals by law?

This is a good question indeed, for it deals with an institution which in some respects has been absent from the political debate due to its definition as private and hence "apolitical and uncriticizable" (Ketchum 264). However, it becomes clear that in the case of marriage the personal, or private, is also political if majoritarian views about the purpose of and players within a marriage become institutionalized into majoritarian law. It now becomes necessary to look at the role of marriage as private- that is, marriage as being about religion and love and separate from the state: or is it?

Marriage has a religious and private side as well as a legal and public one. It is here where the gay marriage debate becomes most perplexing. No one can refute that Judeo-Christian teaching not only condemns homosexuality, but that this strand of thinking has found its way into law. Just look in the Bible at Leviticus 20: 13, "If a man also lie with mankind, as he lieth with a woman, both of them have committed an abomination." As recently as *Bowers v. Hardwick* anti-sodomy laws have been upheld around the U.S. Although we recognize the principle of separation of church and state, it does not look like this in reality. However, not all faiths reject homosexuality, and many strands of faiths do perform "marriage" ceremonies. The state cannot force any religion to perform any such ceremony, but even for those that do, such ceremonies are not backed by the force of law. In any event it is hard to doubt that the very basis of our marriage law stems from Judeo-Christian teaching. It is interesting that marriage is not only seen as a right but a fundamental right (*Loving*), as well as grounded within the constitutional right to privacy (*Zablocki*), yet this right to privacy in no way encompasses homosexuals. It seems that for homosexuals, marriage is hardly a private matter at all.

I have laid out the more general issues involved in the debate over gay marriage, but I would now like to turn to the issue of gay marriage specifically. It seems as though the most common-held purposes of marriage outlined in the beginning of the paper not only apply to opposite-sex couples but also to couples of the same-sex. Surely, gay couples do raise families. If gays were allowed to marry, instant caretakers would be provided for many gay couples just as they are for straight ones. Gay marriage could also serve as both a formal declaration of commitment and as legally binding commitment if marriage rights were extended to gays. In other words, there is no purpose for marriage which has previously been outlined which would not apply to same-sex couples, just as it applies to opposite-sex couples. In this way it is not the institution of marriage in and of itself that prevents the inclusion of same-sex couples.

In arguing against gay marriage conservatives will point out that marriage is primarily for the purpose of procreation. Conservatives argue that people get married because they love one another, that this love translates into sexual attraction which in turn should translate into the rearing of children by the couple (*Commonweal 5/17/96* p6). Because they are unable to procreate, society has no vested interest in homosexual couples from the start. "Whether homosexual relationships endure is of little concern to society. That is also true of most childless marriages, harsh as it is to say" (Schiffren A21). Schiffren also argues that the economic benefits that come with marriage are in place to help couples raise children. Taking the argument one step farther, David Frum argues in "*How Far Do We Take Gay Rights?*" that in order to decrease social ills (defined as "bringing into the world children who will learn less in school, earn less at work, commit more crimes, suffer more sexual troubles, and adjust less well to society") the family needs to be promoted. "Not 'partnerships,' but marriages, between fathers and mothers, lasting for life. And any serious attempt to promote real marriage as an institution necessarily precludes- and excludes- almost every single item on the gay-rights agenda" (Frum 69). Conservatives see social ills as resulting from "fatherless" families, wherein families are defined as heterosexual in origin.

Although gays do have families, they must make use of artificial means and third parties in order to have them. Frum argues against lesbians impregnating themselves through the use of sperm banks or by any other means because the resulting child will be raised without a father. "Everything we have learned over the past two decades about the effects of fatherlessness on children screams at us to try to discourage them- or at the very least refuse to encourage them" (72). Frum views adoption in the same way. Frum continues that trying to accommodate minority lifestyles is no way to raise a family and no good reason to re-define the institution of marriage. Conservatives also question whether gay marriage will serve as a stabilizing factor as they hold that it does in heterosexual relationships. "...the argument that legal marriage will check promiscuity (by gay males) raises the question of how a piece of paper will do what the threat of AIDS has not" (Schiffren A21).

Already touched on briefly was the conservative thought that the legal and economic benefits of marriage are in place to encourage the rearing of children. Along with this train of thought is the argument that extending such rights to gay couples would be an additional burden on the federal treasury which is already strained. Also, it would be a burden on taxpayers who would be subsidizing a lifestyle that many of them don't agree with (*U.S. News and World Report* 6/3/96 p31).

Some conservatives argue that gays already do get certain economic rights through recognized "domestic partnership" agreements. They argue that domestic partnerships could serve as a substitute for marriage for gays. Some companies already recognize such domestic partnership agreements and give benefits to a gay worker's partner such as health and life insurance and leaves for paternity or maternity. Among such companies are Disney, Covington & Burling and Coors Brewing Company (Underwood and Shenitz 83).

There are also gays who are against the whole idea of marriage and would favor something looking more like a "domestic partnership" agreement. Lesbians worry what the power of the state to define their relationship would in fact do to such relationships, and about the implications of such a thing as divorce which comes with ideas already in place about the dissolution of partnerships. Some lesbians "worry about changing the fluidity of lesbian relationships, which now has no sharp knife dividing that early dance with girlfriends from the shift into a committed partnership from the notable (though not universal) lesbian habit of separating into lifelong friends" (Graff 94). Some gay men share similar opinions. The problem, they say, is with marriage itself. Gays tend to organize their lives "more like extended families than nuclear ones" (Browning *A23*). "We may love our mates one at a time, but our 'primary families' are often our ex-lovers and our ex-lovers' ex-lovers" (Browning). Browning goes on to say that marriage tends to isolate a couple which for gays would mean that extended family members become "second-class citizens." Other homosexuals contend that fighting for marriage rights would be giving into an anti-homosexual mainstream and also to an "outworn institution" (Stengel 53).

Conservatives tend to favor "domestic partnerships" over gay marriage because many say that the inclusion of gays in marriage would pose a threat to the very institution of marriage. David Frum contends that including gays in marriage would be a parody of the institution. "The harm inflicted on the prestige of marriage is likely to prove very great; the last thing an already troubled institution needs" (72). As stated before, Frum also argues that we cannot change the definition of one of society's most fundamental institutions just to accommodate a minority lifestyle.

In this light, conservatives do not disagree that our collective moral view has been influenced by religion. "Though many of us are uncomfortable using religious language to discuss social and political issues, Judeo-Christian morality informs our view of family life" (Schiffren A21). Along the same lines they argue that such thinking has produced stable environments in which to rear children for many years and that we should not tamper with such a good thing. Minority lifestyles do not seem to matter as long as majoritarian lifestyles are looked upon by the majority as having the optimum effects.

Refuting such conservative arguments as presented above does not prove to be a difficult task. First is the procreative vision of marriage. Marriage, however, is not specifically designed for procreation. Any conservative arguments which hold that it is are certainly not considering heterosexual couples who choose not to have children, elderly couples or sterile couples (Stengel 53). Yet, these couples do not have their marriage licenses taken away when there are no resulting children. In applying for a marriage license no heterosexual couple has to disclose whether or not they want or are able to have children. To do so would be a gross violation of privacy. Why then, do we withhold marriage rights to homosexuals due to their lack of ability to procreate as a couple? Here it would seem that it is not the institution of marriage which excludes same-sex couples, but the state's definition of who can participate in marriage. Some conservatives claim that it is not necessarily the ability to procreate that is important, but the fact that the couple has the correct anatomical parts to do so (*Commonweal* 6-7). However, if the state's only interest is in unions which can promote children, why are these couples allowed to marry in the first place?

Furthermore, it has been established through two Supreme Court cases in particular that "the right to be free from state interference in decisions about family is logically prior to and independent of any abstract right one might have to engage in sexual conduct (Hohengarten 1523-1524). In the first, *Bowers v. Hardwick*, the Court upheld a Georgia anti-sodomy statute, making it legal to prevent two persons of the same-sex from engaging in sodomy. However, the right to engage in sexual activity does not precede the right to marriage. "*Bowers* does not imply that the state may also prohibit two persons of the same sex from marrying each other. Engaging in same-sex sexual conduct might not be a fundamental right, but the right to marry is one. As a result, the state may not use its power to regulate same-sex sexual conduct in order to prohibit same-sex marriage" (Hohengarten 1524). In a second case, *Griswold v. Connecticut*, the Court over-ruled a Connecticut statute which prohibited a married coupled from using or getting counseling in using birth control. The Court deemed this as a violation of a married couple's privacy rights, since the state could not interfere with the couple's sexual relations because the couple was married. "...marriage was thus the precondition of the couple's sexual liberty, not vice-versa" (Hohengarten 1525).

If procreation were a precondition of marriage then it would logically follow that the inability to have children would be grounds for divorce. In New York State for example, this is clearly not the case. Under New York law there are four grounds for divorce: "cruel and inhumane treatment of the complaining spouse, abandonment for at least a year, confinement in prison during the marriage for three consecutive years, and voluntary commission of the act of adultery" (Hohengarten 1515). In looking deeper into the adultery aspect of this divorce law it becomes pertinent to ask why adultery is grounds for divorce. It could either be because the act could result in the creation of offspring outside the marital relationship or due to the resulting cruelty inflicted on the non-adultering spouse. New York law, however, recognizes as adultery acts that would result in the creation of offspring as wells as acts without procreative powers. "As grounds for divorce adultery includes sexual relations between a spouse and another person of the same sex ," so it becomes clear that it is not that adultery could result in offspring which make it grounds for divorce, but the fact that it "interferes with and undermines the intimate commitment of the married couple" (1516).

Many conservatives feel that a "family" is defined as mom, dad and offspring. They seem to gloss over the fact that gays do in fact have families, or else they counter this with the fact that gays can only have such families as the result of artificial means or third party involvement. They see gay parenting as "fatherless" (or "motherless") and think it will result in social ills. First of all, many heterosexual couples must also turn to artificial means and third parties in order to have children. Does this make the resulting child any less loved, wanted or "legitimate"? These conservatives don't seem to be attacking heterosexual couples that go to extraordinary lengths in order to have children; that's respectable and proves how wanted the resulting child is. When homosexual couples do the same things, it's no longer about love; it's a gross perversion of this conservative idea of family. Gay parenting is also not single parenting. It is not "fatherless" or "motherless." Gay marriage shatters the traditional notions about gender role stereotyping within a family. Children within these gay unions still enjoy and reap the benefits of having two parents. It's just that the roles of these two parents are not designated on the basis of sex. If anything, children within gay marriages are seeing a more egalitarian picture of marriage. There is also no evidence supporting the conservative claim that having gay parents is a detriment to a child. When adopting children we put adoptive parents through a great deal of scrutiny which is never required of biological parents. As long as homosexual couples "meet those same tests of good character, it is hard to see why their sexual orientation should be held against them" (Coyne 69). Gay marriage could also promote stability and long-term commitment in a way that "domestic partnerships cannot (*U.S. News and world Report* 6/3/96 p31).

Currently gays do not receive the legal and economic benefits of marriage which were outlined earlier in the paper. This is clearly a case where marriage runs counter to principles of equality. Cutting off same-sex couples from such benefits is discriminatory. Gays are paying into the system through taxes, but can't legally reap the rewards. Conservatives claim that it will cost a great deal more to extend these rights to gay couples, but since when can we deny groups their basic rights just because it will cost more? Also, not all of these benefits are solely to aid in the rearing of children, as Schiffren claims (putting aside for the moment the fact that gays also rear children). It is nothing more than sex discrimination to deny these benefits to gay couples. Perhaps the question that should be posed is whether or not many of these benefits should be awarded on an individual basis instead of available only through the marital relationship (Pollitt 9).

Although certain companies award such economic benefits through recognizing "domestic partnership" agreements, these agreements are not the equivalent of marriage. First of all, domestic partnerships do not have the same full legal status that marriages do. They are also not commitments which are enforceable by law, and may not be recognized universally. "Although (gay) couples may enter into an enforceable contract governing their reciprocal property rights, they may not enter into an enforceable commitment to remain together" (Hohengarten 1501). There is no substitute for marriage because the "power of marriage is not just legal but social. It seals its promise with the smiles and tears of family, friends and neighbors" (Rauch 23). It does things domestic partner laws do not. Again, by making gays conform to domestic partner laws while heterosexuals have the right to a marriage is nothing more than the "separate, but unequal" principle revisited.

Conservatives will also claim that extending marriage rights to gays would be a threat to the institution of marriage itself. How then, do Tom and Harry or Sue and Patty threaten Bob and Sally? Conservatives can't have it both ways: "accusing gays of being promiscuous and then denying them the right to incorporate into monogamous, legally recognized relationships" (Rich A19). Perhaps what conservatives most fear is the mainstreaming of homosexuality; of deconstructing homosexuality as "the other." "We draw the line when gay sexual mores imitate our own. So long as they prowl the bathhouses or parade around in drag, we are not discomforted. As incomprehensible others, they are, as it were, comprehensible: in caricature is comfort"(Coyne 66).

It seems that much of this discomfort has its base in the indoctrination of Judeo-Christian teaching which has crept into majoritarian law. We simply can't have a law based on the book of Leviticus. It is a gross violation of the principle of the separation of church and state. Since the law already encompasses this anti-gay majoritarian principle, extending marriage rights to gays is not special rights but equal rights. Homosexual couples are claiming "the same right to marry as everyone else, not a special right to marry reserved for same-sex couples" (Hohengarten 1509).

In conclusion, there is no doubt that marriage rights should be extended to same-sex couples. Just because marriage is one of the fundamental institutions of society doesn't mean that it's definition, players or roles of players can not change. We need to ask if tradition is enough in and of itself to justify the exclusion of same-sex couples. If the *Loving* case is any indication, then tradition is not enough. Marriage's role as both a public and private institution should encompass same-sex couples. On the public side same-sex couples should have a right to the legal and economic benefits of marriage since anything else is sex discrimination. Extending these rights through domestic partnership laws is not a sure thing, nor is it marriage. Privately, same-sex couples have a right to be free from institutionalized Judeo-Christian law. Just as the state cannot dictate religious principles, marriage should not be dictated by religion. Marriage needs to be recognized as having two faces with many implications and benefits that all couples should be entitled to.

WORKS CITED

Browning, Frank. "Why Marry?" The New York Times 17 Apr. 1996: A23.

Coyne, Andrew. "How Far Do We Take Gay Rights?" Saturday Night Dec. 1995: 66-69.

Frum, David. "How Far Do We Take Gay Rights?" Saturday Night Dec. 1995: 67-75.

Graff, E.J. "Something Old... Something New." Ms. Magazine May/June 1996: 92-94.

Hohengarten, William M. "Same-Sex Marriage and the Right of Privacy." Yale Law Journal 103(Apr. 1994): 1495-1531.

Ketchum, Sara Ann. "Liberalism and Marriage Law." Feminism and Philosophy. Ed. Mary Vetterling-Braggin, Frederick A. Elliston and Jane English. Totowa, New Jersey: Rowman and Littlefield, 1977. 264-276.

Koppelman, Andrew. "No Fantasy Island." The New Republic 7 Aug. 1995: 22-24.

"Marriage's True Ends." Commonweal 17 May 1996: 5-7.

Pollitt, Katha. "Gay Marriage? Don't Say I Didn't Warn You." Nation 29 Apr. 1996: 9.

Rauch, Jonathan. "For Better or Worse?" The New Republic 6 May 1996: 18-23.

Rich, Frank. "Beyond the Birdcage." The New York Times 13 Mar. 1996: A19.

Schiffren, Lisa. "Gay Marriage, an Oxymoron." The New York Times 23 Mar. 1996: A21.

"Should Gay Marriage Be Legal?" U.S. News and World Report 3 Jun. 1996: 31.

Stengel, Richard. "For Better or For Worse?" Time 3 Jun 1996: 52-53.

Underwood, Anne and Bruce Shenitz. "Do You Tom, Take Harry..." Newsweek 11 Dec. 1995: 82-84.

Zicklin, Gilbert. "Deconstructing Legal Rationality: The Case of Lesbian and Gay Family Relationships." Marriage and Family Review 21 (1995): 55-76.

The Mother-Daughter Relationship of Harriet Taylor Mill and Helen Taylor

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ABSTRACT

Harriet Taylor Mill (1807-1858) was a remarkable and intelligent woman who engaged in an intimate intellectual relationship with John Stuart Mill, co-authoring articles, chapters, and even whole books with him in the mid-1800's while married to John Taylor. Harriet had two sons and a daughter named Helen. During Helen Taylor's stage career, Harriet frequently corresponded with her daughter; based on my transcription of the 1856-1858 letters, a fresh analysis of Harriet and Helen's mother-daughter relationship can be explored. In the last century, Harriet was frequently the target of criticism grounded in patriarchal bias; however, modern psychologists and sociologists studying mother-daughter relationships have identified these patriarchal biases in order to attempt to overcome them. I apply theories of mother-daughter relationships to the correspondence between Helen and Harriet to determine whether Harriet truly deserved the criticism of being a "bad mother." Moreover, I answer the question: Was Helen able to assert her independence during her theatre years free from Harriet? Although Harriet was far from an ideal mother, her correspondence with Helen supports the conclusion that Harriet has been unfairly portrayed in critical analyses; she and her daughter did eventually unite in a truly liberated mother-daughter relationship, characterized by interdependence and the desire for one another's happiness.

BACKGROUND

Over the last century, Harriet Taylor Mill has largely been criticized or simply ignored by scholars who are only now beginning to understand her as an important collaborator in the work labeled as John Stuart Mill's as well as a source of academic interest. For instance, not only is her unique relationship with the two men in her life both interesting and controversial, but the correspondence between Harriet and her daughter, Helen Taylor, can also illuminate a study of their mother-daughter relationship during the Victorian Era. However, a biographical foundation is necessary for this study of Harriet and Helen. In effect, if a person believes that humans' actions, relationships, and decisions are affected by their environment and life experience, then general knowledge of the life of the Taylor/Mill family is invaluable as a precursor to the evaluation of Harriet Taylor Mill and Helen Taylor's mother-daughter relationship.

Harriet Hardy was born on October 8, 1807 to Dr. Thomas Hardy and Harriet (Hurst) Hardy (Mazlish 291). Most scholars agree that in 1826, Harriet married John Taylor after the arrangement was made by her father; Harriet was 18 years old at the time, whereas John Taylor was 29. However, even Carlyle, a friend of the Taylor family, called John "an innocent, *dull* good man" (qtd. in Kamm 31 - Italics mine). In truth, Harriet "had an earnest, inquiring mind, sensitive artistic and aesthetic tastes to which he could not respond" (Kamm 32). Hence, although Harriet and John truly loved each other, Harriet soon became disillusioned with her life as wife and mother of two sons, Herbert and Algernon.

Consequently, William Johnson Fox, a friend of the family, arranged for a meeting between John Stuart Mill and Harriet Taylor when she was pregnant with Helen, her third child and only daughter. After meeting John Stuart Mill, her relationship with both Johns became purely platonic for the remainder of her life. Divorces were unobtainable, but she did have the option of separation. John Taylor allowed Harriet to leave with Helen, supporting her existence in a house apart from him and enabling the continuance of Harriet's intellectual relationship with John Stuart Mill. Harriet married John Stuart Mill in 1851, approximately two years after John Taylor's death.

Although very little has been written about this remarkable woman, she published poetry, reviews, articles, and pamphlets and co-authored newspaper articles, chapters, and perhaps whole books with John Stuart Mill in the mid-1800's. Throughout Harriet's separation from John Taylor and marriage to John Stuart Mill, Helen had been her constant companion, whereas Harriet's two sons had lived primarily with their father. While in their twenties, Helen and Algernon (her second son called "Hadji") lived with Harriet Taylor Mill (HTM) and John Stuart Mill (JSM) for awhile in Blackheath Park until Helen pursued an acting career, accompanied in her travels by Hadji. At the age of fifty, after having married JSM only seven years before, Harriet died of consumption in 1858. After Harriet's death, Helen retired from the stage and returned to JSM, virtually taking over Harriet's role in JSM's life.

Although a skeleton summary of Harriet's life can be constructed with little difficulty, even Hayek, a scholar who has extensively studied HTM and JSM, concedes that "if our main aim were to reconstruct a full-scale picture of her person that task would indeed be impossible" (15). Yet, scholars have frequently criticized Harriet's actions and temperament with relation to various members of her family. For instance, critics describe Harriet as domineering, narcissistic, masochistic, spoilt, and egotistical (Pappe 28; Packe 327; Mazlish 311-2). Like Harriet's relationship with JSM, John Taylor, and her sons (Herbert and Hadji), her relationship with Helen has also been scorned, thereby degrading Harriet's mothering skills as well as her mother-daughter relationship, and labeling Harriet as egotistical, snobbish, selfish, and overbearing.

Obviously, Harriet has never been respected for her mothering skills/qualities. Scholars living 100 years after Harriet know very little about her relationship with her two sons. Granted, critics know she separated from her husband and left her two small sons mostly to his care. Nonetheless, this small piece of evidence is an inadequate foundation to base an argument that Harriet was an incompetent mother, solely responsible for her sons' failure. Furthermore, Harriet's mothering skills have not been examined thoroughly in terms of her relationship with her third child Helen. Primary source information exists in the form of letters between Helen and herself upon which an educated analysis can be made regarding Harriet's mothering abilities with regard to her daughter. I have transcribed the letters between Harriet and Helen written between 1856 and 1858 during Helen's years in the theatre. Although much of their discourse may seem mundane, the way in which the two relate to each other conveys much about their relationship.

CONCLUSIONS

One question must be addressed before approaching the theoretical issue of Harriet's mothering skills: Are there biases present in past critical analyses that might explain why Harriet has been so criticized?

A scholar researching Harriet Taylor Mill may feel that Harriet has been criticized excessively by some scholars with a sexism grounded in a patriarchal society. The work of Vivien Nice can show how patriarchal trends have led to the "mother-bashing" that Harriet has undergone and supply the evidence needed to support the charge that previous critics' assumptions are less than fair.

Nice claims that Freud as well as other "misogynist psychoanalytic theory" is a modern "remything" of the mother-daughter relationship (7). Freud's influence on the analysis of female relationships is not merely the impression of Nice. For example, Caplan also sees a problem with Freud's interpretation of mothers and daughters: "Since the time of Freud, who suggested that how people interact with women is heavily influenced by their childhood experiences with their mothers, little has been written from the standpoint of individual and interpersonal psychology about women's conflicts with other women" (v-vi). Freud prevented a complete analysis of the relationship between mothers and their adult sons and daughters because he focused on the relationship between mothers and their *small* children.

Nice discusses the distortions that result from the "remything" of mother-daughter relationships. Basically, to "remyth" is to alter or change previously existing and accepted myths, so as to convey new morals and beliefs. Although we cannot fully overcome cultural "remything," an acknowledgment of these biases will allow a more objective analysis.

We must carefully be aware of the Freudian bias when asking: Was Helen adequately able to assert her independence free from Harriet during her theatre years? and Did Harriet respond as a "good mother" should to Helen's choice of the stage as a career?

First of all, when deciding whether Harriet was a "good mother," it is important to note that an ideal mother is not only impossible to define, but also impossible to embody in reality. Caplan (vi), Nice (36), and Friday (39) agree that a problem arises when one expects a mother to be perfect and disregards her humanity. This realization about the "human-ness" of mothers is essential to the study of mothers in any era. Before passing judgment on Harriet, we must recognize her as an emotional human being with a set of experiences that no one will ever really be able to fully understand. In addition, every relationship is like a living, breathing organism.

In effect, one must address whether Harriet fostered or discouraged Helen's assertion of independence. Did Harriet encourage Helen to be overly dependent on her? Given the current state of psychological understanding, independence is seen as a healthy progression for young adults. However, did Helen's closeness to her mother throughout her life make Helen overly dependent on Harriet and unable to assert her independence? Many psychologists claim that any inability on the part of the child to disassociate from her mother stems from their relationship when the child was an infant. Virtually no information can be verified regarding Harriet and Helen's interaction when Helen was an infant. We simply know that they were inseparable throughout much of Helen's early life. Some psychologists see the later inability to disassociate completely, resulting in dependence, as immature and dangerous, although Nice recognizes that "We are using here concepts loaded with value judgments - dependency is bad (and female), independence is good (and male)" (48). In fact, only the Western culture views dependency as immature, bad, feminine, and psychologically damaging; Eastern cultures do not equate independence with maturity. The way in which Americans value dependence and independence is culturally and gender defined. Cohler and Grunebaum's analysis reflects these stereotypical gender roles; with regard to mother-daughter relationships, they say that "While childrearing and culture combine to foster a relationship between two and three generations of women within the family who feel a sense of closeness and lack of individuation not generally found among men and their fathers, this continuing closeness is not necessarily a source of psychic pain" (25). In effect, closeness is acceptable and can be helpful rather than painful. Yet, the phrases "lack of individuation" and "dependency" are used freely, attaching value judgments as well. Where do Helen and Harriet fit into this dependency spectrum?

Helen was obviously the child most dependent on Harriet after spending most of her life in a close relationship with her. Packe interprets them as "so emotionally interlocked that they might well have been twins" (384). Moreover, most scholars characterize Harriet as Eugene August does: "strong-willed, intelligent, difficult to please" (August 134). Neither Packe nor August have substantial foundation based on the primary source for their arguments. However, if August has characterized Harriet correctly, she does not seem to be someone from which it is easy to assert independence. Based on my recent transcription and evaluation of the letters, Harriet and Helen's relationship falls into a category between dependence and independence, *inter*dependence. Nice claims that the word "interdependence" fits much better into an analysis of mother-daughter relationships:

> Daughters are seen as dependent on mothers: if the daughter 'fails to separate' from her mother she will fail to develop as an adult, autonomy being equated with separation from the mother. Later in life mothers are seen as becoming dependent on their daughters. These interpretations leave no room for positive images of connectedness, interdependency and support between women and between mothers and daughters. The language, concepts and theories of patriarchy seek to erect barriers between women, and in that first female relationship between a mother and her daughter. (9)

A reexamination of the purpose and function of dependency may reveal that dependency *may* have a place in relationships as long as neither party is hurt. Moreover, Nice's theory of *interdependence* (which successfully avoids the value judgments attached to the words "dependence" and "independence") best encompasses the mother-daughter relationship of Harriet and Helen. Interdependence within their relationship is the balance between the competing needs of independence and security; this balance is different for every mother and daughter pair. When inspecting Helen and Harriet's relationship, one must remember that interdependence is not only acceptable in healthy relationships, but also that the disassociative process is not a process that occurs suddenly. "Symbiosis and the early beginnings of separation do not proceed on one long, smooth, upwardly inclined plane. There are ups and downs, of course" (Friday 38). In this way, individuals that were previously dependent on one another will not be able to achieve and assert independence overnight, rather a process of "pulling" away with independence as well as "pushing" and reverting back into dependence will occur before an equilibrium of interdependence can occur. Likewise, Helen leaves home for the first time when she pursues a career in the theatre, only to revert back into a dependent relationship with her mother at the outset. However, although Helen and Harriet seem to be in this "pulling and pushing" stage when Helen initially leaves home, they seem to progress into an interdependence equilibrium after the first crucial months. Therefore, the key question is: Who was holding on? In effect, "Do mothers keep daughters close, while daughters strive to move away? Or do they push their daughters away whilst the daughter attempts to remain close?" (Nice 58).

Perhaps a modern analogy will shed light upon Helen and Harriet's dependent then interdependent relationship, that of a college freshman leaving home for the first time. Like Harriet, the freshman (depending on the extent of her reliance on her parents) experiences new surroundings that seem to thrust independence upon her. The result, as it is in the case of Helen, is homesickness and a kind of search for the safe, dependent state of home. Letter six of Helen to Harriet illustrates how work is the only way to ease the homesickness which Helen feels: "Being away makes me feel if possible more than ever how precious you are to me. . . . I have to busy

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myself with learning and working incessantly for every minute I am not hard at work I begin to cry. . . . write me plenty when you can and only a word or two when you are tired. Good bye my precious one, although I cannot bear to stop." Indeed, Helen is still very reliant on Harriet and seeks to emotionally unite with home and her mother so as to fight off unpleasantness. In addition, like a college freshman, Helen wants to return home or arrange for her mother to meet her before she has given her new lifestyle a chance. In answer to this proposition, Harriet clearly shows that she is open to Helen's assertion of independence and her new life apart from her mother: "About what you say about coming home dearest girl it does not seem desirable to run home just for a short time and leave again directly - it would be better to come when you can stay a good time" (11). Obviously, Harriet would probably love for Helen to return home at this point, but perhaps she knows that it would be extremely difficult for Helen to go back to her life in the theatre after a short time at home. With regard to the difficult task of separation and individuation, the author of Linked Lives claims that "For most of the daughters, it is the stability of their mothers' attachment to them that allows them to go through the process of separation and develop a sense of independence" (Fischer 24). Harriet's answer to Helen parallels that of the parents of an extremely homesick child: she should not be encouraged to return home until she is comfortable with school or the second parting will be even more difficult. Although Helen reiterates her desire to come home in letter 30, Harriet remains firm in letter 33 that Helen is better off where she is. In fact, by the middle of December and throughout January, Helen's homesickness has obviously subsided and her dependence on Harriet has lessened as she begins to talk more and more about the affairs of the theatre and seems less preoccupied with home. Therefore, the letters reflect a subtle transition from dependence to more of an interdependence.

The next question that may arise is whether Harriet was too overbearing, domineering, and even passive-aggressive in her advice, or whether Harriet did, in fact, respect Helen's decisions. For example, Harriet tells Helen how often to write to her. Harriet says, "Write to me here dear twice a week" (7). Yet, although her directions initially appear to be demanding, the reader soon notices that Helen writes even more frequently than this; Harriet wasn't being demanding, but rather, was trying to *limit* Helen's writing to save her the time: "I have already said write here as often as you like, I said twice a week to save you trouble" (27). However, Harriet frequently advises Helen on other issues as well. Nonetheless, most frequently, it is *Helen* who requests the advice from Harriet. Helen seems to be asking for Harriet's approval for her decisions regarding dress and theatre parts in letters 20, 21, and 22. Helen assures Harriet, "I shall quite understand that you are not persuading me to anything but giving me your mere judgement" (21). Mostly, Helen seems to try to justify her own decisions with the advice of her mother whom she deems to be more experienced than herself in worldly issues: "You are the best judge of this and I will do whatever you tell me, but it seems to me so" (22). Harriet appears to realize her limitations in giving advice to Helen and tells her "I will answer all your questions dearest girl as well as I can: but at this distance it is not always easy to judge about details" (7). Yet, later in letter seven, Harriet makes an admirable effort to attempt to "kick her fledgling out of the nest" (to put it in colloquial terms):

> I have you see dear gone thro' your letter answering each question as well as I can but I feel the waiting very badly. I do not wish to say anything about my feelings or state because I wish you to be wholly uninfluenced by me in all your future proceedings. I would rather die than go through again your reproaches for spoiling your life. Whatever happens let your mode of life be your own free choice henceforth.

This passage seems to imply that Helen has previously scorned Harriet's intrusions and advice; in addition, Harriet sounds a bit defensive while still acknowledging that Helen needs to make the decisions for her own life. Indeed, by January, Helen has accepted responsibility for her own decision (regardless of the reason) and tells her mother, "I cannot ask your advice about things because of not getting the answer for so many days" (72).

In conclusion, the correspondence between Harriet Taylor Mill and her daughter Helen Taylor, two very important historical figures in Victorian England, provides an interesting insight into the complexity of mother-daughter relationships and interaction. Indeed, "The relationship between adult women and their own mothers is perhaps the most complex and emotionally charged of all the relationships within the family" (Cohler 24). Moreover, it may be arguable that the only person who can begin to understand and comprehend the mother-daughter relationship *is* a daughter; a daughter who has, in turn, become a mother is the only person who can *fully* understand the dynamics of this particular relationship. Nonetheless, psychological analyses of mother-daughter relationships can aid the study of the correspondence between Helen and Harriet, neither of whom is the *ideal* daughter or mother. Karen Payne, the author of a book composed of correspondence between mothers and daughters, ended her introduction by stating:

> Within each mother-daughter relationship there is a unique conflict between wanting the richest possible fulfillment for each other, longing to preserve security and needing to break the mutual dependence. Real liberation for women will perhaps only come when mothers and daughters can say wholeheartedly to each other (as Kate does in Chapter Four): I keep on wanting everything, and I want you to want that too. (xvi)

Are Harriet and Helen truly liberated within their mother-daughter relationship? In other words, do Helen and Harriet truly wish happiness for each other? They could only have achieved that state if Harriet allowed Helen to adequately assert her independence and pursue her theatre career so that they could relate in an interdependent state. After reading the letters from November 1856 to January 1857, Helen and Harriet both appear to genuinely desire each other's happiness. For instance, Harriet tells Helen, "The only way I can share in your enjoyment as you say dear is to wish you all possible happiness which I do with all my heart and to be pleased to hear of your pleasure" (11). Likewise, Helen tells her mother, "Remember dear there is nothing you can tell me which interests me so much as how you are" (21). Granted, at times they both appear to be selfish and even passive-aggressive, but their behavior is reasonable as they are not "martyrs" but rather real people dealing with a transition from a previously dependent state. Yet, Harriet's relationships with John Stuart Mill, John Taylor, Herbert Taylor, Algernon "Hadji" Taylor, and Helen Taylor have always been criticized. In particular, most scholars of Mill have denounced Harriet's mothering skills. Modern scholars are beginning to discern and overcome some of the "mother-bashing" biases of the twentieth century thus making it easier to portray and justify the true nature of Harriet's relationship with her daughter Helen. These new theoretical models of mother-daughter relationships, modern Victorian scholarship, combined with the newly transcribed letters between Harriet and Helen, reveal not a perfect mother or daughter, but rather two individuals willing to struggle to define an interdependent relationship which balanced the need for both independence and security for each.

REFERENCES

August, Eugene. John Stuart Mill: A Mind at Large. New York: Scribner's, 1975.

Caplan, Paula J. Barriers Between Women. New York: SP Medical and Scientific, 1981.

Cohler, Bertram J. and Henry U. Grunebaum. Mothers, Grandmothers, and Daughters: Personality and Childcare in Three-Generation Families. New York: Wiley, 1981.

Fischer, Lucy Rose. Linked Lives: Adult Daughters and Their Mothers. New York: Harper, 1986.

Friday, Nancy. My Mother/My Self: The Daughter's Search for Identity. New York: Delacorte, 1977.

Hayek, F. A. John Stuart Mill and Harriet Taylor: Their Friendship and Subsequent Marriage. New York: Augustus M. Kelley P, 1951.

Kamm, Josephine. John Stuart Mill in Love. London, Eng.: Gordon & Cremonesi, 1977.

Kuhl, Amy, ed. "Letters of Harriet Taylor Mill and Helen Taylor, 1856-7." Unpublished transcription, 1995.

Mazlish, Bruce. James and John Stuart Mill: Father and Son in the Nineteenth Century. New York: Basic, 1975.

Nice, Vivien E. Mothers and Daughters: The Distortion of a Relationship. New York: St. Martin's, 1992.

Packe, Michael St. John. The Life of John Stuart Mill. New York: Capricorn, 1970.

Pappe, H. O. John Stuart Mill and the Harriet Taylor Myth. London, Eng.: Cambridge UP, 1960.

Payne, Karen, ed. Introduction. Between Ourselves: Letters Between Mothers and Daughters 1750-1982. Boston: Houghton, 1983.

Pragmatic Faith in John Dewey and Fyodor Dostoevsky

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ABSTRACT

This essay explores similar religious perspectives in the work of American philosopher John Dewey and Russian novelist Fyodor Dostoevsky. Dostoevsky (1821-1881) was deeply concerned with the problems of Western rationalism, and particularly in *The Brothers Karamazov*, offers a penetrating critique of the Western tradition. Dostoevsky's Christian perspective is comparable to Dewey's pragmatic freedom. Dewey (1859-1952) argued that the Western desire for eternal truth and antecedent reality should yield before the greater goods of freedom and moral value. In Dostoevsky's polyphonic novels and Dewey's community of values lies an invigoration of moral and social thought.

INTRODUCTION

This essay offers a Deweyan account of Fyodor Dostoevsky's Christianity. I contend that the pragmatic, democratic philosophy of John Dewey is relevant to Dostoevsky's Christianity as seen through his central characters. No one denies that Dostoevsky belongs in a discussion of great literary artists; I would like to find a place for him in the history of ideas. Following Dewey's suggestion that there is no sharp, categorical division between the great novelist and the great thinker, the artist and the philosopher, I deny that the distinction holds in Dostoevsky's case. By placing his artistic development of Christian life in pragmatic perspective, I see Dostoevsky as a skillful craftsman of ideas, ideas that dramatically challenge the Western intellectual tradition. Dostoevsky's Christianity points toward and lends itself to a Deweyan religious perspective. By seeing Dostoevsky to express a pragmatic Christianity, I concur with Dewey that the artist is often best-qualified to explain the actual workings of an idea or belief, in this case, Dewey's own idea. Dostoevsky the artist and Dewey the philosopher together show us the content of pragmatic Christianity. I find a common critical perspective in the work of Dostoevsky and Dewey in my discussion of Dostoevsky's "Rebellion" and "The Grand Inquisitor" chapters in *The Brothers Karamazov*. I choose these passages because they demonstrate that Dostoevsky rejects classic Western Catholicism. Moreover, he makes an explicit connection between classical Catholicism and the philosophies of utilitarianism and socialism. I compare this connection with connection Dewey sees between the philosophies of rationalism and empiricism; he sees them united historically in a quest for certainty. Their mutual rejection of these philosophies legitimates a comparison of their positive arguments. In *The Brothers Karamazov*, Dostoevsky responds to the arguments of Ivan Karamazov by describing the Christian lifestyle of Ivan's brother Alyosha, and the teachings of Alyosha's mentor, Father Zosima. Dewey's religious faith is faith in a moral ideal, an ideal transcendent of one's culture and tradition, and realized in practice and imagination(48). I find a basic harmony between the two positions.

Since intelligence in operation in operation is the only way to secure a better world, Dewey asks that we put faith in our capability to overcome obstacles to that better world: "Religious faith which attaches itself to the possibilities of nature and associated living would with its devotion to the ideal, manifest piety toward the actual. It would not be querulous with respect to the defects and the hardships of the latter. Respect and esteem would be given to that which is the means of realization of possibilities, and to that in which the ideal is embodied if it ever finds embodiment"(*The Quest for Certainty*, 244). Dewey is arguing that in religious life, attention should fall on the method in operation("the means of realization of possibilities"), because the process of striving and achieving is the only way we can unite the actual with the ideal; *how* one achieves a religious end enables one to know what one's ideals are, and whether or not those ideals are worth pursuing.

Dostoevsky implicitly applies a similar evaluative criterion in his novels. Dostoevsky's characters speak of a "unifying idea" that shapes and orders their life. In the course of a character's development, the reader learns through the character's speech and action what that unifying idea is, and also whether that idea is viable in the face of unexpected events and moral conflicts that the character inevitably faces. Dostoevsky is a novelist of ideas, meaning simply that readers learn through the action and experience of the character, the content of an ordering principle, and whether or not this principle is adequate in the world of his novel. Thus, when critics speak of Ivan Karamazov as the embodiment of rationalism, they mean that through the actions and statements of Ivan, readers can discern a mode of action and embodiment of ideals that are consistent with what on calls "rationalism," Only through paying attention to the details of Ivan's life may the reader come to any conclusions about the value of his belief system. We must evaluate

Dostoevsky's *Christian* characters in the same way.

The comparison between Dostoevsky and Dewey is so far fruitful. but it also gives rise to important questions. How does Dostoevsky's Christianity differ from formal Western Christianity? Are Dewey's religious beliefs Christian? If so, how? Does Dostoevsky's Christianity have anything in common with Dewey's? What may we learn from this comparison? Dewey's religious faith is similar to Dostoevsky's Christianity. Obviously, Dewey's faith does not derive from the Russian Orthodox church, nor he is concerned with the Russian people. Neither does he respond specifically to the wrenching conflicts of the Slavophiles and Westernized socialists in the nineteenth century Russian life. More generally, however, Dewey *does* locate his religious faith in his traditions and in his community. In addition, his pragmatism is an explicit attempt to reconcile the protracted conflicts of religion and science. In *The Brothers Karamazov*, Dostoevsky describes a religious faith that is thoroughly a matter of practice. Ivan illustrates for us the danger of a life committed to intellectual doctrines, while the teachings of Zosima and the life of Alyosha show us the richness of a "pragmatic," or practice-oriented, Christian faith. Dewey's faith is practice-oriented in a similar way, and any attempt to ground religious faith in something more than the power of possibility he sees as superfluous, perhaps detrimental: "It is admitted that the objects of religion are ideal in contrast with our present state. What would be lost if it were admitted that they have authoritative claim upon conduct just because they are ideal?" (CF,41)

We must interpret Dewey's religious beliefs in light of his anti-reductive spirit of inclusiveness. He is committed to showing that moral faith is accessible not only to Christians but to scientists, plumbers and architects. dewey shows that people in a pluralistic community can be committed to common ideals, and that religious faith helps them realize their common ideals. Dewey defends detailed conceptions of the good life, of the right way of living, and of transcendent ideals people should pursue. Dewey's concept of faith as a mediator between the actual and the ideal allows one to be fully Christian and fully democratic and fully scientific, without reducing one to another. Thus, if Alyosha is taught in a Christian tradition, if he lives according to Christian precepts, and has faith in Christian ideals, then he is Christian, without ever having a view on the filioque doctrine or the cosmological proof or the Virgin Birth. This interpretation of Dostoevsky in light of Dewey's inclusive pragmatism is helpful.

IVAN AND THE GRAND INQUISITOR

Ivan Karamozov expresses ideas Dostoevsky felt most compelled to confront, because he offers a clear, strong, and forceful statement against Christianity. Ivan's arguments are not obviously flawed. He is a compelling figure, thoroughly versed in contemporary science and philosophy, yet deeply sensitive and humane. He cannot be dismissed either for being unrigorous or for being cold-hearted. Ivan Karamozov poses significant problems for formal Christianity.

Ivan argues that there is a fundamental contradiction between the intellectual doctrines of Christianity and Christ's moral teachings. He illustrates this fact with respect to the Catholic Church in "The Grand Inquisitor," and his own fate later in the novel is living evidence of it. The attempt by the Church to realize universal happiness on Earth culminates in the tyranny of the Inquisition, and Ivan's acceptance of the maxim, "If God does not exist, everything is permitted," leads him to complicity in his father's murder and eventual insanity.

Ivan believes it absurd and illogical that an infinitely powerful and beneficent Creator would permit human suffering, and if there is a hidden harmony in the cosmos, Ivan's conscience will not allow this harmony to explain away the terrible suffering endured by the children: "With my earthly, Euclidean understanding, all I know is that there is suffering and none are guilty; that cause follows effect, simply and directly; that everything flows and finds its level.... But then there are the children and what am I to do about them? Listen! If all must suffer to pay for eternal harmony, what have the children to do with it? It's beyond my comprehension why they should suffer and why they should have to pay for the harmony.... Too high a price is asked for harmony; it's beyond our means to pay so much.... It's not god that I don't accept, Alyosha, only I must respectfully return the ticket to Him" (238). Human suffering, Ivan says, cannot be explained away, ignored, rationalized, or reconciled with some higher system. Any acceptance of Christian doctrines about God's infinite wisdom and benevolence clashes with his desire for earthly justice. Ivan's speech confronts Alyosha with an unusual form of the problem of evil. Ivan passes over the apparent contradiction in a God whose perfection requires the suffering of innocents, and directly challenges Alyosha to *accept* God's world, appealing to Alyosha's conscience, rather than his logic: "Tell me yourself, I challenge you--answer. Imagine that you are creating a fabric of human destiny with the object of making men happy in the end, giving them peace and rest at last. Imagine that you are doing this but that it is essential and inevitable to torture to death only one tiny creature...in order to found that edifice on its unavenged tears. Would you consent to be the architect on those conditions? Tell me. Tell me the truth" (239).

Ivan's attack extends to Jesus Christ Himself in "The Grand Inquisitor" chapter. Christ came to make men free, the Inquisitor says, but the Church has worked for fifteen centuries to rid the world of this terrible gift. He contends that freedom is the source of men's greatest suffering, and Christ loved men less for allowing them their freedom. (241-243) The Grand

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Inquisitor says of Christ: "'Thou wouldst go into the world, and art going with some promise of freedom which men in their simplicity and their natural unruliness cannot even understand which they fear and dread--for nothing has ever been more insupportable for a man and a human society than freedom.'" Freedom of conscience allows humankind the choice between good and evil, and men, the natural rebels that they are, time and again choose evil. The eternal harmony, when they will be united with God in perfect happiness, has eluded humankind. The Grand Inquisitor maintains, however, that in the three temptations of Satan in the wilderness Christ had the opportunity to act once and for all for the good of humankind. The Grand Inquisitor challenges Christ, in the same way Ivan challenged Alyosha, to consider whether or not He was right to allow humankind's suffering to continue: "Judge Thyself and see who was right--Thou or he who questioned Thee then?" In miracle, mystery and authority, Satan offered Christ the powers to realize eternal harmony at once. Christ could have eliminated the material, spiritual, intellectual, and political suffering of mankind, yet He refused to do so for the sake of human freedom: "Nothing is more seductive for man than his freedom of conscience, but nothing is a greater cause of suffering. And behold, instead of giving a firm foundation for setting the conscience of man at rest forever, Thou didst choose all that is exceptional, vague and puzzling." People have been left to exercise their own judgement and have seen their judgement overwhelmed by their freedom. People live in pain and suffering. If Christ is infinitely powerful, infinitely good, and infinitely knowing, then what excuse does he have for not eliminating man's freedom, or more to the point, what excuse do men have for accepting His excuse? Only by asserting His absolute dominion, and thus his omniscience, could men avoid chaos. Still, Christ refuses. (245-251).

Ivan and the Grand Inquisitor describe a God omniscient, omnibenevolent, and omnipotent, who creates a world that will be reconciled with Him in perfect harmony and universal happiness, a world in which suffering will disappear. Free conscience, however, challenges any happiness tomorrow which is built on suffering today. The Church intercedes, using the powers of miracle, mystery and authority to eliminate freedom of conscience, the chief obstacle to the realization of universal happiness and universal harmony. Ivan and the Grand Inquisitor have driven a wedge between Christ and doctrinal Christianity and have shown that any attempted union will be contradictory and fraudulent.

Christ is an enemy of any attempt to set once and for all *the* religious truth. He is an enemy of any Church that relies on upsetting the laws of nature, on a dogmatic interpretation of the mysteries of Scripture, or on asserting God's absolute dominion. Dostoevsky and Dewey stand with Christ against doctrinal Christianity. Nevertheless, we must still answer the Grand Inquisitor's charge that tyranny is a better and more humane path to happiness than freedom, and Ivan's charge that without doctrinal Christianity's omniscient and omnipotent God, there can be only chaos and nihilism--If God doesn't exist, everything is permitted. We must keep in mind these challenges as we turn to Dostoevsky's and Dewey's positive religious beliefs.

GROUNDWORK FOR A PRAGMATIC RESPONSE

Thus far, I have explored a common attitude of Dewey and Dostoevsky regarding conventional Christianity. The Grand Inquisitor, insofar as he attempts to assert a static, eternal harmony, establish protectorate of religious truth, and impose a world unity, is supporting a doctrinal religion, but not the teachings of Christ. Dewey attacks doctrinal religion on several points. He objects, first of all, to any moral philosophy, whether Christianity, socialism, or utilitarianism, that converts faith in a moral or religious ideal into a question of assent to intellectual doctrines. "There is a difference between belief that is a conviction that some end should be supreme over conduct, and belief that some object exists as a truth for the intellect" (CF 20). Moral faith "conviction that some end should be supreme over conduct," is entirely a practical concern. As such, it asks that we devote ourselves to that end, that we struggle in the face of adversity. "Such moral faith," says Dewey, "is not easy." Unfortunately, instead of devoting their energies to the difficult task of living for a moral ideal, men like Ivan too often become embroiled in an intellectual debate. When Ivan sees clearly that the eternal harmony does not exist "in the nature of things," he abandons the struggle for a better world altogether, and abandons hope as well. Dewey's comment about followers of doctrinal religions applies to Ivan in this case: "(R)eligious devotees rarely stop to notice that what lies at the base of recurrent conflicts with scientific beliefs is not this or that doctrine so much as it is an alliance with philosophical schemes which that the reality and power of whatever is excellent and worthy of supreme devotion, depends upon proof of *its antecedent existence*, so that the ideal of perfection *loses its claim over us* unless it can be demonstrated to exist in the sense in which the sun and stars exist"(*The Quest for Certainty*, 242).

The Grand Inquisitor would have loved humanity better had he devoted himself to ways in which human happiness can actually flourish; namely in a commitment to freedom of conscience, in a commitment to universal brotherhood, in a commitment to the moral capacities of his fellow man. Instead, the Inquisitor believes that a moral ideal can only be secured in dramatic gestures, once and for all, and he ends covered in the blood of innocents. The suggestion here is that the Inquisitors' tyrannical solidarity is as bad as Ivan's nihilistic individualism. Dostoevsky and Dewey have less faith in dramatic attempts to obtain absolute certainty, and more faith in the abilities of human intelligence and human freedom to forge a middle path between two extremes. The suffering in the world is not something to be taken

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for granted or explained away. Rather, "The position of natural intelligence is that there is a mixture of good and evil, and that reconstruction *in the direction* of the good which is indicated by ideal ends, must take place, if at all, through continued cooperative effort" (CF, 47). In other words, the life worth pursuing will embrace the resources necessary for creating a better world.

Dewey is at once a democrat and a Christian. Dewey's ideal of democracy captures his moral and religious commitments deeply and comprehensively. Democracy encompasses the value of egalitarianism, instrumentalism, individuality, community--for Dewey, the moral and religious significance of democracy is unlimited. Pragmatic Christianity means nothing more nor less than following Christ; that is, it means commitment to the moral and spiritual ideals that Christ taught. The commitments to realizing individual freedom, to breaking of oppressive social bonds, to challenging and respecting the established beliefs of the community, to considering the views of others, are ideals held by Jesus Christ and Dewey *in common*. In this sense, the democratic life is also the Christian life; Dewey's religious faith is inseparable from his faith in democracy and from his faith in the possibilities of a better world: "The struggle for democracy has to be maintained on as many fronts as culture has aspects: political, economic, international, educational, scientific and artistic, religious. The fact that we now have to accomplish of set purpose what in an earlier period was more or less a gift of grace renders the problem *a moral one* to be worked out *on moral grounds*" (*Freedom and Culture*, 186). If in the Grand Inquisitor we see as clearly as anywhere the attempt to "fix religious truth once for all," then the lives of Zosima and Alyosha Karamazov provide us a prescient glimpse of "the real Christianity" continuing to grow "in wider and freer channels" ("Democracy and Christianity," 5).

FROM ZOSIMA TO ALYOSHA

Zosima and Alyosha embody the Christian ideal in practice. Their lives also demonstrate the movement of the Christian ideal through time. Father Zosima comes to Christianity through the living example of his older brother, Markel. After Markel dies, Zosima passes his experiences and teachings on to Alyosha, who, at Zosima's death, provides a living example to those around him. Although Alyosha faces an undetermined and uncertain world at the novel's close, he is firmly committed to his moral ideal, and is prepared to pass his beliefs on to the next generation of life. This picture is deeply symbolic. In it we glimpse the practical concept of Christian teachings, the relationship of a moral ideal to the actual world, and the relationship of Christians to the world in which they live. If pragmatic Christianity means anything, it means being practically committed to this moral ideal. It certainly does not entail any particular intellectual doctrine. Dostoevsky critic Roger B. Anderson states, "[Doctrinal] Christianity teaches people to seek the meaning of their lives and the world through specific theological dogmas (such as the Trinity, the virgin birth, grace, salvation, the Resurrection, etc.) But Zosima's highest valuation is the linkage to divine wisdom in all aspects of daily life. He talks of no mediating authority--canonical or institutional--as necessary for directing human reach for the transcendent"(124). Dewey contends that the mediation--the "linkage"--between our moral ideal and our actuality is made possible in our moral faith, and moral faith exists in all of our beliefs and actions. Moreover, our conviction that a moral ideal should shape our actions and our character must be strong enough to overcome practical frustrations. Similarly, Dostoevsky writes, "To transform the world, to recreate it afresh, men must turn into another path psychologically. Until you have become really, in actual fact, a brother to everyone, brotherhood will not come to pass. No sort of scientific teaching, no kind of common interest, will ever teach men to share property and privileges with equal consideration for all. [U]ntil then, we must keep the banner flying... that the great idea may not die"(BK,293). The spiritual ideal's existence depends entirely on our willingness to struggle on its behalf. Pragmatic Christians realize that their everyday actions and beliefs impact the ultimate survival of their moral ideals, a fact acknowledged by Dostoevsky in the words of Ippolit Turentiev, a character from *The Idiot*: "In scattering the seed, scattering you 'charity,' your kind deeds, you are giving away, in one form or another, part of your personality, and taking into yourself part of another; you are in mutual communion with one another, a little more attention and you will be rewarded with the knowledge of the most unexpected discoveries. All your thoughts, all the seeds scattered by you, perhaps forgotten by you, will grow up and take form. And how can you tell what part you may have in future determination of the destinies of humanity? If this knowledge and a whole lifetime of this work should make you at last able to sow some mighty seed, to bequeath the world some mighty thought, then...[as his voice trails off]"(392).

Although death comes to individual Christians, the Christian ideal lives on in the lives of others. Zosima draws his religious faith from the consuming and transcendent power of his relationship with the world--with the rhythms of nature, with those in his community, with those that came before, and with those yet to come. Thus, people who interpret the rapid decomposition of Zosima's body after his death misunderstand his Christian message. The monastery expects miracles at his death, and finding none, deem his message illegitimate and blasphemous. However, "Those hoping for miracles would have nature's rhythm subordinated to their own static measurements of predictability and proof. They deem unseemly the very heart of Zosima's vision of faith--the decomposition of one life from which new forms in the next generation might grow.... Zosima insists that people gain spiritual faith by yielding their individuality to the sacred processes of nature, not by demanding that nature gear down to their personal systems of temporal expectations" (Anderson, 128).

When Alyosha is struggling to overcome doubts and questions about his faith in the wake of Zosima's death, he has a mystical religious experience which firmly renews his moral faith. In it, Zosima appears and tells Alyosha, "Do no fear Him. He is terrible in his greatness, awful in His sublimity, but infinitely merciful. He has made himself unto us from love and rejoices with us. He is expecting new guests, He is calling new ones forever and ever" (BK, 348). Alyosha interprets this vision to mean that although Christ was destined to suffer terribly and die a painful death, he participated fully in life and His message continues to live. Alyosha's vision inspires in him a transcendent, mystical unification with the universe. He has been, as Dewey puts it, "conquered and vanquished" by the power of the Christian ideal (CF,20): "[W]ith every instant he felt clearly and, as it were, tangibly, that something firm and unshakable as that vault of heaven had entered his soul. It was as though some idea had seized the sovereignty of his mind--and it was for all his life and forever and ever" (BK, 349).

PRAGMATIC RELIGIOUS FAITH

Pragmatic religious faith centers on here and now. In Zosima's teachings, there is no speculation of the afterlife, no discussion of a supernatural heaven. Although he is a monk, Zosima does not cloister himself away and wait for the secular world to pass. On the contrary, he instructs Alyosha and his followers to engage the secular world. Zosima wishes anything but that Christians be removed from either the natural world or their membership in their moral community. When discussing pragmatic religious faith, considerations of our natural environment and our moral community are fundamental. Dewey argues that moral and religious ideals cannot be viewed apart from the context in which they are imagined and realized; our environment forms "the matrix within which our ideal aspirations are born and bred" (CF, 85). Faith, which serves as mediator between the actual and ideal, can neglect neither. Without religious faith, Dostoevsky's characters fail in their quest for inner harmony. Andrew MacAndrew tells us that, "Without that unifying idea, there can be no harmony between man and the world around him; nor, whatever he may do, can he have any harmony, which Dostoevsky calls 'beauty' (blagoobrazie). And without it, a man is only a haphazard sequence of unsynthesized impulses and reactions, instinctively searching for a substitute unifying principle. That substitute will most likely be an idol, a false god, a delusion of faith, or perhaps an obsessive passion. But whatever it is, the result will be a whole built around a false principle, a forcibly synthesized and therefore ugly and unstable identity" (xxii). We witness the contrast in *The Brothers Karamozov* between the nihilistic and tyrannical moral lives of Ivan and The Grand Inquisitor and the healthy vital dispositions of Alyosha and Father Zosima. Dostoevsky's novels are filled with moral traps and dilemmas and very few characters grasp moral beauty. Those that do, Dostoevsky's Christians, put their faith in the rich moral possibilities of the Russian earth and moral community, rather than contradictory and unnatural doctrines.

Dewey holds that religious faith "that is devoted to creation of a future, instead of staking itself on propositions about the past, is invincible" (*The Quest for Certainty*, 243). Dostoevsky silently concurs, in the words of Zosima to Alyosha: "You are working for the whole, you are acting for the future. Seek no reward, for great is your reward on this earth: the spiritual joy which is only vouchsafed to the righteous" (BK, 312). If the moral prophets are always poets, (*Art as Experience*, 350), then in *The Brothers Karamozov*, Dostoevsky is the moral prophet of Dewey's pragmatic religious faith.

WORKS CITED

Anderson, Roger B. *Dostoevsky: Myths of Duality*. Gainesville: University of Florida Press, 1986.

Dewey, John. *Art as Experience: The Later Works, 1925-1953*. Ed. Jo Ann Boydston. Vol.10. Carbondale: Southern Illinois University Press, 1987.

---. "Christianity and Democracy." *The Early Works, 1882-1898*. Ed. Jo Ann Boydston. Vol.4. Carbondale: Southern Illinois Press, 1971.

---. *A Common Faith*. New Haven: Yale University Press, 1934.

---. *Freedom and Culture: The Later Works, 1925-1953*. Ed. Jo Ann Boydston. Vol.13. Carbondale: Southern Illinois Press, 1988.

---. *The Quest for Certainty: The Later Works, 1925-1953*. Ed. Jo Ann Boydston. Vol.4. Carbondale: Southern Illinois University Press, 1988.

Dostoevsky, Fyodor. *The Brothers Karamazov*. Trans. Constance Garnett. New York: Penguin Books, Inc., 1986.

---. *The Idiot*. Trans. Constance Garnett. New York: Bantam Books, 1981.

MacAndrew, Andrew. Introduction. *The Adolescent*. By Fyodor Dostoevsky. Trans. Andrew MacAndrew. New York: W.W. Norton & Company, 1971.

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Epistemological Conditions:
How PlatoAnticipates Gettier

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> *"European philosophical tradition... consists of a series of footnotes to Plato"*
> (Whitehead)

In 1963 Edmund Gettier published an article entitled, Is Justified True Belief Knowledge? With two very concise counterexamples, Gettier brilliantly exposed the shortcomings of the accepted definition of knowledge. This definition had been held since the philosophy of Plato. The accepted epistemological conditions stated that knowledge can be owned, if and only if, the thinker has a belief, which is justifiable and, true. Plato's dialectical Theaetetus is excellent example of an ancient piece of philosophical inquiry into epistemology, and adheres to the common Socratic dialectical method of teaching. It is Plato's record of a conversion between Socrates and the young Theaetetus. Plato leads the reader through the problems facing our ability to make claims of truth. Although Plato is credited with the inception of the long held epistemological conditions, we will see that he recognized it's incompleteness. Nevertheless, the justified true belief criteria had served as the sufficient condition for a knowledge claim throughout the history of epistemology. I will set out here to explicate how Plato's dialogue anticipated Gettier's observations. The initial ideas that obtain concrete relevance in Gettier's article can be found in the Theaetetus. Gettier's analytic style of two brief but crucial counterexamples forever changed our view of an acceptable knowledge condition.

Justification is critical to the traditional definition of knowledge within any theory of truth. For example we may, by chance, believe an idea that is true, while having no justification for doing so. For example, before the discovery of microbes, people believed that the coughing, feverish and delirious person was suffering a fate caused by an angry God unleashing unspeakable demons upon the impious. Those who believed (without justification) in tiny corporeal creatures invading our body cannot be said to have had knowledge of microbiology. Justification has historically demonstrated the necessary evidence for believing the proposition. The reason that today we hold microbiology to be an example of true knowledge is that scientists convincingly verified their belief in believing in microscopic organisms.

We can observe this appeal to justification in Plato's Theaetetus where he indicates in Sec. 201 that true belief is influenced by persuasion. True knowledge, on the contrary, is produced through instruction and is always accompanied by an accurate account (Cornford 141). A famous historian of philosophy, Frederick Copleston, adds that Theaetetus suggests the addition of an "'account' of an explanation would convert true belief into knowledge" (147).

By an 'account' Socrates takes Theaetetus to mean one of three things: verbal expression, the reduction into elemental parts, or the noting of differentiation. Socrates analyzes each of these possible interpretations. A true belief can be expressed with words as easily as knowledge can be expressed. This meaning of 'account' as mere articulation adds nothing to our analysis. Reducing the true belief to its knowable parts also does little to solve our dilemma. The pure memorization of the steps to a geometric proof does not equate with a mathematician's knowledge of the theory. The mere reduction of a truth claim to its parts does not transform it into knowledge. Thirdly, Socrates notes that if a true belief of some proposition can be made into knowledge by the addition of a differentiating characteristic we engage in circularity. The problem is that if my true belief did not *already* contain this differentiating characteristic it would not constitute a distinct true belief (Copleston 147-8).

Continuing in the Theaetetus, the question of how a person can form false opinion is raised. Epistemologists typically confine their work to the beliefs that must necessarily be either true or false. Knowledge, by definition, is limited to the set of true beliefs only. Socrates and Theaetetus limit their discussion to those things that exist. It is further agreed, by the characters Socrates and Theaetetus, that non-existence equates with falsehood. Thoughts of non-existent things are not thoughts at all. With this in mind, both Socrates and Theaetetus concur that false opinion results when, "any one thinks one thing as another..."(Plato 53). This construct, however, contains flaws, as Plato demonstrates. We do not confuse one correct idea for another correct idea when reasoning. We do not believe the "unjust just." We also do not "persuade [ourselves] that an ox is a horse, or that two are one" (Plato 53).

Socrates rules out the following possible cases of confusion: (1) One knows both things (A and B) but neither sees nor perceives A or B, therefore he cannot mistake A for B, (2) one knows A but not B (or vice versa), but perceives neither, and so cannot confuse the two, or finally (3) one does not know, and does not perceive A and B, obviously no confusion can occur of such non-existent thoughts. For in 193 c of the dialogue, the analogy of the foot in the wrong shoe is used to explain this error. The true knowledge exists, in keeping with Plato's representational theory of the world, on a waxen tablet analogous to the soul. Error occurs only when the true impression on the tablet is matched up with the wrong perception.

> Socrates. *"When, therefore, perception is present to one of the seals or impressions but not to the other, and the mind fits the seal of the absent perception on the one which is present, in any case of this sort the mind is deceived..."*(Plato 55)

Turning our attention to the 1963 essay by Edmund Gettier, the author begins his essay with the logical schema of what has previously constituted the necessary and sufficient conditions for knowing. His first form is, not coincidentally, footnoted to Plato's Theaetetus:

S knows that P
IFF
(i) *P is true*
(ii) *S believes that P, and*
(iii) *S is justified in believing that P.*
(Gettier 273)

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A summary of the first counterexample is that Smith and Jones have applied for the same job. Smith has strong evidence for believing that Jones has ten coins in his pocket, and that Jones will get the job. Smith's evidence might be that he has on good advice that Jones will get the job, and Smith himself counted ten coins in Jones's pocket. The entailment of Smith's belief is that the person who will get the job has ten coins in his pocket. It turns out to be true that the person who gets the job has ten coins in his pocket, but that person is Smith and not Jones. Smith was unaware that he, too, had ten coins in his pocket. Therefore Smith was justified in believing that the person who would get the job had ten coins in his pocket, but did not *know* this to be true. Smith had true belief, and justification for it, but in fact did not possess knowledge (Gettier 273-74).

This first counterexample Gettier put forth is of the type of deception that takes place in one's mind as expounded above by Plato. The '*perception*' that the person who gets the job will have ten coins in his pocket is analogous to Gettier's "*is justified in believing that...*" The absent perception here is that Smith himself has ten coins in his pocket. As Gettier puts it, "...unknown to Smith, he himself has ten coins in his pocket." The falsification occurs in that the, "Mind fits the seal of the absent perception [Smith's own ten coins] on the one which is present [Jones's ten coins]." Smith has put the 'foot in the wrong shoe.

The second of Gettier's counterexample is a logical disjunction. In a disjunction (an A *or* B statement) the entire proposition is true if either A or B is true. The compound proposition; It is cold outside or it is sunny, is true if either (or both) it is cold *or* it is sunny. The second Gettier counterexample starts with the proposition, "Jones owns a Ford." Smith has strong evidence for believing the proposition, since he has always seen Jones driving the Ford and has even seen the title of ownership for the car. By disjunction, this statement, in combination with a statement about Brown's whereabouts, will be true if our first proposition (Jones owns a Ford) remains true. Whether Jones is in Boston, Barcelona, or Brest-Litovisk will not affect the truth condition of a disjunction that contains a true first premise. In this case, the truth value of Brown's location does not affect the compound proposition's truth.

As a demonstration of a false claim to knowledge the following scenario is enacted, Jones does not own a Ford, but Smith is in Barcelona. Following the above stated rules of a logical disjunction, this statement is clearly true. The second half of the compound proposition (Smith is in Barcelona) is true-- making the disjunction true. The epistemological problem is that Smith believed the statement and had justification for doing so (Jones owns a Ford). Smith, however, did not have knowledge of the statement since he believed it for the wrong reason (Gettier 274).

Gettier in clear analytical form has demonstrated the shortcomings of what had widely been held a universal definition of true knowledge. But, what is often overlooked is that Plato himself was aware that it was insufficient. In summarizing the dialogue with Theaetetus, Plato quotes Socrates as saying, "...how utterly foolish, when we are asking what is knowledge, that the reply should only be, right opinion with knowledge...knowledge is [not]...definition and explanation accompanying and added to true opinion" (63).

I believe that a philosopher asserting the strengths of the Socratic dialectical teaching method must reconsider the value of this method in the light of this comparison. Although Plato recognized that the definition, which Socrates and Theaetetus arrived at, was incomplete he apparently failed to convey this as well as the his modern philosophical counterpart. For the most part, only with the appearance of Gettier's article has this Pandora's box been reopened.

Socrates commends his young pupil, "But if, Theaetetus you should ever conceive afresh, you will be all the better for the present investigation." Perhaps anticipating Gettier he adds "you...will be too modest to fancy that you know what you do not know" (Plato 63). In the more than thirty years of reinvestigation into our study of epistemological necessary and sufficient conditions we are still left searching. As Plato admits, "These are the limits of my art" (63).

Copleston, Frederick. A History of Philosophy, Vol 1: Greek and Rome. New York: Doubleday, 1993.

Cornford, Francis Macdonald. Plato's Theory of Knowledge. London: Routledge & Kegan Paul Ltd., 1957.

Gettier, Edmund. "Is Justified True Belief Knowledge?" Human Knowledge: Classical and Contemporary Approaches. Eds. Moser & vander Nat. New York: Oxford, 1995

Moser, Paul K., & vander Nat, Arnold. Human Knowledge: Classical and Contemporary Approaches. New York: Oxford, 1995.

Plato. "Theaetetus" Human Knowledge: Classical and Contemporary Approaches. Eds. Moser & vander Nat. New York: Oxford, 1995

Pollock, John. "The Gettier Problem" Human Knowledge: Classical and Contemporary Approaches. Eds. Moser & vander Nat. New York: Oxford, 1995

Whitehead, Alfred North. Science and the Modern World. Lowell Institute Lecture of 1925. New York: MacMillan, 1925.

ADVERSITY AND SACRIFICES: THE EXAMINATION OF TWO LIVES

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Abstract

Adversity can develop character, and character enables those who have overcome adversity to make contributions to society. The focus of this study is based on two prominent individuals who have made contributions to scholarship and career. These individuals exemplified the translation of intentions into reality and sustained reality in making a difference to our society. The research methodology used in examining these two lives are prosopographical case studies and combinations of history and biography, beginning from the Summer of 1994 to the present. An interview with The New York Times was conducted on October 16, 1996 for an understanding of that newspaper's methodology as well as background information on the early public lives of these two individuals before they died. Anyone reading the history of these individuals will readily discover their focus on education and career. Each of them prevailed through adversity and sacrifices even when their intentions were scorned.

INTRODUCTION

I became interested in this study in the Summer of 1994 when University Distinguished Professor Harriette Pipes McAdoo supervised my work in the McNair Scholars program. Part of my assignment was to read The New York Times everyday to look for articles relating to teen pregnancy. One day, I could not find anything on that subject, so I turned to the obituary section of The New York Times and read the obituary of Felice Schwartz, that changed my life in two ways: first, the obituary took almost one page of The New York Times, and her live was detailed to the extend that I learned all I could possible know about her work, attitude and endurance. Secondly, Schwartz overcame her critics and dedicated her life to helping women choose and advance their careers. Schwartz perseverance is what changed my thinking.

RESEARCH METHODS

This study used prosopographical case studies and combinations of history and biography, beginning from the Summer of 1994 to the present. Prosopography means a study that identifies and relates to a group of persons or characters within a particular historical or literary context. Visit to the Julian Samora's Institute at Michigan State University on November 8, 1996. Reading of works published by the individuals themselves. The essay format is used to present the lives of these people in order to facilitate making historical knowledge available to a wider audience.

RESEARCH FRAMEWORK

Abraham Maslow and other humanistic psychologists see the goal of life as that of using it to accomplish something in which one believes(Thomas, 1995, p. 347). In examining the lives of these two individuals, I read "The Farther Reaches of Human Nature" by Abraham Maslow, "In a Different Voice" by Carol Gilligan, and "The Winner's Edge by Dennis Waitley. "Reviving Ophelia" by Mary Pipher. In addition, I read R. Murray Thomas's critic of the theory of humanistic psychology. My readings revealed that humanistic psychology is marked by the centering of attention on the person and a focus on experience as the primary phenomenon in the study of individuals. Emphasis is placed on such distinctively human qualities as choice, creativity, valuation, and self-realization, as opposed to thinking about human beings in mechanistic and reductionist terms. The overall view of humanistic psychology in my opinion is based on the person as he or she discovers his own being and relates to other persons and to society. I will integrate the various humanistic themes noted above as they relate to these individuals in my discussion.

INTERVIEW WITH The New York Times

After collecting data on two lives from The New York Times obituaries, I began to question myself on how The New York Times obtained all its information on the personal lives of these people. Therefore, on October 16, 1996, I called The New York Times. The operator put me through to Pany King, the Newsroom Editor of the Obituary section. My call revealed two things: first, there is the commercial obituary section where individuals call and pay to announce the death of their relatives. However, the operator informed me that she is putting my call through to the news division of the obituary section and that families do not pay if the deceased is considered newsworthy. This information was given voluntarily. This was an eye opener for me. I assumed that you had to be prominent to make The New York Times obituary section. When King answered the phone, I nervously introduced myself and became aware that what I am doing was unusual. Perhaps, only people reporting death call that line.

First, I discussed with King the reason for calling. My first question was: What is the criteria for selecting who is newsworthy for The New York Times obituary story? Secondly, I enquired how The New York Times gathered all the public and personal information on the lives of these individuals. King was very accommodating and made one request: she will answer my questions as long as I was prepared to be put on hold from time to time. The phones in the obituary news room is constantly ringing. King put me on hold four times before our interview came to a conclusion. What surprised me the most was the ease with which she spoke to me and her willingness to elaborate.

King stated that The New York Times receives information about the death of individuals through the funeral homes and the families of the people who died. The information is passed on to several editors to make a decision whether to assign a reporter to cover the death.

The next step is to look through the New York Times log and see if that person has been written about previously in The New York Times. After this process, if the individual is approved, a reporter is assigned to research and write a news story. The reporter will interview family, friends, and colleagues of the deceased to verify the authenticity of the information. A government data base is checked for additional information. As King spoke the phone rang again and she said to me that usually she will not spend so much time with one person on the phone, because she is very busy. In closing, she stated that the obituary news is not limited to the United States citizens only. The New York Times covers the death of prominent people world wide, as long as they are newsworthy. I thanked her and hung up.

PERSONAL MOTIVATIONS

It is important for me to state that I was influenced to do this study because of my daily interactions with undergraduate and graduate students at Michigan State University. The issues raised in this paper cut across race, ethnicity, gender, and class. The issues confronted are everyday issues. Personally, I am fascinated by people who have succeeded against all odds. Probably you yourself have confronted and overcome some of the challenges outlined in this paper. Moreover, your child, grandchild, great-grandchild, relatives and friends may one day confront some of the issues discussed in this paper. It is my intent that the lives of these two individuals will serve as a reference point for college students and the general public. It helps when people realize that their experiences, good or bad, have been lived through by people before them.

THE TWO LIVES: JULIAN SAMORA & FELICE SCHWARTZ

Julian Samora was the first recognized Mexican-American sociologist and a leader in founding the academic movement for Mexican-American studies. Julian was born in 1920 at southern

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Colorado. He earned his bachelor's degree from Adams State College, a Master's degree from Colorado State University and a doctorate from Washington University in St. Louis. When Samora earned his doctorate in 1953, he became the first Mexican-American known to have received a doctorate in sociology and anthropology, a distinction that is generally hedged by the observation that if there had been any earlier Mexican-Americans who earned a doctorate in sociology, they made it a point to hide their ethnic heritage. Samora felt his entire career according to him had been fueled by anger, and pursued to prove that he was equal.

When his family was living in southern Colorado, he found it difficult as a child to walk through his hometown and find a sign at the entrance to the public park that read: "No Mexicans, Indians or Dogs." It did not help his frame of mind when he was forced to repeat the first grade because he spoke only Spanish, or when the entire cast of a high school play walked out after he was assigned a leading role. Again he lost a campaign for student body president at Adams State College by one vote, with his own roommate refusing to vote for a Mexican-American. Because of all these experiences Samora decided to use scholarship as a tool to combat prejudice and to improve the lot of his fellow Mexican-Americans. By using scholarship to combat prejudice Samora can be characterized with the humanistic theme of choice and self-realization. He made the choice to go to school and in the process realized that he could improve the lives of his fellow Mexican-Americans. By most measures he succeeded in his goal.

First Samora produced a torrent of research papers focused on Mexican-Americans. One of his early studies traced the different levels of hospital treatment received by Mexican-Americans and other Americans to the Chicano culture's preference for traditional remedies. Samora explored the correlation between ethnicity and the delivery of health services. The above study has been credited with helping to establish medical sociology as an independent discipline. Later, his professional efforts focused on making the dominant society aware of the national importance of Spanish-speaking people through his articles, reports, and books, including the "National Study of the Spanish Speaking People" for the U.S. Commission on Civil Rights. Samora taught at Michigan State University in 1957. Two years later he received a tenured position as professor of sociology at the University of Notre Dame. He turned Notre Dame into a magnet for Mexican-American graduate students, many of whom received doctorates and went on to high academic positions in Mexican-American studies programs that proliferated in the wake of Samora's success.

Using a series of Ford Foundation grants, he helped found the National Council of La Raza, widely regarded as the leading Mexican-American civil rights organization, and engaged in well-publicized research into the cultural links across the United State-Mexican border. Samora had a significant impact both in spotlighting and reducing the social barriers faced by Chicanos. His most influential work was often on a more personal level, whether serving as a distant role model for younger Mexican-American scholars, or in face-to-face encounter at academic conferences or at Notre Dame. He and his wife, Betty, turned their home into a Mexican-American student center.
It was a tribute to Samora's success that after his retirement in 1985 from Notre Dame, Michigan State University created the Julian Samora Research Institute in his honor to continue and expand his pioneering research into the Chicano experience in the midwest.

I personally visited Samora's center at Michigan State University on November 8, 1996. The center is located at the Paolucci Building, room 112. As I opened the door the first thing I saw was Samora's picture hanging at the wall, under the picture is a medium size book case with numerous articles and books written by Samora and about him. I was greeted by Rosemary Aponte, Assistant Director for Administration of Julian Samora Institute and Visha Samy, Administrative Assistant to the center. Aponte and Samy were excited that someone is interested in writing about Samora. I was allowed to look inside the bookcase and go through the pile of materials. The staff offered to copy any article that I was interested in using for my project. One article that I found inside the book case was titled "Remembering the Contributions of One Whose Journey Has Been Our Heritage" written by Refugio I. Rochin, professor and director Julian Samora Research Institute. This article was a tribute to the legacy of Samora. Rochin wrote, "Although Dr. Samora has left us, his memory and his legacy live on, testaments to the measure of the man."

The interactions between Aponte, Samy, and me was useful in the sense that I could relate to the impact Samora made in the lives of people who knew him. As I walked out the door, a thought struck me: Samora is an institution! Julian Samora died on February 2, 1996. His wife died 10 years ago. He was survived by a daughter Carmen, of Albuquerque; three sons, John of Denver, David of Sants Fe, N.M., and Jeff of South Bend and three grandchildren at the time of his death.

FELICE N SCHWARTZ

Felice Schwartz was the founder of Catalyst, a national organization that was dedicated to helping women choose and advance careers. The organization later promoted the participation of women in corporations and their recruitment on corporate board. Felice Schwartz was born in 1925 in New York. Schwartz attended Smith College and became involved in social causes while an undergraduate student at Smith College. In 1945, she founded the National Scholarship Service and Fund for Negro Students. The organization lobbied colleges and universities to open their doors to minority women. Schwartz helped in providing financial aid for college bound African-American women.

In 1946, Schwartz was married to Irving L. Schwartz, a scientist, educator and physician. They had three children. During the early years of her marriage, Schwartz and her husband had commuter marriage. The family first moved to Cincinnati where her husband had been offered a post at a medical school. However, Schwartz who was planning a new organization returned to New York with her three children to launch "Catalyst." As a result, her husband spent the next two years flying back and forth on weekends to New York. Schwartz return to New York to launch "Catalyst" is an example of the humanistic theory of choice, creativity, valuation, self-realization and society. For example, Schwartz realized that women still had a hard time balancing work and family. She took the initiative to find ways of helping women and men realize the difficulties women faced in their lives.

Catalyst pioneered several job-sharing pilot projects in which two women shared a full-time job. The organization undertook studies on family issues in the work place. Mrs Schwartz wrote "How to Go to Work When Your Husband Is Against It, Your Children Aren't Old Enough and There's Nothing You Can Do Anyhow." A second book, "Breaking With Tradition: Women and Work, the New Facts of Life, was published in 1992. In 1989 Schwartz prompted a national debate with an article she wrote that was published in the Harvard Business Review. The article asserted that it cost companies more to employ women than men. She noted in the article that women's careers were often interrupted, or ended when they had children and suggested that employers create policies to help mothers balance career and family responsibilities. Schwartz called for more flexibility in work hours and providing day care for working women with young children.

An uproar began immediately after her article was published. Her proposed alternative career track came to be called the "mommy track." Critics voiced the fear that by raising the higher cost issue, women would not be hired and promoted. That women would be left with the primary responsibility for child care. In response to her critics, Schwartz said her views were widely misinterpreted. In an interview with the Boston Globe in 1992, she said that she violated the politically correct thing by saying that women are not just like men. What she was saying then and still is saying now is that women face many, many obstacles in the work place that men do not face. Schwartz was saying to that group of men at the top, rather than let women's talents go to waste, do something about it.

Despite the adversity, Schwartz continued to emphasize a parent track because according to her, when a woman is faced with doing all the housework, all the child care and full-time work, she is stunted. The same applies to men. In my effort to understand how being stunted applies to men, I read "The Second Shift" by Arlie Hochschild. Hochschild's book was the first groundbreaking study on the dilemma of the working mother. What I found on page 260 of "The Second Shift," is that the most important injury to women who work the double day is not the fact they work too long or get too tired. The deeper problem women face according to Hochschild is that they cannot afford the luxury of unambivalent love for their husbands who do not help them do housework. That many women carry into their marriage the distasteful and unwieldy burden of resenting their husbands.

Schwartz remained the president of Catalyst for 30 years. She retired in 1993 and died on February 8, 1996 at the age of 71. She was survived by her husband; a daughter, Cassie Arnold of Washington; two sons, Tony Schwartz of New York City and James Schwartz of Boston; a brother, Theodore Nierenberg of Armonk, New York, and five grandchildren at the time she died.

CONCLUSION

Anyone reading this paper will readily discover that the experiences of these two lives are significant. This study is similar to Denise Waitley's study which was published in 1980 and republished in 1983. Waitley in his book "The Winner's Edge" stated that self-dimension action includes making a contribution to something or someone for which there is no direct payoff or obligation. This study supports Waitley's and Gilligan's conclusions that adversity can develop character, and character enables those who have overcome adversity to make contributions to society. The implications of this study is that adversity may be a destroyer, yet these two individuals survived and did not give up. The younger generation has to learn about the past experiences of the people who prevailed against all odds. Not much has changed from the experiences of these two extraordinary people. Teenagers and college students who find themselves in a hole, can be inspired by the different experiences of these people. To you, I say, do not give up!

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REFERENCES

Gilligan, C. (1982) "In a Different Voice" Harvard University Press, Cambridge, p. 126.

Hochschild, A.R. (1989) "The Second Shift" Avon Books, p. 260.

King, Pany. (1996) Interview, October 16.

Maslow, A.H. (1972) "The Farther Reaches of Human Nature" Viking Compas Edition.

Pipher, M. (1994) "Reviving Ophelia" G.P. Putnam's Sons, p. 281.

Samora, J. (1996) "Julian Samora, 75, a Pioneering Sociologist" The New York Times February 6, p. B11.

Samora, J. (1996) Visit to Samora's Institute November 8.

Samora, J. (1996) "Remembering The Contributions of One Whose Journey Has Been Our Heritage" Julian Samora Research Institute Newsletter, February 2, 1996.

Schwartz, F. N. (1996) "Felice N. Schwartz, 71 Dies; Working Women's Champion" The New York Times February 10, p. 34.

Schwartz, F.N. (1989) "Management Women and the New Facts of Life" The Bureau of National Affairs, Inc.

Thomas, R.M. (19[illegible]5) "Comparing Theories of Child Development. Brooks/Cole Publishing Company. p. 345 and 347.

Waitley, D. (1983) "The Winner's Edge" The Berkley Publishing.

The Acquisition of Knowledge According to The Theory of Jean Piaget

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Even though historically the United States ranked first in education, presently it is experiencing decline, dropping to fourteenth in mathematics assessment and fifteenth in science assessment with Taiwan and South Korea, both third world countries, among the countries that outrank us (US Department of Education 231-233). Since today's students will be the leaders in industry in the subsequent generation, a concern arises that the economy of the U.S. could begin to decline reflecting our educational ranking.

In order to improve learning, it is necessary to understand how students learn, not just what they should learn. Having opened and operated a school for six years, my experience from the students that came to my school from other unsuccessful learning experiences at other institutions pointed to a need for another way of teaching, to which the global rankings also point.

Presently, the pedagogy of most educators is based on the behaviorist model, (Wadsworth 4) built on the theories of Ivan Pavlov, B. F. Skinner, E. L. Thorndike, and other influential behavioral psychologists. This theory contends that acquisition of knowledge is governed by external stimuli and conditioning techniques, biological or mental maturation, or development, is given little consideration. The learning techniques of the behaviorist theory involve giving the student an immediate reinforcement to his or her response to the stimuli presented in the form of a question. "Each student proceeds through the sequence of material at his or her pace, and each is reinforced or corrected after every response" (Smith & Smith 152).

The present educational system is also based on the mimetic behaviorist approach to education. That is, the teacher transfers the written or spoken word to the student resulting in learning by the student. When he or she does not learn, the fault is usually attributed to the student. The traditional or empiricists' position is that motivation is a result of reinforcement.

Piaget maintains that if one browses through the history of education books, one of the most apparent paradoxes is that those who were innovators in the field were not educators. The innovators came from various camps, such as Comenius who was trained to be a theologian and philosopher. Rousseau had children but held no classes, Froebel was a chemist and philosopher, Herbart was a psychologist and philosopher, Dewey was a philosopher, and Mme. Montessori, Decroly, and Claparede were medical doctors, with the latter two psychologists as well. He asked the question, "So why is pedagogy so little the work of pedagogues?" (qtd. in Gruber and Voneche 699). To which he answers, "The truth is that the profession of educator has not yet attained, in our societies, the normal status to which it has the right in the scale of intellectual values. . . . What the schoolteacher lacks . . . is comparable intellectual prestige (qtd. in Gruber and Voneche 699). Piaget believes that it is unfortunate that a teacher who is well thought of is one who does what is expected and has usually learned a few formulas that enable the student to believe that he or she is being educated. According to Gruber and Voneche (1995), this status quo mentality contributes to the unfortunate status of educators and education.

> Probably the best thing that each group of teachers can do is to invent the approach that fits their situation. Piaget's remark, that only by reinventing a theory can the child understand it, applies equally well to all adults. If the teacher is to understand what he is doing, he must invent it, he can neither invent it well nor understand it if he does not understand the child. What Piaget has done can only be an aid to that understanding, without which teachers cannot invent and reinvent their practice (Gruber and Voneche 694).

While Piaget's theory may seem simplistic at first reading regarding implementation into pedagogy, there are other factors to be considered in the present educational system. That it is an inclusive system which lays vulnerable to society's woes, such as poverty, divorce, and teacher burnout to name a few, adds to the dilemma, and certainly Piaget is not the only answer to these problems. But as an educator, I would like to consider his developmental theory as this could reduce some of the learning problems in the classroom. If a student and his or her developmental stage could be matched with the curriculum, the student should learn quicker. Within the behaviorist model, testing is used largely because it is a measurable device. Piaget offers nothing in which to provide such a secure method of determination of student success in a class. However, as a businesswoman, I must consider the global rankings of the United States, which, in time, will enter the economic arena. To prefer testing because it is measurable seems somewhat like not being able to see the forest for the trees. In order to construct knowledge according to Piaget, one must act upon the object.[1] This can be done nicely in the form of exploration in any subject through research and writing. If it were introduced to the student at an early level commensurate with development, research and writing may not be such a frightening experience for the student in high school and/or the university. A research paper done in any subject, on any developmental level, can be a tool for assessing a degree of success for the student.

The emotional component, which Piaget refers to as affect, may be utilized as an invitation to motivate the individual to attention and disequilibration. Disequilibration is the unbalance between assimilation and accommodation. Briefly, the process is that if an individual applies a construct of knowledge, or schema, and it works, then equilibration exists. If the schema does not produce a satisfying result, then disequilibrium exists, and the individual is uncomfortable. She or he continues to search for a solution in order to maintain equilibrium or balance. As an example, when one solves a mystery, exploration of all pertinent facts is conducted. So it should be with learning. The exploration can neither be planned nor should there be a time-constraint. The hypotheses and hunches should be tested repeatedly by the individual. The role of the teacher is to produce curiosity in the child and then employ methods to utilize the curiosity in order to provoke learning through disequilibrium.

One of the methodologies that has come about, largely due to the efforts of some educators who wish to apply the Piagetian theory, is the constructivist method. Iran-Nejad (1995) believes that Piagetian theory is constructivist because the individual constructs knowledge.

> Piaget's theory is constructivist because it implies the process of building, creating, or making mental structures instead of merely absorbing or reproducing products. To Piaget, the child's mind is self-organized by a constant antagonism between internal, subjective mental states and external reality. In Piagetian theory there is no objective ontological reality. According to this view, knowledge does not exist as a separate product ready to be unloaded in the classroom and consumed by the student. Knowledge is representative of existing reality for each individual. (Iran-Nejad 19)
>
> Constructivism is greatly influenced by Piagetian epistemology (Duckworth, 1987; Confrey, 1990, von Glaserfeld, 1984, Kamii, 1985). Duckworth (1987) defined constructivism succinctly: "Meaning is not given to us in our encounters, but it is given by us, constructed by us, each in our own way, according to how our understanding is currently organized. . . . According to Resnick (1987b), "We are in the midst of a major convergence of psychological theories . . . today, cognitive scientists generally share the assumption that knowledge is constructed by learners" (qtd. in Iran-Nejad 1995, pg. 16).

While not conclusive, research has verified Piaget's theory concerning the invariance of cognitive development. That is not to say that learning may not be facilitated in another fashion, but at the heart of this issue is the failure of the child to learn. When held accountable for this failure, the child resorts to cheating and other test taking strategies in order to improve his or her grade. A failure of a student due to mismatching development and curriculum leads to affective complications. If a student is in over his or her head academically, with proper guidance and support, learning can occur as the student accepts the challenge. However, the material to be learned cannot be beyond his or her developmental stage. The affective component of a failure environment is grave and in some cases, produces lifelong effects.

Within each of the developmental stages in Piaget's theory, there are certain characteristics representing qualitative changes in the individual's ability to reason.

1 The stages are characterized by qualitatively different reasoning with each new construction

2 The reconstructed reasoning is evident in all areas of reasoning, with objects and space taking on a new meaning

3 Each advance integrates existing knowledge with new knowledge providing a better more efficient adaptation to reality

4 Development is invariant, with less sophisticated reasoning giving way to more sophisticated reasoning with each stage

5 Each stage has its own characteristics of egocentrism

6 Intellectual development proceeds through disequilibration followed by assimilation and accommodation of experience "The control mechanism is affective, with unconscious feelings, tendencies, and inclinations functioning as gatekeepers for what experiences affect intellectual development" (Wadsworth 141)

7 Social interaction, one of the four variables in the Piagetian theory (the others are maturation and heredity, active experience and equilibration), is necessary for intellectual development Piaget defined social interaction as an exchange of ideas among peoples At all levels of intellectual egocentrism (affective and cognitive), social interactions are necessary as a tool for confronting ideas of others Even though construction of knowledge occurs in the mind of the child, a social context is often necessary for the construction to occur (Wadsworth 140-141)

Piaget believes that intelligence is an equally cooperative effort with cognitive, social, and affective aspects However, since Piaget wrote more on the cognitive development, researchers tended to see only this aspect Barry Wadsworth tends to broaden from the position of most researchers, maintaining without qualification that Piaget asserted that all three aspects play equal roles in intelligence "[A] careful reading of Piaget's writing makes clear that a view of intellectual development that includes only cognitive development without fully taking into account the affective aspects is incomplete" (Wadsworth 145) Knowledge is constructed when the individual encounters disequilibration, such as a discomforting thought that is at odds with the individual's schemata previously constructed This discomforting thought is made by the affective system Piaget and Inhelder write, "Affectivity, which includes feeling, interests, drives, tendencies (such as "will") and values, "constitute[s] the energetics of behavior patterns whose cognitive aspect refers to the structures alone There is no behavior pattern, however intellectual, which does not involve affective patterns as motives" (qtd in Wadsworth 146) Intellectual development is a unity of affect and cognitive conceptions

Piaget's theory can be considered a tool for analyzing educational practices to ascertain how they incorporate developmental principles Rates of development vary, even though their course is the same For example, half the adult population will not enter the formal operational stage Piaget maintains that the developing child has been ignored in favor of the educated or finished man

> How is one to define the new methods of education, and from when should we date their first appearance? To educate is to adapt the child to an adult social environment, in other words, to change the individual's realities to which the community consciously attributes a certain value There are, therefore, two terms in the relation constituted by education on the one hand the growing individual, on the other the social, intellectual, and moral values into which the educator is charged with initiating that individual The adult, viewing the relationship between these terms from his own point of view, began by paying attention solely to the second, and thus by conceiving of education as a mere transmission of collective social values from generation to generation And out of ignorance, or even on account of this opposition between the state of nature characteristic of each individual and the norms of socialization, the educator concerned himself at first with the ends of education rather than with its techniques, with the finished man rather than with the child and the laws of its development (qtd in Gruber and Voneche 695)

Piaget wrote the aforementioned quotation in 1935, in 1965 he writes that there has been no improvement in pedagogy since his previous writing He believes that part of the problem lies with the examinations that must be taken at the end of school, maintaining that the "use of these data entails both a begging of the question and a vicious circle

> A begging of the question, to begin with, because we are postulating that success in those examinations constitutes a proof of durability of the knowledge acquired, whereas the real problem, still in no way resolved, consists precisely in attempting to establish what remains after a lapse of several years of the knowledge whose existence has been proved once by success in those examinations, as well as in trying to determine the exact composition of whatever still subsists independently of the detailed knowledge forgotten On these two prime points, then, we still have almost no information A vicious circle, in the second place--and this is even more serious--because we are saying that it is possible to judge the value of scholastic instruction by success in final examinations when the fact is that a great deal of the work done in school is influenced by the prospect of those very examinations, and is even seriously distorted, according to some respected thinkers, as this preoccupation becomes increasingly dominant (qtd in Gruber and Voneche 697-698)

Jean Piaget maintains that "every organism interacts with the environment in an ongoing process that changes and refines the individual's conception and understanding of reality" (Smith & Smith 155) He is convinced that biological development is a process of adaptation to the environment and cannot be explained by maturation alone He believes "that the mind and body do not operate independently of one another and that the mental activity is subject to the same laws that biological activity generally is This led him to conceptualize intellectual development in much the same way as biological development This does not imply in any sense that mental behavior can be attributed completely to biological functioning, but that the concepts of biological development are useful and valid for looking at intellectual development Intellectual and biological activity are both part of the overall process by which an organism adapts to the environment and organizes experience" (Wadsworth 13-14)

Social interaction and collaboration are important to the learning process, especially in development of cognitive conflict and disequilibration Social interaction becomes even more critical when the child realizes that there is more than the viewpoint of the self Of course, social knowledge is only constructed when there is social interaction Strategies that can be used to evoke surprise such as the unknown and the unpredictable, can help in the learning process resulting in construction or reconstruction of schemata

Intellectual autonomy is learning how to make decisions, it is self-regulated and has an affective and a cognitive component Intellectual autonomy does not mean allowing the child to do whatever he or she deems desirable, nor does it mean abandoning the learning process It is the process of learning self-regulation, and of controlling and of directing the self efficiently, effectively, and responsibly Intellectual autonomy, according to Piaget, allows the individual to utilize her or his own values within relationships that provide shared values with mutual respect Affective autonomy integrates one's values with a sense of obligation to act on these values It stems from mutual respect relationships, and is based on freely chosen cooperation

Piaget's theory does not address individual differences, yet in any classroom there are considerable differences in intellectual development Traditional grouping seems to do little if anything to stimulate learning, and the students could be better served if the grouping were by interest In a typical class, the developmental stage can vary as much as eight years To group by ages can make the learning very difficult for the slow learner or those at the beginning of the developmental stage

Piaget maintains that an authoritarian model for the child is not sufficient to provide sound moral reasoning and behavior As is consistent with his theory, moral reasoning must be constructed by the individual

> It is absurd and even immoral to wish to impose upon the child a fully worked-out system of discipline when the social life of children themselves is sufficiently developed to give rise to a discipline infinitely nearer to the inner submission which is the mark of adult morality It is idle to try and transform the child's mind from outside, when his own taste for active research and his desire for cooperation suffice to ensure a normal intellectual development The adult must therefore be a collaborator and not a master, from this double point of view, moral and rational (Piaget 1965, p 404) (qtd in Wadsworth 160)

According to Jean Piaget and John Dewey, authoritarian teachers should modify their role so as to be collaborators and equals to the student As the child constructs moral knowledge and reasoning, moral behavior is consistent with these values In Piaget's theory, the behavior is under the discretion of the will If the individual has a strong will, then there usually will be a strong sense of obligation to ones values Wadsworth (1996, 16) maintains that the following guidelines are consistent with the Piagetian theory

1 Teachers should assume mutual respect in a non-authoritarian relationship with young children for at least part of the time, this mutual respect should occur all the time with high schoolers
2 Punishment, when necessary, should be based on reciprocity rather than expiation
3 There is intellectual value to any issue that a child might raise in the classroom spontaneously, including moral questions
4 Teachers can initiate discussions of moral issues, even with pre-school children The social interaction with the child's peers may lead to disequilibration, which may lead to a reorganization of their concepts
5 Responsibility, cooperation, and self-discipline cannot be transmitted to the child authoritatively, and the classroom should be structured so that the child can participate more fully Mutual respect relationships are vital "It is questionable whether children can develop concepts of justice based on cooperation in environments in which justice is based only on authority" (Wadsworth 161)

Jean Piaget's own words sum up the theory and provide the pedagogy Now the educators must provide the application

> *A student who achieves a certain knowledge through free investigation and spontaneous effort will later be able to retain it; he will have acquired a methodology that can serve him for the rest of life.*

Piaget, To Understand Is to Invent
(qtd in Wadsworth 147)

References

Iran-Nejad, Asghar "Constructivism as Substitute for Memorization in Learning Meaning is Created by Learner" Education Volume 116, No 1, Fall (1995) 16 - 32

Piaget, Jean -"Science of Education and the Psychology of the Child (1935 and 1965)" The Essential Piaget Ed Howard E Gruber and J Jacques Voneche New Jersey Jason Aronson Inc , 1995

Smith, Joan K , and Smith, Glenn L Education Today New York St Martin's Press Inc 1994

United States Department of Education The Condition of Education 1995 Table 18-2 Distribution of proficiency scores of 13 year-olds mathematics assessment, by country 1991 Washington D C U S Government Printing Office 231 1995

United States Department of Education The Condition of Education 1995 Table 19-2 Distribution of proficiency scores of 13-year-olds on science assessment, by country 1991 Washington D C U S Government Printing Office 233 1995

Wadsworth, Barry J Piaget's Theory of Cognitive and Affective Development Whiteplains, NY Longman Publishers USA, 1996

Woolfolk, Anita E Educational Psychology Sixth Ed Needham Heights, MA Allyn and Bacon 1995

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A Descriptive Survey of the Three Contemporary Approaches to Fluency Disorders

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The purpose of this independent studies project was to do a descriptive survey of the three contemporary approaches to fluency disorders. The three fluency approaches are known as the stuttering modification approach, the fluency shaping approach, and the integration approach. By reviewing abstracts, journal articles, and books, the three fluency approaches were compared with regard to their four goals and two clinical procedures. The findings revealed that *feelings and attitudes* and *general communication skills* are distinguishing characteristics for the stuttering modification approach; *structure of therapy* and *data collection* are distinguishing characteristics for the fluency shaping approach; while *speech behaviors* and *fluency maintaining strategies* are distinguishing characteristics for the integration approach.

BACKGROUND

Stuttering is an astonishing act which confuses and sometimes exasperates listeners. "Why doesn't he go ahead and say what he needs to say," people often ask, "instead of stopping and starting and stumbling around like that?" The basis of stuttering lies in its disruption of fluency. Stuttering occurs when the forward flow of speech is interrupted abnormally by repetitions or prolongations of a sound, syllable, or articulatory posture, or by avoidance and struggle behaviors (Van Riper & Emerick, 1990). Like theories on the cause of stuttering, assumptions about its treatment have wavered between widely divergent views (Bloodstein, 1993). Reduced to its simplest form, however, the attempt to help clients who stutter has veered back and forth between methods that teach clients to *talk differently* and methods that teach clients to *stutter differently.*

THREE FLUENCY APPROACHES

The three main therapeutic approaches for stuttering have all evolved since the 1930s. They are the traditional, operant, and integration approaches. Presently, the term *stuttering modification therapy* is used to describe the traditional approach. The term *fluency shaping therapy* is the contemporary term used to describe the operant approach, and the *integration* designation remains unchanged. With that in mind, stuttering modification therapy, fluency shaping therapy, and integration therapy can be compared in many ways. Guitar and Peters (1980) feel, however, that the following six comparisons are the most important with regard to the treatment of stuttering. Four of these comparisons relate to: (a) feelings and attitudes, (b) speech behaviors, (c) fluency maintaining strategies, and (d) general communication skills. The two clinical procedure comparisons deal with (a) structure of therapy and (b) data collection (Guitar & Peters, 1980). Each approach will now be given a general overview and their goals and clinical procedures analyzed.

Stuttering Modification Approach

Stuttering modification therapy refers to an approach to stuttering based on the theory that most of the stutterer's problems in speaking are the result of avoiding or struggling with disfluencies (repetitions and / or prolongations), avoiding feared words, and / or avoiding feared situations. The process of therapy includes reducing avoidance behaviors, speech related fears, and negative attitudes toward speech. It also includes helping the stutterer learn to modify the form of his stuttering. This can be done in a variety of ways. For example, the stutterer can reduce his struggle behavior and smooth out the form of his stuttering. He can also reduce the tension and rapidity of his stuttering to stutter in a more relaxed and deliberate manner. To that end, the goals and clinical procedures will now be discussed.

Goals of Therapy

1. *Feelings and Attitudes:* Guitar and Peters (1980) state that stuttering modification therapy places a great deal of emphasis upon reducing the fear of stuttering. The area of feelings and attitudes is definitely a distinguishing characteristic of the stuttering modification approach.
2. *Speech Behaviors:* Guitar and Peters (1980) believe that most speech pathologists who practice the stuttering modification approach see their ultimate goal for the client to be able to speak normal (spontaneous fluency).
3. *Fluency Maintaining Strategies:* Guitar and Peters (1980) reveal that speech pathologists who practice the stuttering modification approach urge their clients to stop avoiding words or situations.
4. *General Communication Skills:* Guitar and Peters (1980) state that stuttering modification therapy gives consideration to speech flow after stuttering behavior is reduced. The area of general communication skills is also a distinguishing characteristic of the stuttering modification approach.

Clinical Procedures

1. *Structure of Therapy:* Guitar and Peters (1980) state that stuttering modification therapy is usually conducted within a teaching or counseling situation.
2. *Data Collection:* Guitar and Peters (1980) state that speech pathologists who practice the stuttering modification approach do not put a great deal of emphasis upon the collecting and reporting of objective data.

Fluency Shaping Approach

Fluency shaping therapy is based on operant conditioning and programming principles (for example: successive approximations of antecedent stimulus events, and use of reinforcement of appropriate responses). In a fluency shaping therapy program, some form of fluency is first established in a controlled stimulus situation. This fluency is reinforced and gradually modified to approximate normal conversational speech in the clinical setting. This speech is then generalized to the person's daily speaking environment (Guitar & Peters, 1980).

Goals of Therapy

1. *Feelings and Attitudes:* Guitar and Peters (1980) state that speech pathologists who practice the fluency shaping approach do not directly attempt to reduce the client's fear of speaking; however, it is felt that often the programming leads to a reduction in fear.
2. *Speech Behaviors:* Guitar and Peters (1980) feel the adherents of fluency shaping therapy also have as their goal spontaneous fluency.
3. *Fluency Maintaining Strategies:* Guitar and Peters (1980) reveal that speech pathologists who practice the fluency shaping approach stress the maintenance of fluency by such techniques as slowing speech rate or monitoring speech carefully.
4. *General Communication Skills:* Guitar and Peters (1980) state that speech pathologists who practice the fluency shaping approach suggest that organization and flow of verbal output may be an important consideration for treatment.

Clinical Procedures

1. *Structure of Therapy:* Guitar and Peters (1980) remark that fluency shaping therapy is usually performed in a highly structured situation. With that in mind, structure of therapy is a distinguishing characteristic of the fluency shaping approach.

clinical procedures (cont'd)

2. *Data Collection:* Guitar and Peters (1980) reveal that speech pathologists who practice the fluency shaping approach put a great deal of emphasis on the collection and reporting of objective and reliable data. Data collection is definitely a distinguishing characteristic of the fluency shaping approach.

Integration Approach

Guitar and Peters (1980) state that during the past 25 years there has been increasing controversy between the proponents of the stuttering modification approach and the fluency shaping approach. In recent years, however, many speech pathologists have found that techniques based upon the stuttering modification approach can be beneficial to those employing the fluency shaping approach (Guitar & Peters, 1980). With that in mind, when both approaches are combined, the approach is referred to as the integration approach. Essentially, the integration approach may offer more to the person who stutters because this approach encompasses everyone who is involved with helping the client stutter less, such as family, friends, teachers, and coaches.

Goals of Therapy

1. *Feelings and Attitudes:* Evins-Smith states that feelings and attitudes are more important to the older stutterer and less important to the youngster who stutters (personal communication, 1996).

2. *Speech Behaviors:* Evins-Smith states that speech behaviors can be used to reinforce fluency (personal communication, 1996). Speech behaviors are a distinguishing characteristic of the integration approach because the integration approach involves the entire family.

3. *Fluency Maintaining Strategies:* Evins-Smith (personal communication, 1996) states that it is important to check the family's "checks and balances," for example, parents being conscious of their child's fluency techniques. With that in mind, fluency maintaining strategies are a distinguishing characteristic of the integration approach.

4. *General Communication Skills:* Evins-Smith states that Hugo Gregory's ERA-SM (Easy Relaxed Approach-Smooth Movements) can be used for any person who stutters to generalize their speech (personal communication, 1996).

Clinical Procedures

1. *Structure of Therapy:* Evins-Smith states that structure of therapy can be either structured or non-structured, intensive or non-intensive (person communication, 1996).

2. *Data Collection:* Evins-Smith states that it is important to track every session, in order to gather a quantitative ratio (personal communication, 1996).

CONCLUSION

In summary, the findings revealed that *feelings and attitudes* and *general communication skills* are distinguishing characteristics for the stuttering modification approach; *structure of therapy* and *data collection* are distinguishing characteristics for the fluency shaping approach; while *speech behaviors* and *fluency maintaining strategies* are distinguishing characteristics for the integration approach. Implications based on these findings include that transfer and maintenance need to be more prominently addressed during the course of treatment, as opposed to simply direct therapy that takes place in the therapeutic setting. Moreover, therapy for the person who stutters should not end just because that person is dismissed from therapy. A speech pathologist should be assigned to monitor that person's speech periodically (for example: once a month). To that end, *transfer* of behavior change involves the occurrence or acquisition of changes in behavior in situations other than where the previous learning took place (Fraser, 1994). Similarly, *maintenance* of behavior change refers to the continuation or persistence of speech and attitudinal changes over time (Fraser, 1994). Until transfer and maintenance issues are more clearly addressed during the course of treatment, people who have fluency disorders will continue to struggle with the depressing problem of having their stuttering resurface.

267

With an emphasis in therapy placed on the issues of transfer and maintenance, the person who stutters will be less likely to have his stuttering resurface because he will have a speech pathologist available to answer various questions he may have about times when he feels his stuttering is resurfacing.

REFERENCES

Bloodstein, O. (1996). Stuttering: The search for a cause and a cure. Needham Heights, MA.: Allyn and Bacon, pp. 50-178.

Evins-Smith, P. (1996). Personal communication.

Fraser, J. (1994). To the clinician. Stuttering therapy: Transfer and maintenance. Memphis, TN.

Guitar, B., & Peters, T. (1980). Stuttering: An integration of contemporary therapies. Memphis, TN.: Stuttering Foundation of America, 13, 14, 15.

Van Riper, C., & Emerick, L. (1990). Speech correction: An introduction to speech pathology and audiology. Englewood Cliffs, NJ.: Prentice-Hall, 294, 334, 335.

Cosmos and Chaos:
An Analysis of Themes and Issues in Doris Lessing's The Fifth Child

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In a narrative about literal reversions to primitive states of being, Doris Lessing effectively communicates her ideas about the nature of time and our societal notion of fate. These themes have evolved, both in Lessing's conscious meditations on our society's current state of mind and in her fictions. Her reflections in Prisons We Choose to Live Inside (a series of lectures given in 1985) appear to be especially formative for the images and ideas communicated in The Fifth Child (1988). However, beyond Lessing's conscious intentions, The Fifth Child is also a literary work clearly influenced by and paralleling the emerging interdisciplinary field known as the science of chaos.

In The Fifth Child (1988), Doris Lessing tells the story of David and Harriet Lovatt, a young couple who meet, fall in love, acquire a large house, and fill it with happiness and four children in quick succession. However, the story makes it clear that the Lovatts choose their home-centered lifestyle in ignorance. Their dream of escaping from the world around them collapses with the birth of Ben, the fifth Lovatt child. Harriet's painful pregnancy results in an alien birth; the horror of this fifth child brings the Lovatt's self-centered existence into question. The narrative not only exemplifies Lessing's social beliefs, but it attests to the emerging scientific theory of chaos. As a text representative of this new idea, The Fifth Child relates local sites to global structures, questions the relationship between order and disorder, and shows an awareness that small causes can lead to massive effects. A close textual reading of The Fifth Child will enable us to determine the Lovatt's unexamined motivation for living the life that they choose, their odd relationship to time and history, and will uncover the presence of a propelling fate that far exceeds the Lovatt's control and imagination.

Harriet and David Lovatt, the protagonists of The Fifth Child, are motivated by an unexamined and unquestioned need to create a family. Their desires and vague notions are rooted in nostalgia and an uncomprehending view of the past. Unfortunately, these easily accepted and simple drives lead to disaster on a much greater level. For Harriet, establishing a family is an unexamined desire originating in her childhood. Her mother "was a contented woman" (Lessing, *Fifth* 7) and her parents had "taken it for granted that family life was the basis for a happy one" (7). Although David's background was one of divorce, "quite different" (7) from Harriet's, his unexamined motivation to have his own family is also rooted in the past. In fact, David wants his life to "annul, absolve, cancel out all of the deficiencies" (13) of his parents' lives. The combination of two individuals with identical unexamined desires based on "the enormity of their demands on the future" (8) is not disastrous because of the content of their desires, but because of the ignorance with which they are grasped and achieved. Lessing, in her highly developed critique of "not thinking" (Lessing, *Prisons* 25), claims that people blindly "crave certainty, they seek certainty, and great resounding truths" (21). The Lovatts, in their blindly optimistic grasp of their reproductive calling in life, are actively seeking certainty and refusing to acknowledge, with their choices, the "horrors of which we are capable" (9). For the Lovatts, this means a constant denial of the extraordinary and the cynical outside of themselves with an insistent and "stubbornly held view of themselves, which was that they were ordinary and in the right of it" (Lessing, *Fifth* 3).

Lessing's critique of the Lovatts is not aimed at debunking their old-fashionedness, but rather at critically examining their overconfidence that their own ways are better than others'. The moment that the Lovatts meet, they reduce themselves to a tunnel vision which only expands wide enough to contain themselves and their future off-spring. Their initial conversation is symbolically placed in a closed room after they escape the party at which they have effectively objectified all persons. Instantly, Harriet "knew [David's] look of watchful apartness mirrored her own" (4). Their actions and choices continually omit strangers and in fact, all awareness of social situations outside of family gatherings. Eventually, even those closest to them are not immune to the most intimate criticisms which stem from their cloistered and self-absorbed mind-set. To begin with, their process of acquiring an enormous house ("'Are you going to run a hotel?' enquired Frederick" (12)), assumes a role of utmost importance. In fact, the Lovatts expect their parents to pay for the house and family, David's father with monetary assistance, and Harriet's mother with her endless labor. The Lovatt's "demand on life" (37) is excessive and exclusive. Harriet even excludes her own sister when she attributes her sister's Down's syndrome daughter, Amy, to marital discord, which "probably attracted the mongol child" (22). With her narrow view of the world Harriet smugly feels that her own happiness based on four perfect children is deserved.

This "since I am right, you must be wrong" attitude that the Lovatts represent is examined in Lessing's lecture "You Are Damned, We Are Saved" (Lessing, *Prisons* 17). Lessing claims that "when we think, reflect, and allow our rational minds to dominate us, we... suspect that this 'I am right, you are wrong' is, quite simply, nonsense" (16). The lecture suggests that seeing one's self as simply "*a* communist," or "*a* right-wing conservative," is always going to be too narrow to be correct or finally conclusive. In fact, Lessing often employs the phrase "being in the right" in her 1985 series of lectures. "There is no such thing as my being in the right...within a generation or two, my present way of thinking is bound to be found perhaps faintly ludicrous..." (16). We find echoes from Lessing's meditations on belief structures in the description of the Lovatts and their unconsciously exclusive attitudes towards all around them. In a comfortable smugness, the Lovatts say, "And look, they had been right to insist on guarding that stubborn individuality of theirs, which had chosen, and so obstinately, the best..." (Lessing, *Fifth* 21). The Lovatt's concept of "right" is certainly not capable of expanding to include others.

We also find that because of their narrowness, David and Harriet cannot see themselves in multiple roles or even accept inner paradoxes. Instead, they view their lives as a linear progression through time ("their story" (6)) which rises when they meet at the work party , continues until "they were made for each other" (6), and climaxes with a large Victorian house "full of space for children" (8). They see their deepest and best selves as called into being solely by the execution of the parental role. Oddly enough, their image of a Victorian house bustling with children is based on a way of life which they have never known; it is an imagined nostalgia for a past which seems ridiculous from the standpoint of their late 1960s environment. This strange relation to time shows us that their relationship, and even their physical intimacy, is a sort of a "throwback." This is clearly exposed in the discussion of Harriet's virginity. Harriet had not thought of herself as a virgin, "but rather as something like a present wrapped up in layers of deliciously pretty paper, to be given, with discretion, to the right person" (5). The "enlightened girls of now" (5) attribute her abnormality to some psychological problem, while the "good women of her grandmother's generation" (5) would have accused them of immorality.

The text further supports the idea that the Lovatts believe they are struggling against the time that they live in. "The Lovatts were a happy family. It was what they had chosen and what they deserved" (21). This achievement is obviously seen by both of them as the fulfillment of all that they have hoped for in life. "It had been hard preserving their belief in themselves when the spirit of the times, the greedy and selfish sixties, had been so ready to condemn them, to isolate, to diminish their best selves" (21). The Lovatts seem to think that the castle of their home is the only safe place in the world. "The Lovatts made themselves read the papers and watch the News on television, though their instinct was to do neither" (22). Their insistence on creating this "fortress, their kingdom" (22) denies the time in which they live, and allows for fatalistic notions to creep in. However, the Lovatt's view of fate or nature and its operations has not been broad enough to include its relation to necessity and to history. This is brought out when Harriet's mother rebukes her for saying, simplistically, that in another country it would be normal to have six or eight children. Dorothy says, "'if you were in . . .Egypt or India or somewhere, then half of them would die and they wouldn't be educated either. You want things both ways. . .It seems to me you haven't thought it out'" (16). Here we find the Lovatt's "fatal flaw"; they have slighted reason and history in order to attend to their own personal fantasy which is both out of place and out of time. This flaw creates vulnerability that allows space for ideas of fate and deserved retribution to grow in the Lovatts.

To begin with, we see something greater than human desire at work in the story when David and Harriet instantly recognize each other as destined mates. It is almost as if they think of being "made for each other" (6) as a literal phrase which defines a physical destination. The speed that whirls them past any sort of courtship and directly into marriage revives the ancient idea of fate, but also serves to keep the reader from empathizing too strongly with the Lovatts. The manner in which they conduct their first lovemaking creates a very powerful scene. Harriet almost stops the ancient myth of fate's control with reason, "For had they not decided to put off having children for two years?" (10). Instead, she is "overwhelmed by [David's] purpose--yes, that was it, he was making love with a deliberate, concentrated intensity. . .taking possession of the future in her" (10). This momentous occasion is out of the ordinary and they lay there until they are themselves again and able to "kiss with small reassuring daytime kisses" (11).

Harriet's acceptance of the inevitability of her maternal destiny also hints that an underlying force is active in their lives. When she tells David that Sarah and William's quarrelling had probably attracted the mongol child, he is upset. "David disliked this trait of Harriet's, a fatalism that seemed so at odds with the rest of her. He said he thought this was silly hysterical thinking: Harriet sulked and they had to make up" (22). Harriet's position is out of time and assumes a methodical divine retribution that strikes those who do not choose what is "ordinary and in the right of it" (3). The Lovatts do not believe in randomness or bad luck; on the contrary, the divine retribution that they have received is completely positive. When they lay face to face, "the doors in their breasts flew open, and what poured out was an intensity of relief, of thankfulness" (21). This glory that the Lovatts take in their rightful reward of happiness on earth is quickly dissipated by the satirical tone which Lessing occasionally uses, and by the continual foreshadowing of the approach of something wicked.

In addition to the direct presence of fatalism in the novel, hints at the working of fate are given in the reactions of others to their decision to reproduce incessantly. William says, "'Give it a rest, Harriet. That's all we ask of you'" (26). Harriet and David enjoy seeing themselves as rebels, going against their families and the modern logic of family planning. Even when Sarah, Amy's mother, pleads for them to recognize the randomness of fate, "they all knew she was saying, four more challenges to destiny" (27), David and Harriet refuse. They believe that their rightness and marital harmony shield them from such disasters. David and Harriet's extended family does not just scorn their actions, they also scoff at the root and source of the actions, ideas as ridiculous as Harriet's announcement that "'This is what everyone wants, really, but we've been brainwashed out of it'" (27). Even James, usually silent except for monetary donations, corrects Harriet, "'You're quite wrong, Harriet. The opposite is true. People are brainwashed into believing family life is the best. But that's the past'" (28). The inevitable financial burden of educating the future brood is discussed; "'How do you know James will be able to help you? Anything can happen in the world'" (30). William adds to this admission of fate with "'Anything does, all the time'" (30).

However, Harriet and David are oblivious to warnings of impending doom. Together at the window they exchange a look, "half guilty because of the irrepressible smiles on their faces, which they felt were probably going to exasperate the others" (31). Hints gradually make it clear that some agency outside of ordinary life is driving the novel. The realistic, practical text, is pulled from beneath by some foreboding subtext which we occasionally glimpse. In particular, the Lovatt's view of Bridget is what finally makes them see themselves uneasily. Bridget is an adolescent girl who visits the Lovatts; she adores and covets the family atmosphere in their home. The question looms when they realize that she shouldn't be expecting so much because life is not like that: "But life *is* like that, if you choose right; so why should they feel she couldn't have what they had so plentifully?" (31). The final clue that we receive of the horrors which are to come at the hand of fate is the unexpected pregnancy. "How could it have happened? They had been careful, particularly so because of their determination not to have any more children for a while" (32). With this final note, the horror of something far beyond their knowledge and control begins the destruction of their self-righteous fortress.

With a theme of fate so deeply imbedded in the text, The Fifth Child is obviously concerned with the individual's choices in relation to a much larger societal and even cosmic system. Although Lessing may not have any specific knowledge about chaos theory, she is obviously aware of the newfound implications that the theory points to: the drastic impact that an individual's actions can have on a much broader scale, and the possibility of the integrated nature of order and disorder. The ecological perspective that Lessing's writing represents is closely tied to chaos theory in that they both deal with the integral and intricate connections that tie the specific, local event to a larger, global phenomenon. The Fifth Child not only literarily represents Lessing's personal philosophies regarding social awareness, it also stands as a witness to the intensity with which our culture is currently focused on the idea of chaos.

The emerging science of chaos began with the study of non-linear systems and looks for "recursive symmetries between different levels of the system" (Hayles 170). While James Gleick's bestseller, Chaos: Making a New Science (1987), gives us a historical narrative about the development of chaos theory, N. Katherine Hayles argues that the paradigm shift towards chaos has been building in our culture over time, fueled mainly by the growing complexity of information (Hayles 196). Lessing's novel reflects and incorporates this evolving notion of chaos as both a potentially empirical predictor and as a mythic solution to the unexplainable. Although this unspoken theme is not necessarily a conscious part of Lessing's creative process, it is a pervasive and effective part of her literary style. Hayles claims that Lessing's writings show the importance of a concept that is entering into our cultural discourse through the observations and creations of many disciplines, not just that of theoretical science (236).

While The Fifth Child retains an un-fractured narrative line structure, the ramifications of symbols and events in the novel grow almost exponentially, leaving a linear cause and effect system unapplicable to the Lovatt's situation. With a neutral, informative style, Lessing presents the story as a mere set of facts or series of events. This style lays out the plot of the Lovatt's life in a sterile manner, while the events taking place quickly dismantle our typical ideas of order and disorder. The symbolism that Lessing chooses to employ in her description of the Lovatts' life also emphasizes the gap between the local and the global, while the events taking place leave the two sites inextricably connected. The process which Harriet goes through in an attempt to rationalize Ben's existence further proves that predictability is not a constant, and that a traditional linear system could not account for the experiences that Harriet goes through.

An argument could be made for the underlying presence of a complex, chaotic system in the very sequence of events that Lessing presents in The Fifth Child. David and Harriet's ignorance and self-righteousness could be seen as the local and specific site leading to the horrible event of Ben's creation which holds cosmological implication. This simplistic analysis of the novel would easily lend itself to analogy with the now trite example of "a butterfly stirring the air today in Peking can transform storm systems next month in New York" (Gleick 8). However, this perspective on the narrative may be too narrow and could consequently restrict interpretation. Although Lessing certainly juxtaposes the local site of the Lovatt's ignorance with the global picture of Ben's horror, she does not draw a complex web of inter-relating variables between the two. In fact, the information that she chooses to present the reader with further problematizes any connection that there may be. Lessing does not take the same stance that a person embracing chaos theory would: that all apparently random and disorderly events are actually microcosms contained in a much larger, ordered system. The narrative conveniently refuses to place Ben and the Lovatts as any part of a larger, unified system. Harriet's final speculations about Ben are both smaller and larger than real life; she sees Ben through the reductionist scope of the black box television, but also in the expansive stretches of her imagination. This paradox of rational containment juxtaposed with the vast unknowable reaches of Ben's existence is at the heart of The Fifth Child.

Lessing successfully uses the symbols and images of The Fifth Child to accentuate the apparent gaps and paradoxes between the local and global, and the orderly and disorderly. The effectiveness of this tool greatly depends on the current societal fascination with chaos theory and unpredictability, and the doubt in the traditional binary systems of logic and predictability. Lessing is intensely aware of these trends when she writes about the Lovatts creating a "fortress, their kingdom" (22) as a physical and mental barrier against "the greedy selfish sixties" (21). This symbolic barrier between two extreme ways of thinking helps Lessing create two separate worlds which, on the surface, may never be integrated, or even meet. Allusion to the Lovatt's classical bed, and the presence of the television as their only connection with the real world further accentuate the gap between the local and the global. The order and peace that the Lovatts presume is in their household is seen atomistically; they do not realize how close they are to the global unrest that surrounds them.

Perhaps an even greater amount of tension is created in the narrative by the imposition of Lessing's informative style on the dreadful connotations of the words used to describe Ben. The child is every bit as alien as they have imagined: Ben emerges violently from his mother's womb, weighs in at eleven pounds, and is "muscular, yellowish, long" (48). His father's first response is a dismayed, "'He's a funny little chap'" (48). Harriet's reaction is stronger, "'He's like a troll, or a goblin or something'" (49). Ben begins his infancy by bruising his mother's nipples, attacking his grandmother and his siblings, and killing family pets. Obviously this living situation becomes intolerable, and Ben is referred to as a "Neanderthal" (53), a "changeling" (59), and "throwback" (106). David and Harriet feel Ben has "willed himself to be born...invaded their ordinariness" (58), which is actually the product of a conscious commitment to a narrow and private vision, and not "ordinary" at all. The novel shows us the disaster that Ben brings to the Lovatt family; all that was formerly "right" and "ordinary" is stripped away by this chance genetic mutation. The horror of these events is intensified by the clinical tone with which they are conveyed. By writing about Ben in this manner, Lessing is welcoming the thought of unpredictability, inviting it into the world of logical linguistic representation, and using this tool to further accentuate the gap between the ordered and the unknown.

Lessing aligns Ben's undeniable difference with Harriet and David's ignorance, leaving the possibility that a localized event feeding back into a complex system can result in horror of global proportions. The bulk of the narrative is devoted to Harriet's attempts to rationalize Ben's innate disorder and horror. She searches for some physical explanation with repeated trips to the doctor, attempts to devote herself to him in an effort to infuse him with mothering, and tries giving him behavioral training. All of her time and effort are spent on Ben; she wants to reason away his alien nature, and place him in his pre-ordained role of the perfect fifth child. Harriet's frustration is increased when no professional will acknowledge Ben's differences. Everyone is anxious for him to fall under the range of the standard, normal curve of child development. With the birth of Ben, Harriet's ideas of her family's cocooned immunity are forced to change. Her concepts of the private and public sectors as distinct entities collapse as she realizes that Ben's existence has global significance and that her devotion to him will mean that she cannot maintain her previously vital sanctuary (65).

Harriet tries to establish a spatial and temporal context for the disaster that has become their lives by balancing her cosmic and evolutionary view of things with a more individual one. While she can hypothesize that the genes of "all those different people who lived on the earth once--they must be in us somewhere" (114), she also feels, without any rationality, that she and David are being punished for some sort of hubris. She says, "'We are being punished that's all . . . For presuming'" (117). David is extremely disturbed by this, "'Gods, distributing punishments for insubordination...Don't do it, Harriet...if you have to, then leave me out. I'm not going to be dragged back to the Middle Ages'" (118). The idea that we have scientific knowledge of ourselves as social and evolutionary beings, but refuse to fully incorporate that knowledge into our lives is one of the major themes in Lessing's Prisons We Choose to Live Inside. Lessing tells us, "I believe that we are in the grip of something very powerful and very primitive, and that we have not yet begun to come to grips with it. To study it, yes, that goes on in a hundred universities. But to apply it--no" (Lessing, *Prisons* 28). These conflicts are both logical and mythological fears that fail to explain a non-linear series of events like that which the Lovatts were a part of. Lessing realizes the inadequacy of these explanations and the impact that their failure can have on our consciousness.

Lessing's own stance on social issues and the "unexamined life" calls for us to look beyond the immediate cause and effect relationships that our choices are a part of and see the possibility of global repercussions. This technique of presenting a seemingly impossible situation and a complex tangle of ethical questions, is what makes The Fifth Child so effective as a novel. The reader is almost forced to ask and answer these questions for themselves. What will reign, reason, or the out-moded idea of fate? Can individuals go against history without experiencing personal disaster? Harriet's final image of Ben, disappearing into the underworld to search for others of his kind, presents him as the bearer of inevitable future which the Lovatts have tried to ignore. Lessing tells us that "Laughter is a very powerful thing, and only the civilized, the liberated, the free person can laugh at herself, himself" (44). I have reached the end of The Fifth Child and I am not laughing. The horrors presented in this short novel prove humankind to be essentially uncivilized, chained to a powerful, primitive part of our past that we will never be released from. However, Harriet has one last hope. Through distance of perspective, she may someday find herself objectifying this horror that was born of her. As Lessing puts it, "people outside can easily see it" (51). When Harriet finally sees Ben through the flat lens of the television box, freedom from his intense grip on her emotion and reason may be achieved. And with this freedom, perhaps there will be freedom from the ancient thoughts of fate, divine retribution, and thunderbolts from on high. This freedom, if it is possible, would be divine, freeing us from thoughts that lead, as David tells Harriet, to "Pogroms and punishments, witch-burnings and angry Gods" (118).

REFERENCES

Gleick, James. Chaos: Making a New Science. New York: Penguin Books, 1987.

Hayles, N. Katherine. Chaos Bound: Orderly Disorder in Contemporary Literature and Science. Ithaca, New York: Cornell University Press, 1990.

Lessing, Doris. The Fifth Child. New York: Random House Inc., 1988.

Lessing, Doris. Prisons We Choose to Live Inside. New York: Harper and Row, 1987.

Toni Morrison's Sula: The Pharmakos of Her Community

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Sula, the eponymic character of Toni Morrison's novel, is as mysterious to the reader as she is to her community. Sula focuses primarily on the lives of several strong women in the Bottom, an African American community, during the years 1919 to 1965. In the Bottom life is hard and isolated from the rest of the world. Sula is one of the few characters who leaves and returns. From childhood on Sula is marked by difference, in appearance and behavior. It is that difference that leads the community to consider her a scapegoat. It is the function of Sula as scapegoat or rather as *pharmakos* that I will describe in the following discussion, for in the tradition of *pharmakos* Sula is both the poison and antidote of her community.

In his Anatomy of Criticism, Northrop Frye re-defined scapegoat as *pharmakos* and as a literary archetype:

> The pharmakos is neither innocent nor guilty. He is innocent in the sense that what happens to him is far greater than anything he has done provokes, like the mountaineer whose shout brings down an avalanche. He is guilty in the sense that he is a member of a guilty society, or living in a world where such injustices are an inescapable part of existence. (Frye 41)

The prefix "pharm" of pharmakos is also evident in the words "pharmacy" and "pharmaceutical." As these latter words signify a cure for human sickness, so does the pharmakos become the cure for society's problems. The society has thus conveniently defined the problem and the solution to exist in one person. However, the society's creation of a pharmakos must be looked at critically, for its justification often seems erroneous and its results are only temporary.

The pharmakos is a tragic figure in the modes of tragedy and irony where he or she attracts the reader's sentiment or pathos. This pathos is aroused by a depiction of the character as isolated from society by a weakness, which appeals to our sympathy because it is on our own level of experience. The pathos of the tragic figure arises from the isolation of the figure from their own community, as Frye states:

> The root idea of pathos is the exclusion of an individual on our own level from a social group to which he is trying to belong. Hence the central tradition of sophisticated pathos is the study of the isolated mind, the story of how someone recognizably like ourselves is broken by a conflict between the inner and the outer world, between imaginative reality and the sort of reality which is established by a social consensus. (Frye 39)

The conception of irony is also important in the creation of the pharmakos because irony involves an absence of moralizing. Irony "takes life exactly as it finds it," but it results in a sense of hopelessness because the fate of the ironic character is arbitrary or counter-intuitive (Frye 41). Frye concedes, "Irony isolates from the tragic situation the sense of arbitrariness, of the victim's having been unlucky, selected at random or by lot, and no more deserving of what happens to him that any one else would be" (Frye 41). Thus, the pharmakos will become isolated from her community regardless of whether she deserves it or not. Such is the case in Sula, where the community unwarrantedly creates a scapegoat in Sula through a process of myth and rumor.

Morrison often uses a vivid sense of community as a seemingly active character in Sula. From the very start the reader is drawn into place where close inter-personal relationships unify the community. Isolated by race, location, and economics, the Bottom develops into a neighborhood wherein feelings and attitudes, although quite dynamic, are collectively felt. A primary distinction of the neighborhood is its passive acceptance of evil: "They let it run its course, fulfill itself, and never invented ways either to alter it, to annihilate it or to prevent its happening again. So also were they with people" (Morrison

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89-90). This stoical endurance of evil can be seen as a form of skeptical indifference or fear. In any case, it becomes self-defeating in the light of what Barbara Christian specifies: "[The community's] view of survival and of Nature exists only on the physical plane and is rooted in the fear of dying rather than in a desire to live" (Christian 53). In a community where "the purpose of evil was to survive it," the people of the Bottom struggle to separate themselves from the intense imminence of evil (90). Hence, there is a definite reversal of the citizens of the Bottom and how they see themselves "above" the clutches of evil: "They didn't stone sinners for the same reason they didn't commit suicide—it was beneath them" (90). As we see in the novel, this futile struggle leads the Bottom to create a scapegoat that will carry the burden of evil.

The sense of fear felt by the community in Sula results in their creation of false objects of evil instead of dealing with the issue of evil itself. The characters seem to create external structures and focus on these instead of actual causes. For example, Shadrack, a war veteran residing in the Bottom, founds National Suicide Day, an event that is highly regarded by the community. National Suicide Day is a means to impose order over fear, not death, that is felt by the community. Being allowed to kill themselves and each other only on January third, the community's fear is somewhat ordered and even alleviated—National Suicide Day gives the community one day to anticipate and overcome, as opposed to a daily fear of death. Of course, this ritual is seen as absurdity to an outsider, but the Bottom appreciates it in order to depreciate its immense fears. The practice is important to the community psychologically. Yet, it is crucial to note the community's insistent neglect of dealing with the true causes of evil, and its constant recognition of objectified, tangible objects which are deemed evil in themselves. As stated by one critic, "This need for finding an objective correlative for fear will lead the community to focus its fear and hatred on the River Road, the tunnel, and on Sula for their perceived inherent evil while remaining blind to the mysterious and protean nature of evil" (Carmean 33). The community's ignorance regarding such abstractions is perhaps due to its unawareness of its own oppressed condition in relation to the rest of the world. In this sense, the people of the Bottom remain perpetually cut off or alienated from the world, left only with themselves and their own dubious judgment of good and evil.

Quite different from others in her community, Sula is a rebel in the Bottom—she is an individual who makes no commitments and abides by no rules of any kind. She is an unpredictable girl, neglecting the expectations that the community places on her as a citizen of the Bottom. Sula's individuality and detachment from morals can partly be accounted for by two experiences she has at the critical age of twelve. When Sula hears her mother saying, "I love Sula. I just don't like her," a significant bond between Sula and Hannah is severed, making Sula realize her own difference from her mother (36). Chicken Little's death, which immediately follows, leads Sula to become absolved of personal responsibility. She merely showed concern for her friend Nel's statement, "Somebody saw," and when she gets away "clean," she loses something central to her becoming whole (61). Sula has no center, nothing that may guide her through life. As clearly stated in Sula:

> ever since her mother's remarks sent her flying up those stairs, ever since her one major feeling of responsibility had been exorcised on the bank of a river with a closed place in the middle. The first experience taught her there was no other that you could count on; the second that there was no self to count on either. She had no center, no speck around which to grow. (118-119)

Sula later irritates the community of the Bottom with her refusal to accept a woman's role. Sula seems to do just as she pleases, and she behaves "like a man. She's adventuresome, she trusts herself, she's not scared. And she is curious and will leave and try anything" (Stepto 487). But what did Sula do to attract the reputation of "devil" and "pariah" (117, 122)? She places her grandmother Eva in a dilapidated nursing home, is spiteful toward the community, and engages in sexual intercourse with various married men. The rest is rumor and myth.

Although Sula's rationale for putting Eva in the nursing home is self-defense, the community sees it strictly as an act of evil. Because Eva shows much disagreement with Sula regarding Sula's life, Sula fears her. Sula expresses this fear to Nel, but similar to the rest of the community, Nel refuses to believe the rumors that Eva had murdered her son. The act of placing Eva in the old, run-down nursing home was perceived with disdain by the community as a whole, and triggered the spreading of many harsh rumors about Sula.

Sula's promiscuity with neighborhood men was not the sole cause of the community's contempt for her sexuality. The women of the Bottom see Sula's sexual intercourse with their husbands as a mockery of themselves and of the entire community. Unlike her mother Hannah, who simply couldn't do without some "touching every day," Sula antagonizes the women of the Bottom by sleeping with their husbands (44). Karen Carmean compares Hannah with Sula in this regard: "Hannah's sexual acts did not antagonize the women of the Bottom. The difference stems largely from Sula's refusal to flatter male egos and thus seemingly devalue the men and, by extension, their wives" (Carmean 39). Sula's lack of genuine affection and intimacy for her male partners is perceived by the community as mockery and disrespect.

We can understand Sula's inability to empathize by referring to her childhood experiences. Sula's free-flowing individuality had set her apart from the rest of the community. When she learns that "there [is] no other that you [can] count on," Sula loses all motivation to cultivate strong inter-personal relationships. Even Nel cannot rely on her best friend in Sula, and Sula finally admits to Nel that their friendship never "mattered" (144). The only person that Sula ever cares for is Ajax, a man who admires female independence. However, even in this case Sula is unable to understand the other, and when she invites him to "lean on her," Ajax' affection for her dissolves (133). The sexual act actually becomes for Sula an act of self-exploration and affirmation. Her sexual partner is practically unimportant; he merely serves as the medium to her personal fulfillment, "the postcoital privateness in which she met herself, welcomed herself, and joined herself in matchless harmony" (123). Sula's inability to find common understanding with anyone even during the act of sex demonstrates her complete inwardness and alienation from inter-personal relationships.

The question immediately arises: If Sula offers no genuine intimacy towards her male partners, then why are men constantly drawn toward her? Sula challenges men with her capriciousness. Sula herself seems "beyond good and evil" and seems without a superego or conscience. This, coupled with her capriciousness, gives her a strange and amoral innocence, even as she violates communal laws. Sula's innocence is denoted during her death, when she assumes the fetal position: "that she might draw her legs up to her chest, close her eyes, put her thumb in her mouth and float over and down the tunnels…and she would curl into its heavy softness and it would envelop her…" (149). Sula's free spirit is an inviting challenge to her male partners, who seemingly desire to gain control over her. These men soon realize failure, for Sula "tries them out and discards them without any excuse the men can swallow" (115). These men are left feeling both rejected and defeated, as are their wives.

When the community finds out that Sula had placed Eva in the nursing home and that Sula had mocked the town through her sexual practices, they begin to see her as a malicious, evil woman. The gossip that spreads soon incites rumors about her, which ultimately leads to her reputation as a devil. Sula's character shifts from the free-spirited rebel who scoffs at her community to the manifestation of evil. Sula is mythologized after returning to the Bottom, for in all her opposition and spite for the community she seems like a stranger or an outsider. The selection of the victim is explained by René Girard:

> The victim is a person who comes from elsewhere, a well-known stranger. He is invited to a feast which ends with his lynching. Why? He has done something he should not have done; his behavior is perceived as fatal; one of his gestures was misinterpreted… If the stranger behaves in a strange or insulting way in the eyes of his hosts, it is because he conforms to other customs. Beyond a certain threshold of ethnocentrism the stranger becomes, for better or worse, truly mythological. The smallest misunderstanding can be disastrous. (1986 32)

The community's victimization of Sula is irrational, for it is founded on a bias and created from fiction and myth. Although the community will not form a lynch mob against her, Sula is condemned because she is seen as different, and because the community wishes to alleviate its fears through displacing their guilt upon her. As Girard points out:

> The less rational the persecutors' conviction the more formidable that conviction becomes… Admittedly, scapegoats cure neither real epidemics nor droughts nor floods. But the main dimension of every crisis is the way in which it affects human relations. A process of bad reciprocity is its own initiator; it gains nourishment from itself and has no need of external causes in order to continue. As long as external causes exist, such as an epidemic of plague for example, scapegoats will have no efficacy. On the other hand, when these causes no longer exist, the first scapegoat to appear will bring an end to the crisis by eliminating all the interpersonal repercussions in the concentration of all evildoing in the person of one victim. (1986 43)

Sula thus becomes the repair for the dysfunction and sufferings of the people of her community, and she ultimately becomes a mythologized human sacrifice.

The mytholization of Sula becomes a demonization reminiscent the witch trials of seventeenth century Europe, which is historically known to be a large-scale case of society's creation of a scapegoat. The citizens of the Bottom use Sula's physical characteristics as a means to demonize her. The most conspicuous aspect of Sula's appearance is the birthmark over her eye. Nel, who generally avoids involvement with the community's victimization, considers the birthmark a stemmed rose. However, the rest of the community regards it as something quite sinister, referring to it as "that evil birthmark" (115). The birthmark is also called a "rattlesnake," indicating that the community sees her as a sort of evil trickster or temptress (104). Perhaps the most damning interpretation of the birthmark was by Teapot's Mamma, who saw it as "Hannah's ashes marking her from the very beginning" (114). Although the birthmark is merely a natural genetic flaw, it serves the community as another reason to condemn her. In the same way, the community builds further evidence that Sula is a devil by considering other "peculiar" aspects of her physical appearance. The rumors spread quickly that "Sula did not look her age. She was near thirty and, unlike them, had lost no teeth, suffered no bruises, developed no ring of fat at the waist or pocket at the back of her neck… she was free of any normal signs of vulnerability… when she drank beer she never belched" (115). The community judges Sula on the fact that she seems inhuman, that is, invulnerable to the signs of suffering and ugliness that plagues the entire community. Hence, they identify her as being otherly and inherently evil.

More rumors were spread by the citizens of the Bottom. They remembered the plague of robins that had accompanied Sula's return and considered it to be the work of Sula's evil magic. The community was also convinced that Sula had simply watched as her mother burned to death, showing no concern whatsoever. The community blames Sula for Mr. Finley's death, when he "saw Sula, choked on a bone and died on the spot" (114). When it was found out that Shadrack, a rejected citizen in his own right, had tipped his hat to Sula, they were called "two devils" (117). One of the most compelling rumors involved Sula's alleged engagement in what was considered taboo by the citizens of the Bottom—Sula's sexual relations with white men. The community felt that "there was nothing lower she could do, nothing filthier…They insisted that all unions between white men and black women be rape; for a black woman to be willing was literally unthinkable" (113). It must be noted that these particular forms of evidence were not required by the community to deem Sula a witch, but are rather the arbitrary results of Sula's victimization. These particular rumors themselves are not crucially important, for the community would eventually accumulate enough evidence to pass judgment on her as a demon, no matter what form the rumors took. Sula is condemned to become the scapegoat simply by her rebellious nature toward the Bottom; her erroneous mytholization as a demon is merely the community's means of shifting guilt and blame onto her.

There are some fascinating parallels between the mytholization of the scapegoat in Sula and the witch craze of seventeenth century Europe. Although the scapegoats were created for different reasons, both cases include a variety of erroneous, mythical claims made against the victim in order to render the victim 'otherly' and 'inherently evil.' Just as Sula was considered dangerous by her community, so did many Europeans claim that witches posed a threat to the safety and well-being of Europe: "They can make men or women love or hate each other, they can be-witch and take the life of men or women, and

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likewise they can make spirits either to follow and trouble persons" (James 45). The witches were also thought to have the physical mark of evil on their bodies, what was known as the "devil's mark." While Sula's birthmark served this purpose, the witches allegedly receive the devil's mark on their bodies during a pact made with the devil. Thus, any woman with a peculiar mark on her body was subject to accusations of witchcraft. The witches also allegedly engaged in what was considered the most treacherous sin anyone could possibly commit: sexual relations with the devil himself. A witches' sabbat is described as:

> a lurid affair attended by numerous witches who flew in from considerable distances on broomsticks, shovels, spits, or a variety of domestic animals… The devil might appear to his congregants… Generally, the proceedings began with the witches kissing their master's rear…Incest and homosexual intercourse were encouraged. Often the devil would climax the proceedings by copulating. (Klaits 267)

This is comparable to Sula's professed sexual relations with white men, who are regarded by the Bottom as evil tricksters or devils, as shown by the "nigger joke" parable (4). Sexual relations with those who are intrinsically evil leads the witches and Sula to be considered also wholly evil. Thus, rumor and myth allow seventeenth century Europe and the community in Sula to create the scapegoat, an object of evil who carries the burden of the societies' guilt.

Interestingly, the displacement of guilt and hatred onto Sula actually works in temporarily strengthening the inter-personal relationships in the Bottom. When the community blames Sula for Teapot's broken arm, Teapot's "failure" of a mother becomes "the most devoted mother: sober, clean and industrious" (114). Other mothers also became more conscientious, for they "defended their positions as mothers from Sula's scorn for the role" (153). The conviction of Sula's evil leads the town to become more unified as a whole: "Once the source of their personal misfortune was identified, they had leave to protect and love one another. They began to cherish their husbands and wives, protect their children, repair their homes and in general band together against the devil in their midst" (117). Just as separate countries may form an uneasy alliance against a threatening enemy, so does the community come together to defend their own "righteousness" from the menace of Sula's evil. Sula serves the purpose of pharmakos right up to her very death, after which the community "returned to a steeping resentment of the burdens of old people. Wives uncoddled their husbands; there seemed no further need to reinforce their vanity" (154). Without Sula to carry the guilt of the community, the Bottom naturally returns to its previous dysfunctional state.

In Toni Morrison's Sula, the dysfunctional and fearful community of the Bottom mitigates its fears by objectifying evil in mythologized yet tangible scapegoats. Since Sula's actions are rebellious and mocking in the eyes of her community, she eventually becomes one of these scapegoats, defined as a demon or witch who is a pernicious threat to the community. It would be too simple to say that either the community or Sula is completely guilty for Sula's condemnation, for both sides contribute to causing it. However, the community's ineptitude for dealing with abstract concepts such as the nature of evil can ultimately only prove destructive. While Sula's victimization may have served to temporarily "cure" the sociological disposition of the community, the community's need to objectify evil in mythologized, tangible forms never truly solves anything, and only maintains the community in a state of perpetual blindness to the essential nature of evil. The citizens of the Bottom live unexamined lives in this respect, and seem content with achieving a false sense of security by transferring their inherent guilt onto something external instead of accepting responsibility for themselves and their community. Is Toni Morrison critiquing the African-American community in Sula? It would seem so. However, Morrison could also be depicting the African-American populaton as a victimized community that, like Sula, has been oppressed, condemned, and finally shattered.

278

Works Cited

Carmean, Karen. Toni Morrison's World of Fiction. New York: The Whitston Publishing Company, 1993.

Christian, Barbara. "Community and Nature: The Novels of Toni Morrison," *Journal of Ethnic Studies* 7: 1980.

Frye, Northrop. Anatomy of Criticism. New Jersey: Princeton University Press, 1957.

Girard, Rene. The Scapegoat. Translated by Yvonne Freccero. Baltimore: The Johns Hopkins University Press, 1986.

Klaits, Joseph. Sexual Politics and Religious Reform in the Witch Craze. Bloomington: Indiana U., 1985.

King James I. Demonologie in Fomre of a Dialogue 1597 and Newes From Scotland. London: John Lane The Bodley Head Ltd, 1924.

Morrison, Toni. Sula. New York: Knopf, 1973. All references but the first will be noted in parentheses.

Stepto, Robert B.. "Intimate Things in Place: A Conversation with Toni Morrison." *Massachusetts Review* 18: 1977.

The Search for Innocence in the Art of Jean Cocteau

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From August 29th to November 1, 1997, the Huntington Art Gallery of the Jack S. Blanton Museum of the University of Texas at Austin will house the exhibition entitled, *The Search for Innocence in the Art of Jean Cocteau*. The following document is an excerpt from the exhibition's proposal.

EXHIBITION GOALS

The purpose of this exhibition is:

A. To curate an exhibition on Jean Cocteau using original source material from the University of Texas' vast holdings.
B. To raise public awareness of Jean Cocteau and the Blanton Museum
C. To satisfy Severin Wunderman's $3 million gift contract with the Blanton
D. To bring attention to the new campus museum that will contain a gallery dedicated to the Wunderman-Cocteau Collection
E. To promote the Austin performance of Philip Glass' version of *Les Enfants Terribles* scheduled to be performed on November 4, 1997 in Bass Concert Hall

EXPLANATION

The Frenchman, Jean Cocteau (1889-1963), was a true poet. He believed in and modeled himself after the Greek definition of "poet" in which the poet is equal to the creator. Cocteau's ultimate state of being was being an active poet. He created fanciful poetic drama in every facet of his life and art. A Renaissance man of art forms, Cocteau transformed his own poetic language into many diverse media including poems, novels, plays, essays, drawings, and films. Cocteau's work is controversial and has been called many things from outlandish, vulgar, sensitive, erotic, heavenly, to revolutionary.

As an artist, Cocteau continually sought to astound his audience by whatever means necessary. Cocteau was the complete antithesis of Flaubert who believed that "*...the artist must make posterity believe he never existed.*" Cocteau hungered for attention and directed it onto himself by fully integrating his life and art. He chose to exist on a plane between dreams and reality believing that art is "*...an accumulation of visions and sensations.*"

The exhibition, *The Search for Innocence in the Art of Jean Cocteau*, will focus on Cocteau's art relative to the theme of youth as it is deeply influenced by his addiction to opium and his religious beliefs. This exhibit highlights Cocteau's work from 1919-1935 and 1950-1963. The first period will discuss Cocteau's addiction to opium after the death of his friend and lover, Raymond Radiguet, by focusing on three series: *Jean L'Oiseleur*; *Les Enfants Terribles*; and the *Opium Series*. The second period will highlight the chapel frescoes at Villefranche-sur-mer, Menton, and Milly.

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It is important to understand that Cocteau repeatedly deals with the theme of innocence throughout his life in a variety of media. Cocteau's "innocents" are the characters he portrays as foolishly trustful or free from all evil. Cocteau admires the quality of innocence in all humans, but he attributes these traits mostly to children. Cocteau exploits the innocent by coloring them with his own views. He ingests mind altering drugs or interjects religious dogma. The manner in which Cocteau presents youth changes in relation to his own psychological development. When he takes opium, his innocents are gritty and raw characters. When Cocteau focuses on God, his representations of youth become cleaner and more joyous. The result is an interesting body of artwork that shows the spiritual evolution of one man.

Cocteau investigates questions of humanity by searching for innocence. Cocteau stands out as an individual and as an artist because his approach to these conventional questions is unconventional. Cocteau rejects his privileged upbringing, choosing to live an alternative lifestyle as a homosexual and drug user. Yet by the end of his life, he finds it necessary to reconcile himself with God and through his belief in Catholicism. Cocteau strives for immortality by finding redemption in religion and art through the theme of innocence.

Driven by an unending need to find his true identity, Cocteau is obsessed with escaping the present moment. Purposefully, he diverts himself from normal time searching for innocence. As a young man, Cocteau distorts his own vantage point by smoking opium to transcend from his normal view point. Later in life, Cocteau reconciles himself with Christianity while dwelling on his own mortality and eventual death. In both cases, Cocteau tries to abandon the present, believing he can try to understand life by being apart from it. This leaves Cocteau in a constant state of flux which provides him with a wealth of creative subject matter. Cocteau believes that, "*Art is the child of a kind of incest, the lovemaking of self and self, a parthenogenesis...all of us contain in ourselves a night we scarcely know or do not know at all. This night tries to emerge from us, yet resists emerging. That is the drama of art, a real struggle....*" By escaping actual time, Cocteau felt like he could find his "*night*," his inner source of innocence.

Cocteau's fascination with childhood can also be thought of as an adult in search of his own lost innocence. The majority of Cocteau's work deals with children or childlike emotions. Cocteau is intrigued by the simplicity of a child's life. Cocteau explores the stereotypical naughty and nice child. For example in *Les Enfants Terribles*, thought to be his most famous work, Cocteau pairs a strong female child with a weak, impressionable brother. He reveals their co-dependence, strengths and weaknesses. Cocteau admires the minds of children. In his own words, "*Childhood knows what it wants. It wants to emerge from childhood. The trouble starts when it does emerge. For youth knows what it does not want before it knows what it does want. But what it does not want is what we do want.*" The characters in *Les Enfants Terribles* exemplify this instability of youth.

Cocteau's art is dominated by religious imagery. He focuses on the pagan gods of the Greeks as well as the Christian God. He believes, "One must envision art as a priesthood." Toward the end of his life, he undergoes a Catholic reconciliation. He does this to face his own fear of death. Cocteau is uncertain of what the afterlife will bring, so he comes back to the Catholic Church of his youth. This change in personal philosophy also brings about a dramatic change in his art. Cocteau begins to paint frescoes on churches in the south of France. One of the churches he adorns with his work is located in Villefranche-sur-mer, a church that Cocteau had spent much time in as a young child. His motivations for painting the religious frescoes were two-fold. Cocteau desires to inspire the fisherman's children, the innocents, to think and dream of a higher power like God. Second, Cocteau studies and copies the works of art masters like Giotto, Mantegna and Michelangelo. By leaving murals on the walls, he feels that he is gaining immortality.

EXHIBITION CHECKLIST

YOUTH	
L'Enfant Terrible	Pen and ink on paper
Tete d'enfant	Pastel on gray paper
Jeunesse de Tolstoi	Brown crayon and black pencil on paper
Les Enfants Terrible	India ink on paper
Les Enfants Terrible	Ink on paper
Les Enfants Terrible	Ink on paper
Les Enfants Terrible	Ink on paper
Les Enfants Terrible	Ink on paper
Les Enfants Terrible	Ink on paper
Les Enfants Terrible	Ink on paper
Les Enfants Terrible	Ink on paper
Visage d'enfant	Pastel on paper
Les Voleurs d'enfants	Lithograph
Untitled (Boys Posing)	Lithograph
Untitled (Five Small Boys)	Lithograph
Jeune Homme Velo	Pencil on paper
Raymond Radiguet	Pen and India ink on paper
Study, Young Aviator	Graphite on paper
Color study, Young Aviator	Pen, pencil, & colored pencil on paper
Young Aviator	Gouache, pen, and collage on board
Four Guerriers	Pen and ink on paper
Le Boule et Neige Terrible	Pen and ink on paper
Boys in the Street with Snowball	Pen and ink on paper
Le retour dans le basimetre	Pen and ink on paper
Third picture from Les Parents Terribles	Pencil, blue and red crayon on paper
L.E.T.	Pen and ink on paper
OPIUM	
Relief for Opium	Collage on Board, pen, India ink, pencil on paper
Fumeur d'opium	Pen and India ink on paper and laid down on paper
Dessin pour Opium	Pen, India ink with graphite and traces of gouache on paper
Dessin pour Opium	Pen, ink and pencil on paper
Opium: vue impregnable	Pen and ink on paper
Un reveil du brule hopital laque menthe	Pen and ink on paper
Opium: Le Sens du Futur	Pen, ink and pencil on paper
Opium: Le Perroquet	
Opium: Le Drust ou l'effet de l'opium brut	Pen, India ink, and ink wash on paper
En souvenir d'opium	Collage with gouache, pen and ink
Tete geometrique	Felt-tip pen on paper
RELIGION	
Le Christ	Graphite and colored pencils on paper
L'Ange	Felt-tip pen on paper
L'Ange	Pen, ink and watercolor on paper
Dessin pour decor, Les Enfants Terribles	Pencil on gray paper
Affiche: Villefranche-sur-mer	Lithograph
La Chapelle de Villefranch	Lithograph
La Madone et l'Enfant	Glass Sculpture

Etude pour Villefranche	Pencil on paper
La Crucifixion	Brown and black felt-tip pens on paper
Mur de droite	Lithograph
D'apres Mantegne	Lithograph
La Chapelle St. Pierre	Lithograph
Etude pour le Christ	Lithograph
Etude d'apres Michel Ange	Lithograph
Villefranche-sur-mer	Lithograph

EVENTS

The following are suggested events to take place in conjunction with Gallery Exhibition:

Screening of the Film *La Voix Humaine* -Introductory Lecture By Dr. Penny Marcus

Screening of other Cocteau films from Blanton Museum Collection with Les Enfants Terribles, Les Parents Terribles, Orphee and La Belle et La Bete

Noon Gallery Talk with Dr. Jean-Pierre Cauvin on *Cocteau and his Contemporaries*

Noon Gallery Talk with Alex Wettlaufer on *French Art and Culture Early 20th Century*

Noon Gallery Talk with Dr. Christopher Middleton on *Poets and Poetry*

Voix Humaine or scene from *Les Enfants Terribles*)

Playing of music in Gallery by local Erik Satie master Jehan Mitchell or other UT musicians

READINGS AND REFERENCES

- Alexandra and Carol Saltus eds. Jean Cocteau and the French Scene. New York: Abbeville Press Publishers, 1984.
- Brown, Frederick. An Impersonation of Angels: A Biography of Jean Cocteau. New York: The Viking Press, 1968.
- Cocteau, Jean. Diary of an Unknown. Trans. by Jesse Browner. New York: Pragon House Publishers, 1988.
- Cocteau, Jean. Souvenir Portraits : Paris in the Belle Epoque. Trans. Jesse Browner. New York: Paragon House, 1990.
- Huntington Art Gallery of the University of Texas at Austin: Severin Wunderman Collection
- Rothschild, Deborah Menaker. Picasso's Parade: From Street to Stage. Ballet by Jean Cocteau. Score by Eric Satie. Choreography by Leonide Massine. New York: Sotheby's Publications and The Drawing Center, 1991.
- Steegmuller, Francis. Cocteau: A Bibliography. Boston: David R. Godine, Nonpareil Books, 1986.

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Preferences of Positive Reinforcers Among Elementary Students

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The purpose of this study was to determine the preferences of positive reinforcers among elementary students. A sample of 346 fourth and fifth grade students was given a questionnaire in which each child rated different types of reinforcers. Each student also chose a reinforcer that he/she most liked and one he/she least liked. It was found that: (1) Primary and activity reinforcers were more preferred reinforcers; (2) Girls rated their preferences for primary, social and token reinforcers significantly higher than boys; (3) Students with grades of C/D rated their preferences for activity reinforcers significantly lower than students with grades of A/B or B/C; (4) Of the twenty reinforcers, the five most preferred were sundae party, coke break, game day, extra recess, and good grades; the five least preferred were progress charts, telling parents about good behavior, stickers, compliments to the student, and candy. The results could be applied by teachers when selecting positive reinforcers.

INTRODUCTION

Positive reinforcers have been used in the elementary classroom as a motivational strategy, according to Paul Chance. Chance adds that it is frequently the teacher that chooses what the reinforcers will be and the instructor makes these choices based on what he/she believes the students prefer. However, the positive reinforcers that the teacher chooses may or may not reflect the true preferences of the student and in order for reinforcers to be effective, they must be, "relevant and meaningful to the child" (Thompson, 1978). The purpose of this study is to determine the preferences of positive reinforcers among elementary students. More specifically, this study was conducted to address the following questions:

1. Which types of positive reinforcers were most and least preferred by the students?
2. Were there any differences of preferences of reinforcers between boys and girls? Among A/B, B/C, and C/D students, were there any

differences in preferences?

3. Which specific reinforcers were the most liked and least liked by the elementary students?

METHOD

Subjects

The subjects in this study consisted of 178 male elementary students and 168 female elementary students. The sample was drawn from several school districts in central Indiana. Included in this sample were 16 classes of fourth and fifth grades. There were 8 classes at each level.

Instruments

A twenty item questionnaire was used. Four different categories of positive reinforcers (primary, token, social, and activity) were used in statements such as, "I would enjoy earning good grades as a reward." Each statement was rated by the students on a four point Likert scale which ranged from "strongly agree" (4) to "strongly disagree" (1). The total range possibility, for each child in each category was from 5 to 20. The lower scores show a general dislike in the reinforcers.

Also included as a means to check response consistency, were two open ended questions. Each child was asked to choose one reinforcer from the list that was his/her favorite and state the reasoning behind this choice. Each child was also instructed to choose the reinforcer that was the least desirable to him/her and state the reasoning for that choice.

Procedure

The teachers of the 16 selected classrooms administered the questionnaires to their classes. The questionnaires were compiled and subdivided into six categories as seen in Table 1.

Table 1: Number of Students in Each Category

CATEGORIES	NUMBER OF FEMALE STUDENTS	NUMBER OF MALE STUDENTS
A/B Students	107	90
B/C Students	50	71
C/D Students	11	17

Among the subdivisions, the ratings of the statements were totaled according to type of reinforcer and the mean and standard deviation were calculated. The open ended questions, most liked and least liked reinforcer, were ranked based on frequency for each reinforcer. The rankings were compared within the subdivisions of male/female and A/B, B/C, and C/D students to determine which reinforcers were the most liked and which ones were the least liked. The written responses to these questions were also reviewed to provide more insight. Together, the statistics from the twenty questions, the rankings of the most and least liked reinforcers and the responses were compared to determine preferences of these positive reinforcers among elementary students.

285

RESULTS

Categories of Reinforcers

Inspection of Table 2 revealed that the most preferred categories of reinforcers were activity and primary reinforcers; the least preferred were social and token reinforcers. The means for each category of reinforcer, based on responses by each subgroup, is presented in this table. A 2 X 3 (sex x grade) ANOVA was performed for each category to test whether there were any significant differences.

Table 2: Means of Reinforcers Preferred by Fourth and Fifth Grade Students

TYPE OF REINFORCER		A/B	B/C	C/D
ACTIVITY	Male	16.69	17.44	15.35
	Female	16.52	16.50	15.82
PRIMARY	Male	16.98	16.53	14.88
	Female	16.91	16.94	17.00
SOCIAL	Male	14.47	13.56	13.00
	Female	14.73	15.18	14.18
TOKEN	Male	14.69	14.13	13.71
	Female	15.50	15.42	15.82

The results of ANOVA for activity reinforcers showed that there were no significant difference in preference ratings between boys and girls. However, C/D students' ratings were significantly lower than A/B and B/C students. (F= 6.56; df= 2, 340; P <.01).

The results of ANOVA for primary reinforcers showed that girls' preference ratings were significantly higher than boys (F= 5.41; df=1, 340; P < .05) and that there was no difference among students with A/B, B/C, and C/D grades.

The results of ANOVA for social reinforcers indicated that there was a significant difference in preferences with respect to gender. Girls rated social reinforcers higher than boys (F= 5.29; df= 1, 340; P < .05). Again, no difference was found among A/B, B/C, and C/D students.

The results of ANOVA for token reinforcers indicated that girls were significantly higher in their preference ratings than boys (F= 14.66; df= 1, 340; P <.001). Students with A/B, B/C and C/D grades showed no difference in their preference ratings.

Most and Least Liked Reinforcers

Table 3 shows the frequency of each specific reinforcer that was mentioned as most liked and least liked. The five most liked reinforcers are sundae party, coke break, game day, extra recess and good grades. The five least liked reinforcers are progress charts, telling parents about good behavior, stickers, compliments to the student, and candy.

Table 3: Frequency of Each Reinforcer

REINFORCER	Frequency for most liked	Frequency for least liked
1. stickers	1	36
2. student of the month	11	8
3. watching movies	14	10
4. cookies and milk	10	20
5. good grades	25	11
6. call parents	6	52
7. extra recess	25	5
8. coke break	62	2
9. certificates	2	9
10. letters of praise	2	21
11. eat lunch with teacher	18	20
12. popcorn party	0	19
13. end of the year award	10	5
14. words of praise	1	12
15. play games	2	4
16. sundae party	88	0
17. progress charts	7	73
18. compliments from teacher	5	40
19. game day as a class	46	11
20. candy	11	24

The correlation between the frequency scores for the most liked and the least liked reinforcer was significant (r= -.74; df= 18; $P < .01$). Thus indicating that student responses were consistent.

CONCLUSIONS

In general, elementary students preferred activity and primary reinforcers to token and social reinforcers. As a group, girls rated their preferences of reinforcers higher than boys. The differences were statistically significant with respect to primary, social, and token reinforcers. Thompson's study also found that girls rated social reinforcers higher than boys. As a group, C/D students rated lower than A/B and B/C students in their preferences of reinforcers; however, the difference was significant only for activity reinforcers. The Thompson study supports this finding. Based on students' choices, the five reinforcers they liked most were sundae party, coke break, game day, good grades, and extra recess. The five reinforcers they liked least were progress charts, calling parents about good behavior, stickers, compliments to the student, and candy.

The findings in this study may provide some guidelines for the teachers who would apply positive reinforcers in their teaching and learning activities.

REFERENCES

Chance, Paul. "Sticking Up for Rewards". Phi Delta Kappan Number 10. 1993.

Thompson, L.J. "Reinforcement Principles". Research Bulletin Number 3. 1978.

Implementation of Civil Rights Policy in Education

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Although equal education opportunity continues to be a goal in the process of attainment, public education is the arena where civil rights legislation has been implemented the most successfully. In 1985, the United States was in a three-way tie for second place among sixteen nations in a study for spending on all levels of education at the figure of 6.8 percent of national income (Cochran 1995, 292). However, more is spent by the United States on post-secondary education than in any other nation. This leaves our K-12 institutions at a gross disadvantage especially when factoring in the redistributive nature of resources which has been a detriment to minority education. For this K-12 population, "the United States spends less than all but two of these [sixteen] nations" (Cochran 1995, 292). According to Pierre Bourdieu, this disparity in our educational system has made it the leading factor, beyond family, church, or workplace, to determine the transmission of social stratification across generations (Cochran 1995, 297). The historical implementation of civil rights legislation is discussed through major Supreme Court decisions and Congressional acts concerning school desegregation. Then, the future implementation is determined through analysis of what needs to be and has been done and the aim in this process.

SCHOOL DESEGREGATION

In order to discuss the implementation of policies with regard to civil rights policy in education, the major decisions and acts need to first be outlined. *Brown v. Board of Education* (1954, 1955) called for the desegregation of schools which had been segregated by state or local statutes. The Civil Rights Act of 1964 authorized the active pursuit of desegregation through litigation, negotiation, and fund termination by the Justice Department and the Department of Health, Education, and Welfare (HEW). *Green v. New Kent County School Board* (1968) required the elimination of dual schools. *Swann v. Charlotte-Mecklenburg Board of Education* (1971) cited busing as an acceptable remedy. The Supreme Court found, in *Keyes v. School District No. 1* (1973), illegal segregation in a non-Southern school. In 1977, Congress began to use its appropriations powers to place limitations on busing by prohibiting federal authorities from requiring busing. Each of these decisions, and their individual effects, need to be explored in further detail to determine their specific impact on the implementation process for civil rights policy in education.

The school desegregation movement, beginning with the 1954 *Brown* decision, spearheaded the NAACP's efforts to attain equality of opportunity. The implementation of this decision has failed more miserably than it may seem when casually looking at the statistics. Racial integration on a school-by-school level has gained some ground, but students are often retracked at the classroom level. The success has also been limited, in part, by the two-faced mannerisms of the north. "Ironically, today the greatest degree of racial segregation occurs in the Northeast and the least is in the South" (Mickelson 1995, 292). Desegregation programs, if they are well-run, have been shown through research to benefit minority and majority children both academically and socially (Mickelson 1995, 292). Still today, implementation has largely

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failed because most schools continue to be segregated by race, ethnicity, and class, and this has led to largely unequal education between these groups.

Success in the implementation of the 1954 *Brown* decision has also been limited by the lack of attention given to the family background of the student. Public policy dealing with desegregation, instead of focusing on the poor and minority children and their families as the ultimate sources of unequal school outcomes, directed its effort at the operation of the schools. Research has shown that schools have minimal effect when compared to family background, but the effect that schools do have in reinforcing the disadvantages of race and class are due almost entirely to the unequal, and still segregated education received by minorities.

The three sections applicable to education in the Civil Rights Act of 1964 greatly aided the implementation of desegregation policy. "The new legislation contained provisions that:

1. authorized the Justice Department to sue school districts on behalf of black students (Title IV)
2. authorized the Justice Department to join school desegregation suits filed by private plaintiffs (Title IX)
3. directed that institutions that segregated be denied federal funds (Title VI)" (Bullock 1984, 57).

No longer was the burden of desegregation placed on black parents with the financial resources and the bravery to battle both the system and white hostility. The vast resources of the Justice Department were better equipped to successfully challenge segregation than individuals' efforts could be. The obstacle of the long appeal process in the courts was finally overcome, in 1964, as the cutoff of federal education funds to unresponsive districts and federally sponsored litigation were authorized.

Green v. New Kent County School Board (1968) stated, for the benefit of uncooperative schools and in unmistakable language, that schools had "the affirmative duty to take whatever steps might be necessary to convert to a unitary system in which racial discrimination would be eliminated root and branch" (Bullock 1984, 58).

Swann v. Charlotte-Mecklenburg Board of Education (1971) stated that, despite the inconvenience it posed for some, students would be bused out of their neighborhood school districts to other districts in order to achieve the racial balance necessary to follow the letter of the law.

Keyes v. School District No. 1 (1973) upheld the double standard between Northern and Southern schools. *Keyes*, in failing to rule de facto segregation as unconstitutional, allowed the disparities between North and South to remain. The South has been held to a standard of eliminating substantial racial imbalance. The North, without regard for its more demanding standards placed on others, has resorted to the redrawing of school attendance zones and optional attendance zones in the local government to keep blacks and whites separated despite the intent of the law.

Congress impeded the implementation of equal education in 1977 through a series of legislative checks on the use of busing. In the wake of this legislation, HEW was prohibited from requiring schools to use busing to promote racial balance, and the neighborhood school concepts, leading to mostly segregated schools, were favored.

WHAT NEEDS TO BE DONE AND WHAT HAS BEEN SUCCESSFUL?

Seven guidelines need to be met, to some extent, in order for the successful implementation of civil rights policy in education to occur. First of-all, the policy's goals need to be clear. The most change occurred when the ambiguity of the objectives was partially resolved. HEW and the courts, as they specified more precisely what was required of the districts, had more success. The multiple objectives of policies such as ESAA need to be narrowed to a more direct, all encompassing goal that increases the chances for successful implementation. Secondly, standards for change need to be specified that are quantitative and can be measured. The subjectivity of measurements, such as the intent of the districts, allowed too much freedom of interpretation in districts that still received federal money such as ESAA funding. Third, although the effectiveness of HEW's Office for Civil Rights (OCR) is questionable, the presence of an enforcement agency is an asset to an implementation program. This requirement can not be effective alone, but it definitely can aid in implementation. Fourth, monitoring by OCR has had an impact on the districts within its jurisdiction. Its visits, inspections, and interviews allowed adjustments to be made more expediently when problems arose. Fifth, OCR, as a new agency, was committed to its goals and was filled with zealots. OCR's commitment needs to continue to be strengthened even as it ages. OCR's primary goal should not change over the years, and its primary purpose should not be its own maintenance as an existing agency. Sixth, presidential support needs to remain behind desegregation efforts for it to be equally successful on a national level. Pressure was first put on the South and on rural areas with less political clout, and it is not a coincidence that they are the most desegregated areas. As presidential support tapered off, the North and urban areas were not held to the same standards as the South and rural areas. Finally, federal involvement, more than just presidential support, in desegregation is important to its success. The more pressure a district feels from the federal government, the more willing it is to alter its programs. Largely due to this factor, the South has been more effective than the North at desegregation because they received this additional pressure from the federal government. Overall, implementation has varied greatly throughout time and across districts. Different combinations of the above factors have led both to times of great success and to times of minimal progress. (Bullock 1984, 75-86)

WHAT DO WE AIM FOR NOW?

John Rawls proposes the solution promising the greatest probability of success in equality of outcomes in education. He holds that "only those inequalities are justified which are to the benefit of the least advantaged. Only inequalities of position or resources that result in greater productivity and thereby provide greater benefits to all, may be justified" (Cochran 1995, 310). The only way to have truly equal outcomes in education is to delete "accidents of birth." This is especially true when accounting for the disadvantages of both race and class suffered by so many blacks in our society. In order for justice to prevail, the common good needs to be placed before individual liberties in education to benefit both our economy and our society as a whole.

Education is a fundamental part of the necessary action which is required to reverse the unequal footing that racial status causes in our society. Although many solutions are conscious of race, the goal should be total nondiscrimination both in law and in practice. "To be sure, in 1963, Dr. King told the world of his dream - a nation where his children would 'not be judged by the color of their skin but by the content of their character.' Dr. King, however knew that not judging by skin color was a goal and was not the entire route to progress" (Berry 1996, 58). Racial equality needs to be central to all policies implemented, especially in education, until society becomes color-blind and equality on the basis of race is accomplished without added effort or thought.

REFERENCES

Berry, Mary Frances. "'Plessy v. Ferguson' Separate has never been equal," Emerge, (May 1996), p. 54-58.

Bullock III, Charles S. and Charles M. Lamb, Implementation of Civil Rights Policy (Monterey, California: Brooks/Cole Publishing Company, 1984).

Cochran, Charles L. and Eloise F. Malone, Public Policy: Perspectives & Choices. (New York: McGraw-Hill, Inc., 1995).

Mickelson, Roslyn Arlin and Stephen Samuel Smith, "Education and the Struggle Against Race, Class, and Gender Inequality," Race, Class, and Gender Second Edition, (Belmont, California: Wadsworth Publishing Company, 1995).

Jewish resistance to the Nazi occupation of Lithuania and Belarus during World War II

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It is commonly believed that the Jewish population of Europe did not resist the Nazi genocide. However, there were many instances of armed resistance in both city ghettos and rural area. This research traces the development and effect of the earliest Jewish resistance in Lithuania and Belarus, two countries where independent Jewish resistance and partisan organizations first formed. Evidence suggests that potentially large numbers of Jews in those areas were not passive to the threat, but actively resisted the Nazi efforts at extermination.

Resource material has been obtained from published historical documents and surveys and from primary resource material authored by persons involved in resistance activities. Additional qualitative research was conducted by personal interviews with resistance participants during the researcher's travels in the areas studied.

This research studies four examples of Jewish resistance in Lithuania and Belarus. These include the resistance movements in the cities of Vilna, Lithuania and in Minsk and Glebokie, both in Belarus and the Jewish partisan movement based in the Nalibocki forest west of Minsk. For the purpose of this research, Jewish resistance is defined as any Jew taking up arms against the Nazis or their sympathizers or Jews actively involved in sabotage activities.

It is important to understand the circumstances surrounding the perceived passivity among Europe's Jews to the Nazi threat. Historically, European and Russian Jewry had been subject to grievous persecution, anti-Semitism and murder for centuries prior to the Nazis rise. From medieval times into the 20th century, hatred towards Jews was a common theme throughout Europe. Over the centuries, thousands of Jews had been murdered, expelled from their homelands or forced into ghettos in countries across Europe. In the early stages, Europe's Jews accepted their persecution by Nazi Germany as one more phase in their long history of European anti-Semitism.

On June 24, 1941, the city of Vilna, Lithuania was captured by invading German army forces. Vilna fell less than 48 hours after the commencement of the invasion. Despite summary executions and confinement of the cities Jewish population into two ghettos, life continued for Vilna's Jews at a somewhat normal existence. In September, 1941 the 10,000 residents of the medieval ghetto were taken away and shot.

There was a major difference between what happened in Vilna and other occupied cities where Jews were targeted for mass exterminations. In western European countries and in the occupied East, Jews would be transported hundreds of miles to extermination camps. By contrast, Vilna's Jews were executed in the Ponar woods, just 6 miles south of the city center. It was apparent only weeks into the occupation the fate that awaited the Jews of Vilna.

On January 23, 1942, during the same week the Wannsee Conference convened in Berlin to plan the Final Solution, representatives from Vilna's Jewish political and religious organizations allied into a resistance group named the Farinikte Partisaner Organizatsia, the United Partisan Organization. The FPO became the first Jewish resistance group organized in any Nazi occupied country.

The FPO's primary objective was organization of a ghetto revolt by its Jewish population against the Nazi occupiers. By the time of the FPO's organization nearly half of Vilna's 80,000 Jews had been executed. Still, the FPO did not gain popular support within the ghetto or succeed in convincing large numbers to join them. The Nazi-appointed Jewish council argued that armed resistance would only aggravate the situation and ultimately cause more deaths. This was a fatal assumption for in September, 1943 the Vilna ghetto was liquidated. About 200 FPO fighters escaped to the forests around Vilna by using the sewers as their route out of the city.

Despite its failure to incite revolt, the FPO engaged in an aggressive sabotage campaign against the Nazi occupiers. FPO members destroyed rail lines and blew up at least one German troop train. FPO members working in forced labor camps disabled hundreds weapons being assembled for the German troops in the camp factory. FPO saboteurs burned a warehouse containing 60,000 winter coats bound for the front and destroyed large quantities of fuel, ammunition and equipment vital to the German army. The FPO's sabotage campaign against the German army was arguably the most successful aspect of resistance carried on by any Jewish group during the war.

Perhaps the most important legacy of the Vilna resistance organization was its ability to spread the idea of armed resistance to other cities, most notably Warsaw, Poland. It was a direct result of notification from the Vilna FPO that alerted Jewish leaders in other cities to the Nazi threat and allowed for the establishment of resistance organizations in other locations.

Minsk, Belarus was captured on June 28th, 6 days after the German invasion of Russia. During the 3 year occupation, Minsk served as the capital of the Reich Commissariat Ostland, a geographic district that included the Baltic countries and much of what is now western Belarus. German General Wilhelm Kube was named Reichskommisar for the Ostland and governed from offices in Minsk.

Starting in July, 1941 Minsk's Jewish population was restricted to a ghetto. By the beginning of January, 1942 only 25,000 of the original 100,000 occupants of the ghetto remained alive. During the fall of 1941, an anti-German underground emerged in the city and began organizing escapes from the ghetto into the surrounding forests. Unlike in Vilna, where the FPO attempted resistance from within the ghetto, Minsk's Jewish population realized attempts at ghetto revolt would be futile.

Jewish escapees formed into a seven independent partisan groups aiming to assist further escapes from the ghetto. These seven partisan groups were instrumental in assisting in the escape of nearly 10,000 Jews from the Minsk ghetto. This was the largest number of Jews saved by any Jewish partisan group during the war.

In addition to assisting in escape from the Minsk ghetto, Jewish partisan groups played a prominent role in sabotage activities. In July, 1942 500 children from the Rotomskaya Street Jewish Orphanage were forced into a large excavation near the ghetto gate. While General Wilhelm Kube threw the children candy, German soldiers opened fire, killing the 500.

Jewish partisans were instrumental in planning the assassination of Kube. Kube, who called Jews "the main bearers of the partisan activity in the East", was killed in 1943 by a bomb placed under his bed by a woman partisan employed in Kube's headquarters as a domestic servant.

The Jewish resistance was not limited only to large city ghettos. A force of nearly 300 fighters used the Glebokie, Belarus Jewish ghetto as a base of operation. Glebokie is a small town located 150 kilometers northwest of Minsk.

In August, 1943, as a response to continued ghetto unrest and to prevent Glebokie's Jewish partisans from joining Russian partisan groups in the nearby forests, German army units surrounded the ghetto and ordered the remaining Jews to prepare for 'resettlement' transportation. The Germans were met with small arms fire and grenades. For three days, Glebokie's Jews fought against the Germans until finally running out of ammunition. The partisans set the ghetto on fire and attempted to escape to the forests. A small number was successful, but the majority was captured and executed.

In 1941, Tuvia Bielski, a Belarussian Jew, and 16 others, established a refuge in the Nalibocki forest west of Minsk for Jews fleeing the Nazis. The Nalibocki forest is the largest forest in eastern Europe and for much of the war served as a base of operations for many partisan groups operating in western Belarus and eastern Poland.

By 1943 the Bielski group had grown to nearly 1,500 Jewish men, women and children. The group functioned as a structured community hidden within the confines of the forest. It was divided into two segments: the Bielski Brigade and the Zhukov Detachment. The Bielski Brigade, comprised of skilled and semi-skilled individuals such as medical workers, blacksmiths, bakers and tailors operated as a support group for the larger Russian-backed partisan groups in the forest.

The Zhukov Detachment was militarily active throughout the war as adjunct fighters to the Russian partisans. They specifically targeted sympathizers known to have collaborated with the Nazis against Jews. Tuvia Bielski survived the war, immigrated to America, and in 1995 was awarded the inaugural Medal of Resistance from the US Holocaust Memorial Museum.

Research indicates the four examples studied were not the only instances of Jewish resistance to the Nazis. It has become increasingly clear that Jews in Lithuania and Belarus were

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were not passive to the German threat but actively sought to resist the extermination attempts.

Research additionally revealed that as many as 20,000 Jews fought the Germans from partisan groups in these areas. Another 10,000 Jews survived the war by taking refuge with partisans. This 30,000 figure is relatively small compared to the total 6,000,000 Jews murdered by the Nazis but can be considered a significant number when compared to the approximately 800,000 Jews killed by the Nazis in the areas researched.

Despite these numbers, resistance Jews offered against the Nazis cannot be overlooked or minimized. Perhaps it can best be summed up by a quotation from the Talmud, the ancient commentary on the Jewish laws: "Whoever destroys a single life destroys the entire world, whoever saves a single life, saves the entire world."

References

Ainsztein, R. (1974). Jewish resistance in Nazi-occupied Eastern Europe.
New York: Harper & Row Publishers.
Barkai, M., editor. (1962). The fighting ghettos. Philadelphia: J.B. Lippincott Company.
Botwinick, R.S. (1995). A history of the Holocaust: From ideology to annihilation.
Upper Saddle River, NJ: Prentice Hall.
Calvocoressi, P., & Wint, G. (1972). Total war: The story of World War II.
New York: Pantheon Books.
Cohen, I. (1943). Vilna. Philadelphia: Jewish Publication Society of America.
Dawidowicz, L. (1975). The war against the Jews 1933-1945.
New York: Holt, Rinehart & Winston.
Dobroszycki, L., & Gurock, J.S., editors. (1993). The Holocaust in the Soviet Union.
Armonk, NY: M.E. Sharpe.
Eckman, L. & Lazar, C. (1977). The Jewish resistance. New York: Shengold Publishers.
Ehrenburg, I., & Grossman, V., editors. (1980). The black book: The ruthless murderof Jews by German-Fascist invaders throughout the temporarily-occupied regions of the Soviet Union and in the death camps of Poland during the war of 1941-1945.
New York: Holocaust Library.
Jewish resistance during the Holocaust: Proceedings of the Conference on Manifestations of Jewish resistance. (1971). Jerusalem: Yad Vashem.
Kowalski, I. (1969). A secret press in Nazi Europe: The story of the Jewish United Partisan Organization. New York: Central Guide Publishers.
Kowalski, I., editor. (1986). Anthology on armed Jewish resistance 1939-1945.
Brooklyn, NY: Jewish Combatants Publishers House.
Lazar, C. (1985). Destruction and resistance: A history of the partisan movement in Vilna.
New York: Shengold Publishers.
Levin, N. (1968). The Holocaust: The destruction of European Jewry 1933-1945.
New York: Thomas P. Crowell Company.
Stokesbury, J.L. (1980). A short history of World War II.
New York: William Morrow and Company.
Syrkin, M. (1947). Blessed is the match: The story of Jewish resistance.
Philadelphia: Jewish Publication Society of America.
Tec, N. (1993). Defiance: The Bielski partisans.
New York: Oxford University Press.
United States Holocaust Memorial Museum. (1996). Historical atlas of the Holocaust.
New York: Macmillan Publishing Company.
Waletzky, J. (1986). Partisans of Vilna [Videocassette, VHS].
Washington, DC: Euro-American Home Video.
Yahil, L. (1990). The Holocaust: The fate of European Jewry, 1932-1945.
New York: Oxford University Press.

Peddling Public Assistance: The Children's Bureau and the Aid to Dependent Children Program in the Social Security Act of 1935

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When President Franklin D. Roosevelt addressed Congress on June 8, 1934, about the chief accomplishments of the New Deal, he eloquently claimed: "Among our objectives I place the security of the men, women, and children of the Nation first...the security of the home, the security of livelihood, and the security of social insurance are, it seems to me, a minimum of the promise that we can offer the American people" (*The Reports of the Committee on Economic Security* 136, 139). Shortly thereafter he issued Executive Order No. 6757 which allowed for the establishment of a Committee on Economic Security to make "recommendations concerning proposals which in its judgment will promote greater economic security" (*The Reports of the Committee on Economic Security* 140). FDR's initial vision of Economic Security excluded provisions for aid to a multiplicity of groups, including a public assistance program for women with dependent children. It was Katherine Lenroot, Grace Abbott, and Martha Eliot of the U.S. Children's Bureau who wrote Title IV, the Aid to Dependent Children program (ADC), and asked Edwin Witte, the Executive Director of the Economic Security Committee, to include it in the Economic Security Bill.

The Children's Bureau's advocacy for ADC was rooted in the inability of individual state welfare systems, known commonly as "mothers' pensions" programs, to provide for the dramatically increasing numbers of impoverished single mothers and children during the Depression. In addition to the absence of mothers' pensions in Alabama, Georgia, and South Carolina, the economic crisis within the nation caused pension program in Arkansas, Mississippi, and New Mexico to be discontinued or rendered inoperable (Report on the Social Security Bill 10-11). The Federal Emergency Relief Administration's (FERA) attempts to compensate for the disintegrating state mothers' aid programs were moderately successful, but FERA was unable to sufficiently reach all the families with great need. The Children's Bureau was therefore motivated to advocate a permanent federal public assistance program because by 1935 "there were more than three times as many families on [Federal Emergency relief] as there were receipt of mothers' pensions" (*Hearings Before the Committee on Ways and Means* 159). That the Social Security Act of 1935 contained ADC shows the Children's Bureau's success in moving the federal government to recognize single mothers and their children as a group in need of some type of permanent assistance.

Yet in the attempt to make ADC palatable to the government and to guarantee its passage, the Children's Bureau marginalized the program in its conceptualization. The primary causes of this marginalization were the Children's Bureau's maternalist perceptions regarding single mothers and their pre-conceived ideas about these mothers' moral classification. Therefore, the Children's Bureau emphasized to a Congress disinterested in ADC, but concerned with unemployment, that this program took "the housekeeping-mother approach to the care of children," arguing that supporting mothers in the home decreased women's competition with male workers (Berry 105). In addition to these imposed limitations, the Children's Bureau severely restricted the overall reach of ADC by stressing the greater importance of Title V, by making crude estimations of the number of families eligible to receive aid, and by reducing the amount of federal allocations needed to operate the program. Title IV was thus inhibited by both theoretical and structural deficiencies, limitations which have contributed to making it the most harshly criticized welfare program in the United States.

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Maternalist ideas and attitudes toward single mothers and children in need were rooted in the beliefs of early twentieth century reformers. Single mothers had long been subjects of charity, pity, and moral discussion in the United States, although the designation "single mother" itself is a contemporary term. Reformers in the early twentieth century used more specific titles of widow, abandoned woman, unwed, or illegitimate mother, terms which hinted at the moral categories ascribed to these mothers. By the twentieth century most social reformers and feminists began to perceive this "problem" of single motherhood as a serious threat to the family and to the functioning of civil society. Most welfare advocates believed deeply in the moral family, which included a male breadwinner who provided means for his full-time domestic housewife and children. Social feminists too advocated the sphere of domesticity for women, arguing against mothers' employment because it took mothers out of the home and away from their child-rearing duties. Campaigns for welfare aid drew from these beliefs in the moral family and in cult of female domesticity, shaping the formulation and promotion of programs that aided single mothers and their children.

Welfare reformers and feminists indeed expressed genuine concern for the plight of single mothers, but many viewed deserted wives and unmarried mothers as the critical moral problem, and they allocated fault and determined worthiness with respect to relief (Gordon 25). Seeking to galvanize public support for welfare relief programs, social feminists in the early twentieth century de-emphasized the image of the immoral unwed mother by speaking exclusively in terms of providing aid to widows, since widows were blameless victims. In structuring the welfare dialogue around widows, the welfare reformers caused the stigmatization of unwed or deserted mothers to magnify, for in claiming the widow's innocence they insinuated the noninnocence of others (Gordon 27). While most reformers agreed that single mothers in general were victims of circumstance, what these reformers ultimately developed was a strict distinction between widows as the "deserving poor" and illegitimate mothers as the "undeserving poor."

These pre-conceived ideas regarding what "kind" of single mothers and families deserved aid pervaded what little dialogue occurred in the committee hearings and Congressional debate over Title IV. Of all the framers of ADC, Grace Abbott expressed succinctly how issues of the mothers' moral qualities were a central concern for the creation of a federal aid to dependent children program. In testimony before the Committee on Ways and Means on January 25, 1935, she reminded the board that ADC would assist people with strong moral fiber. She explained: "Usually the children are really nice children and the families are nice families" (*Hearings Before the Committee of Ways and Means* 496). Privately, Abbott's ideas regarding the distribution of federal aid evidence how resolute her pre-conceived biases toward particular single mothers were. She adamantly believed that "for successful administration of mothers' aid laws it is necessary to establish by investigation the need of the mother and her moral and physical fitness to maintain the home" (276). The Committee on Ways and Means did not question Abbott's assumptions, and included them in an April 5, 1935 report to the House. The Committee gave the states considerable leniency to "impose...eligibility requirements--as to means, moral character, etc.,--as it sees fit" when distributing ADC funds (*Report on the Social Security Bill* 24). The final draft of the bill did not include this provision verbatim, instead it couched the idea in a nebulous phrase, enabling the states to conduct "such other investigations as the Board may find necessary" (*The Reports of the Committee on Economic Security* 10).

Following the maternalist reform tradition further, the Children's Bureau and its supporters believed it to be crucial that mothers remained within the home and out of the work force. Considerable effort during the Depression was put forth in general to prevent women from entering the work force and many women with jobs were fired due to the emphasis of putting men to work. ADC thus became attractive to politicians in Congress worried about unemployment figure because it supplied financial assistance to single mothers' in the home with their children, theoretically preventing them from working in the public sphere. This emphasis upon keeping mothers within the domestic sphere asserted that supporting needy single mothers in the caring for their children guaranteed future economic and social security. Grace Abbott concluded that this argument summarized "the whole idea of mothers' pensions...that [funds] should be enough to care for the children adequately, to keep the mother at home and thus give some security in the home" (*Hearings Before the Committee of Ways and Means* 495).

In addition to their discussion of moral and employment concerns, the Children's Bureau limited the scope of ADC by placing greater emphasis upon other components of the Economic Security Bill. The Children's Bureau focused primarily upon Title V of the bill, which, similar to the defunct Sheppard-Towner Act, established a national program for child and maternal public health services. Historian Linda Gordon explains that "they [the Children's Bureau] had been agitating for this from very early on in Roosevelt's administration and ranked this program first in the recommendation they made to Witte" (257). The Children's Bureau regarded ADC to be a temporary supplement to this health services program, a belief reflected in how they deliberately separated ADC from the public health services program. As Grace Abbott indicated in her testimony before the Committee on Ways and Means, the basic measures of ADC were "to a very considerable extent ... a child welfare program" (493). Title IV in the Social Security Act of 1935 thus emerged as a timid and modest effort to provide financial assistance to single mothers and their dependent children.

When writing and presenting Title IV, the Children's Bureau and its supporters further restricted the overall reach of ADC by making very conservative and inaccurate estimates about the number of single mothers and children the program would aid. The framers insisted that ADC was designed to cover the unusual cases of need, which according to Title IV in the Social Security Act were children "under the age of sixteen who [have] been deprived of parental support or care by reason of the death, continued absence from the home, or physical or mental incapacity of a parent" (*Reports of the Committee on Economic Security* 11). The Children's Bureau's research revealed that "there were above 350,000 families on [emergency] relief, the head of which was a widowed, separated, or divorced mother and whose other members were children under 16" (*Report on the Social Security Bill* 10). However, the Committee on Economic Security agreed with Edwin Witte that not all of these 350,000 families were dependent (*Hearings Before the Committee on Ways and Means* 161). The framers of ADC therefore assumed "that half of the relief families [350,000] headed by widowed, separated, and divorced women with dependent children under the age of 16 years would be found eligible for aid to dependent children" (*Social Security in America* 248). Surmising that only 179,000 of these families would qualify for ADC, the Children's Bureau added to that figure the number of families, 109,000, receiving mothers' pensions. The Children's Bureau ultimately concluded from these estimates that 300,000 families at most were in need of ADC.

Why this modest estimation was used demonstrates the Children's Bureau's wish to keep the program small, avoid controversy, and guarantee ADC's passage. The purpose in exploring these limitations is not to reproach and vilify the ADC framers and supporters, but instead to indicate the structural deficiencies of Title IV. The Children's Bureau clearly and purposely remained silent about the number of unwed or abandoned mothers from their discussion of whom would qualify for ADC. Their exclusion of unmarried and deserted mothers from Congressional dialogue shows that a moral classification between deserving and undeserving poor remained a cogent perception for them. Thus, the absurdly low and inaccurate calculation of eligible families made by the Children's Bureau evidences "their desire to make [ADC] an elite assistance program, to serve only the deserving, perhaps even the exemplary" (Gordon 257).

Based upon this limited estimation, the grants-in-aid to states given by the federal government to administer ADC covered only one-third of the total expenditures, an inferior allocation when compared to other Social Security programs. The Children's Bureau chief, Katherine Lenroot, acknowledged to the Committee on Ways and Means that "the amounts of money included in the bill are very conservative," and that larger requests might well have been justified (263). The Children's Bureau thus estimated the total annual outlay for ADC to be $120 million, about $125 million less than what was then being spent to support the families currently on emergency relief and mothers' aid (Coll 104). The Children's Bureau and its supporters, however, never pushed for a greater allocation from the federal government. Few welfare advocates in Congress extended the arguments of Representative Robison of Kentucky, who argued that the Title IV measures were "grossly inadequate" and would indeed be a "great disappointment to the millions of needy children" (*Congressional Record* 5695). According to Edwin Witte, "that the grants to states for [ADC] were limited to one-third of their expenditures, while the grants for old-age assistance and blind pensions are for one-half of the expenditures, reflects this lack of interest [in Congress] in the aid to dependent children" (164).

Yet Witte's rationalization does not entirely absolve the Children's Bureau's failure to demand that the federal grants be changed to the one-half figure. Certainly the ADC framers and supporters faced a Congress with a "current political interest in the aged" (Abbott 229). That political reality was recognized by the Children's Bureau, and they understood that they had a much smaller constituency endorsing their cause. However, in spite of the excessive attention given to the aged, even detractors of the Economic Security Bill in Congress expressed support for a federal aid to dependent children program. Representative Treadway of Massachusetts voiced his opposition to Federal Old-Age Benefits, Unemployment Insurance, and Federal Income Taxes, but resoundingly affirmed his favor for Title IV (*Congressional Record* 5529). The Children's Bureau basically feared losing Congressional support and federal funds for their programs, for Title V especially, and therefore they "did not feel it was wise to raise the point" of challenging the one-third appropriation (Witte 165).

The one-third figure remained in Title IV when the bill was enacted in August of 1935. The provision went unchanged until 1939 when most of the programs in the Social Security Act of 1935 were amended. However, the limitations and deficiencies within the framework of ADC endured. The maternalist emphasis upon providing aid to mothers within the home to care for their children continued to be largely counterproductive. ADC payments were often insufficient, and in 1940 "three fourths of ADC mothers worked, most in part-time low-paying jobs" (Coll 119). The Social Security Act of 1935 and its multiple amendments have become the foundations for the welfare state, but the programs have subsequently made a distinction between public assistance and social insurance. This differentiation has enabled public policy to discriminate invidiously between categories of dependent people. The elderly, the unemployed, and the disabled worker may claim aid as a right of social insurance. However, women with dependent children in general have been "morally tarred" by their association with relief in the contemporary assistance program Aid to Families with Dependent Children (Katz 15-16).

In spite of the current problems with ADC, we must recognize that the program was part of a constructive effort by the Children's Bureau to create a firm foundation within federal legislation for the extension of public welfare to single mothers and their children. Edwin Witte admits that had the Children's Bureau not pressed the Committee on Economic Security on the issue of ADC, "nothing would have been done on this subject" (164). We must not minimize the achievements of the Children's Bureau and its supporters. Yet we must likewise acknowledge the theoretical and structural limitations they imposed upon their framing and promotion of ADC.

The Children's Bureau had a unique opportunity in 1935 to create a program for assisting single mothers and their children. In Europe and Scandinavia, reformers and welfare advocates expressed that there was an "endowment of motherhood," and they largely based the construction of their welfare states upon this idea. The preoccupation with the aged and the pervasiveness of pre-conceived beliefs toward single mothers, however, marginalized the U.S. Children's Bureau's conceptualization and institution of Title IV. In their efforts to promote the public assistance program, the Children's Bureau undeniably insinuated the relative inferiority of certain single mothers, imposed great limitations on the scope of ADC, and implied that there might indeed be a "deserving poor." Yet, Title IV of the Social Security Act of 1935 must be considered both a significant and a problematic beginning, and as Linda Gordon concludes: "Our task is to continue" (306).

REFERENCES

Abbott, Grace. *From Relief to Social Security: The Development of the New Public Welfare Services and Their Administration.* Chicago: University of Chicago Press, 1941.

Berry, Mary Frances. *The Politics of Parenthood: Child Care, Women's Rights, and the Myth of the Good Mother.* New York: Penguin Books, 1993.

Coll, Blanche D. *Safety Net: Welfare and Social Security, 1929-1979.* New Brunswick: Rutgers University Press, 1995.

Gordon, Linda. *Pitied But Not Entitled: Single Mothers and the History of Welfare, 1890-1935.* New York: Maxwell Macmillan International, 1994.

Katz, Michael B. *The Undeserving Poor: From the War on Poverty To the War on Welfare.* New York: Pantheon Books, 1989.

The Report of the Committee on Economic Security of 1935: And Other Basic Documents Relating to the Development of the Social Security Act. Washington: National Conference on Social Welfare, 1985.

Robison. *Congressional Record: Proceedings and Debates of the First Session of the 74th Congress.* Vol. 79. Part 5. Washington: U.S. Government Printing Office, 1935.

Social Security in America: The Factual Background of the Social Security Act as Summarized from the Staff Reports to the Committee on Economic Security. Washington, D.C.: United States Government Printing Office, 1937.

Treadway, M. *Congressional Record: Proceedings and Debates of the First Session of the 74th Congress.* Vol. 79. Part 5. Washington: U.S. Government Printing Office, 1935.

United States Congress. House. "Hearings Before the Committee on ways and Means: Economic Security Act." 74th Congress, 1st session. House Committee on Ways and Means, January, 1935. H.R. 4120. Washington: U.S. Government Printing Office, 1935.

United States Congress. House. "Report on the Social Security Bill." 74th Congress, 1st Session. House Committee on Ways and Means, April 5, 1935. Report No. 615. Washington: U.S. Government Printing Office, 1935.

Witte, Edwin Emil. *The Development of the Social Security Act: A Memorandum on the History of the Committee on Economic Security and Drafting and Legislative History of the Social Security Act.* Madison: University of Wisconsin Press, 1962.

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A Case Study of the Tax Reform Initiative by Marylanders

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This study examines the Tax Reform Initiative by Marylanders to ascertain why Prince George's County residents viewed the existing tax cap as an effective tool for holding elected officials fiscally responsible. The data collected for this study covered the seven month period before the November 5, 1997 election. The substantive findings from this research suggest that tax caps are justifiable and effective in Prince George's County which has even larger implications for the state of Maryland.

INTRODUCTION

Studies on tax reform in the United States have concentrated on the issues of tax limitations and public service finance (see, for example, Catterall and Thresher 1979, Picus 1979, Ladd and Boatwright-Wilson 1952, Brighton and Northup 1990, Miler 1969, Grasberger 1971, Newfeld 1977, Walker 1984, Day 1989). In their drive to build theories about tax reform, researches have utilized the case study approach to investigate the issue. This approach allows researchers to investigate a contemporary phenomenon within its real life contexts. Although the case study approach is very useful in examining a phenomenon, many times, it is too broad. This broadness does not allow for an examination of sub-levels within the phenomenon.

Thus, employing the same approach, this study examines the sub-level of tax reform. More specifically, it deals with tax caps as applied in Prince George's County, Maryland. This study seeks to examine the systemic aggregation of the inputs, outputs, and feedback offered by Prince Georgians' regarding the current tax cap. Tax cap issues have become increasingly important to voters locally and nationally. Many taxpayers feel that tax caps are justifiable because they force elected officials to be fiscally responsible. However, others feel that they are cumbersome, unnecessary, and severely restrict elected officials. This essay attempts to show how the electorate and elected officials feel about tax caps.

The major questions of this research are as follows: (1) Are tax caps justifiable and effective? (2) Why did the majority of Prince Georgians vote against the repeal of TRIM?

THEORETICAL FRAMEWORK

Systems analysis is the mode of study employed in this research. The primary components of systems analysis are the transformational process, inputs, outputs, and feedback.

The transformational process is the political system. The political system authoritatively allocates the values for society. Inputs into the political system include those of the actors who initiate demands and lend support. Demand is an expression intended to influence the political system so that the actor receives a favorable output which also favors his/her interests. Supports are the remaining transactions that exist after demands have been subtracted. Outputs are the authoritative decisions and actions of the system's leaders that bear on the allocation of values for the system (Easton:49). Feedback encompasses the response(s) of the people regarding government output. This feedback can be positive, which equals acceptance, or negative, which equals rejection.

299

RESEARCH MTHODOLOGY

The research methodology employed for this research is qualitative. Revenues gained by taxes provide for the economic stability of the county. However, taxpayers wanted to know whether removing the cap would provide for more efficient public services and lend to stability. For this essay, efficiency and stability are examination factors. The basic assumption is that there is a connection between the Tax Reform Initiative by Marylanders and Prince Georgians' perceptions of tax caps. More specifically, the underlying proposition is that there is a negative association between the Tax Reform Initiative by Marylanders and the current state of public service programs within the county. This proposition is testable because efficiency is examined in terms of the minimum waste and expense in current tax revenues and stability is examined in terms of continuous inputs into existing public service programs. Generality is achieved because the results of the November 5 election can be projected to predict future action on "like" issues. The Tax Reform Initiative is examined on a micro level because only Prince George's County is being examined.

INPUTS OF COUNTY RESIDENTS FOR THE REPEAL OF TRIM

Proponents of TRIM's repeal tried to influence the political system in Prince George's County so they could receive the favorable output of TRIM's repeal. Since the initial discussion regarding TRIM, many organizations lobbied for its repeal and promulgated continuous supports to persuade county residents to vote for its repeal. These organizations included the Prince George's Revenue Initiative Dedicated to Excellence (PRIDE), the Chamber of Commerce, several religious coalitions, and many others. Their arguments, in sum, were: (1) TRIM limits the flexibility of the county government to provide resources necessary to meet taxpayer expectations; (2) TRIM does not allow a rate adjustment to maintain county revenues in times when property assessments decline, and (3) TRIM does not allow county legislators to shift revenues by adjusting rates.

OUTPUTS OF COUNTY RESIDENTS FOR TRIM'S REPEAL

Many county legislators, members of the school board and the county executive contributed much action to facilitate TRIM's repeal. By their actions [both negative and positive], they hoped to influence the values of Prince Georgians' by convincing them that TRIM was wrong for the county. Before the November 5 election, the county executive outlined a $63 million spending plan that was based on TRIM's repeal. Curry's plan showed how the additional revenues would cost the homeowner, as represented in Table 1.

TABLE 1: ADDITIONAL REVENUES FROM TRIM'S REPEAL AND THE TELEPHONE TAX

TRIM's Repeal	Total Cost	Annual Cost to Homeowner	Total Revenues
Reallocations of current rates (*)			
(*) M-NCPPC	$ 6 cents	$0	$13 million
(*) Stormwater Management	$ 2 cents		
Rate Increases (+)			
(+) Affects all property taxes commercial and residential	$.12 cents	$65	$20 million
Telephone Tax			
All bills – commercial and residential	10%	$36 (1st $10/month exempt)	$30 million
		$101 a year $8.42 per month	$63 million

The figures in Table 1 show that the increased revenues would be raised by increasing the county's combined property tax rate by $.12 cents per $100 of assessed valuation and by creating a 10% tax on telephone service. The county executive estimated that this plan would cost the typical homeowner only $101 a year or $8.42 per month.

INPUTS OF COUNTY RESIDENTS AGAINST TRIM'S REPEAL

Opponents of TRIM's repeal also tried to influence the political system in Prince George's County so they could receive the favorable output of TRIM's continuance. In addition to the county residents who were opposed to TRIM, organizations such as the Truth iN Taxation Committee (TNT) and the Interfaith Action Committee offered tremendous support to prohibit TRIM's repeal. Their arguments, in sum were: (1) Voters should be given the authority to approve all new taxes and/or fees; (2) There should be a mandated guarantee that revenues raised for education and public safety will go to those entities; and (3) Hidden taxes [telephone and energy] should be discouraged.

OUTPUTS OF COUNTY RESIDENTS AGAINST TRIM'S REPEAL

On this end, there were also county legislators and many county residents who offered a significant amount of opposition to those in favor of repealing TRIM. These opponents of TRIM's repeal criticized PRIDE, the county executive and other legislators who pledged their support for TRIM's repeal. They also hoped to influence the values of the countys' taxpayers by convincing them that TRIM was advantageous for the county because if forced elected officials to be fiscally responsible for the current revenues. The opponents of the TRIM cap argued that: (1) the repeal of TRIM was unnecessary because county revenues had increased as the tax base within the county grew; and (2) raising the tax rate could drive away homeowners and businesses from the county.

FEEDBACK FROM THE LACK OF TRIM'S REPEAL

The feedback of proponents for TRIM's repeal was negative; however, the feedback of opponents against TRIM's repeal was positive. After a long political battle with continuous inputs and outputs by the opposing spheres, TRIM was not repeal on November 5. The results can be seen in Table 2.

TABLE 2: RESULTS FOR THE TAX REFERENDUMS

<table>
<tr><td colspan="4">Question B: To repeal the limit on the real property tax rate of the county and to require that any increase in the tax rate greater than the rate in effect in the prior fiscal year be approved by an affirmative vote of two-thirds of members of the full council.</td></tr>
<tr><td>% of Votes YES</td><td>% of Votes NO</td><td>Numeric # — YES</td><td>Numeric # — NO</td></tr>
<tr><td>36</td><td>64</td><td>76,325</td><td>119,054</td></tr>
<tr><td colspan="4">Question I: To provide that any ordinance or resolution levying or charging certain taxes or fees in excess of the amount levied or charged in the preceding fiscal year shall be referred to referendum of the qualified voters.</td></tr>
<tr><td>% of Votes YES</td><td>% of Votes NO</td><td>Numeric # — YES</td><td>Numeric # — NO</td></tr>
<tr><td>62</td><td>38</td><td>113,331</td><td>68,704</td></tr>
</table>

The figures in Table 2 show that Prince Georgians' failed to repeal TRIM and approved Question I. These figures show that county residents are serious about having control over how their tax dollars are spent. The feedback for opponents of TRIM's repeal was positive because many residents had reservations about the repeal measure from the initial debate. Their reservations included: (1) the ballot question did not specify that any increase in tax dollars would go to schools and public services; (2) Prince Georgians pay the second highest combined property tax rate in the state; and (3) [before the November 5 vote] elected officials appeared to have something to hide from the taxpayers because they were highly evasive when questioned about the repeal effort.

TRANSFORMATIONAL PROCESS OF INPUTS AND OUTPUTS

There were many societal organizations that sought to authoritatively allocate their resources of demand and support to sanction and prohibit TRIM's repeal. However, in spite of all their efforts, neither the proponents for TRIM's repeal nor the opponents for TRIM's continuance could implement their demands or supports because "government" is the only institution that makes binding decisions for society. Prince Georgians voted not to repeal TRIM on November 5 and, consequently, the county government — the county executive and the county legislature — must adhere to the mandate of the people and make decisions, possibly negative in their application, which would compensate for the shortfall in funds

CONCLUSION

The systems analysis framework, as identified by "inputs", "outputs", and "feedback" is a useful tool for comparing the manner in which the proponents for TRIM's repeal nor the opponents for TRIM's continuance formulated demands and supports to sanction or prohibit TRIM's repeal. This approach provides a rigorous and disciplined framework by which data can be methodically organized and interpreted. Thus, systemic aggregation of relevant information makes a genuine comparison between proponents and opponents' views on repealing TRIM.

At the same time, this paradigm must be criticized for its shortcomings and inadequacies. Systems analysis is too broad and generalized and does not follow the analysis of concrete subsystems such as cultural, social, and racial factors. More concrete tools must be developed to investigate these areas and the role they played in the failure to repeal TRIM. Despite its shortcomings, systems analysis proves to be a strong preliminary tool for comparing the opposing spheres of the TRIM debate.

This research sought to demonstrate that voters in Prince George's County, Maryland strongly believe that tax caps are, indeed, justifiable and effective because they force elected officials to be fiscally responsible and accountable to the taxpayer. Repeal of the tax cap would not have provided for substantial public service efficiency or stability because the additional revenues were not earmarked for any specific area. Prince Georgians realized that public service funds are severely deficient; yet, they were not willing to give elected officials the "go-ahead" to raise their taxes by an unspecified amount. Many of these residents would not give the green light to elected officials because the believed that they are wasting their money on items such as highly favorable pension packages and unwarranted wage increase for top county officials. Prince Georgians hold firm to the belief that the county government will never be satisfied with the amount of money if receives from the taxpayers. Thus, they sent the very strong message on November 5 that they [the voters] will keep a close tab on taxes and the re-allocation of those revenues.

BIBLIOGRAPHY

Brighton, Deb and Jim Northup. The Tax Base and the Tax Bill. Tax Implications of Development. September 1990.

Catterall, James and Thomas Thresher. "Proposition 13: The Campaign, the Vote, and the Immediate Aftereffects for California Schools." California. March 1979.

Day, Susan G. "Public School Financing: Is It Fact or Fiction?" Planning and Changing. 1989:195-205.

Easton, David. A Framework for Political Analysis. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. 1965.

Grasberger, Friederick J. "A Country Income Tax for Education? A Report Prepared for the Monroe County Educational Planning Committee." October 1971.

Ladd, Helen F. and Julie Boatright-Wilson. "Who Supports Tax Limitations: Evidence from Massachusetts Proposition 2 1/2." Boston. January 1982.

Newfeld, John L. "Taxrate Referenda and Property Taxpayer's Revolt." National Journal December 1977:441-456.

Picus, Larry. "California and Proposition 13: A Brief Analysis." Oregon. July 1979

Walker, Billy D. "The local Property Tax for Public Schools: Some Historical Perspectives." Journal of Education. 1984:265-288.

Famous and Forgotten The Life and Death of *The Dubuque Dial*, 1934-1935

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In June of 1934, a radical literary magazine came off the presses in a small town along the Mississippi The editor, Karlton Kelm, at the age of 25, launched one of his biggest experiments, *The Dubuque Dial*, a literary magazine publishing short stories Although Kelm chose an unlikely city for the unveiling of a literary experiment, the time was right Out of nationwide despair, rose a plethora of writers energized by the need to document and understand the unprecedented tragedy of the Depression. The emergence of social protest literature in 1932 was one literary movement that catalyzed writers Many writers immersed in the trauma of the human condition during the Depression were influenced by Marxist ideology, cultivating themes of economic determinism, class struggle, capitalist decadence, and proletarian revolution.[1]

In this radically changing literary world, Karlton Kelm emerged as both writer and editor At the age of 25, Kelm had appeared twice in *The American Mercury*, and in 18 magazines Kelm's decision to launch *The Dubuque Dial* in 1934, in the unlikely city of Dubuque, at the height of the Depression, was only one color on Kelm's literary palette In 1936 Kelm published two novels, *The Cherry Bed* and *Brother*. The young editor also came close to having a play, co-written by his brother, produced on Broadway Despite his ambitions as a playwright, Kelm entered the world of the editor with the publication of *The Dubuque Dial*.[2]

Yet unlike many other editors, Kelm dared to hope that small town neighbors and local farmers, themselves only half-alive, might find new energy in radical literature. Kelm's original idea was to publish only Iowa writers Despite the new literary atmosphere the Depression created, however, Kelm's success was uncertain from the outset. Part of his success depended on acceptance of his experiment Kelm, however, was pulled by his own literary ambition, as well as the need to have his experiment accepted by his literary peers and the general public While Kelm kept one eye on his own literary ambition, his other eye watched for a response to his newest experiment Kelm's hope rested in the words of his literary peer, Josephine Herbst, "There is room for many kinds of writing in this country, or there ought to be."[3]

Although Kelm ultimately abandoned his original idea to publish only Iowa writers by the second issue of the magazine, he continued to attempt to introduce the Midwest as a new player in the literary world Many of the writers included in the magazine, such as Meridel Le Sueur, possessed both Midwestern origins and literary fame, enabling Kelm to tickle the pride of the community while satisfying literary critics.[4]

The content of *The Dubuque Dial* also seemed to attempt to appeal to a more general audience Although the magazine's more obvious themes related to the Depression itself and proletarian literature, *The Dubuque Dial* also represented other issues stemming from Depression life Themes relating to class conflict, the plight of women, and living in the moment all occupied a significant place in the magazine As K.C Shelby wrote to Karlton

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[1] Charlotte Nikola and Paula Rabinowitz, eds *Writing Red* New York The Feminist Press, 1987, pp 1, 26-30

[2] Camelia Waite "A Note On Karlton Kelm" *The Blue Pencil* August, 1934, p 3 Catherine Laux "Second time around better" *The Jersey Journal* February 28, 1985
Papers of Karlton and William Kelm Special Collections University of Iowa, Iowa City

[3] Stephen Halpert and Richard Johns, eds *A Return to Pagany* Boston Beacon Press, 1969 p.369

[4] Papers of Karlton and William Kelm Special Collections University of Iowa, Iowa City

Kelm, "I know, too, that *The Dubuque Dial* is not, strictly speaking, a proletarian magazine."[5] Many of the themes in *The Dubuque Dial* were not purely proletarian, on the other hand, themes such as social class tension often stemmed from proletarian issues.

The proletarian issues found in the magazine tended to vary in perspective. For example, Josephine Herbst seemed to place hope in the working class citizen's ability to survive the suffering and misery of life. In her story "You Can Live Forever," Amos Wendel, a worker, was glorified as a survivor. Others, such as Fred R. Miller and Emanuel Berkenfeld appeared to attack the capitalist system. Miller's "The Go-Cart Race" demonstrated the pitiful attempt of an immigrant family trying to realize the American dream. Berkenfeld's "Liberty Take a Bow" demonstrated the suffering experienced by the poor when capitalism and patriotism hid the effects of poverty.[6]

Several stories offered critiques of the economic system, yet maintained a focus on the immediate lives of the victims. In "Sunday," Thomas Cummings used the drowsy, indifferent atmosphere of a Sunday afternoon to bring out the characters' attitudes toward their livelihood, and toward one another. The characters Cummings created were lost in the shuffle of an economic nightmare, yet were so immersed in the horror of their positions, that they were unable to attack the system that produced the horror.[7]

Because survival consumed the lives of the characters, there seemed little sense of the future in most of *The Dubuque Dial's* stories. The two boys' conversation with the used car salesman in "Sunday," for example, illustrated a numbed response to the future. Similarly, in "Cistern," a woman instinctively jumped into a cistern to save the life of a child who symbolized her unhappy marriage. The woman's economic position forced her to marry, for survival, a man she did not love. Yet, she unhesitatingly sacrificed her own life to save her husband's child.[8]

The writers' choice to convey characters without panic in the face of inevitable devastation gave *The Dubuque Dial* a dark tone. The characters in the magazine seemed beyond the stage of a human response to calamity. They are reduced to actors rather than elevated to humans through their struggles to overcome the Depression and the economic system in which they existed. For example, in many stories the characters never expressed a sense of the future because actions were repetitive and cyclical.

This sense of being trapped in the present, in a pattern of living only for survival, however, was not unchallenged in the magazine. Proletarian themes again surfaced as class conflict was a very popular theme in many of the short stories. Although most stories dealt with the world of working class people, many stories contained vivid attacks on both the upper class and the upward mobility aspirations among all classes. In Karlton Kelm's "Hat Story," the superior attitude of a young lady eventually caused her downfall. Kelm continued his criticism of the destructive power of popularity and upper class aspirations in the second issue of *The Dubuque Dial* in his story "Greetings." Instead of one person being destroyed, an entire family was destroyed by their persistent competition for popularity among the town's wealthy citizens.[9]

Other writers, such as Robert O'Erisman, concentrated on positive ways to deal with class conflict. In his story "Chart of a New Friendship," a young man's experience with the superficiality of his wealthy girlfriend's family caused him to develop pride outside of social status. Stories like O'Erisman's showed the connection *The Dubuque Dial* appeared to have with proletarian issues. Often, the working class characters triumphed in the end. Moreover, the transformation of the main character from intimidation to confidence also appeared related to proletarian issues. As the Depression worsened, this sense of pride or triumph probably developed increasing importance as more and more people succumbed to poverty and the toppling class structure. Josephine W. Johnson's story took the concept of pride one step

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[5] Letter from K.C. Shelby to Karlton Kelm. Jan. 11, 1935. Papers of Karlton and William Kelm. Special Collections. University of Iowa, Iowa City.

[6] Josephine Herbst. "You Can Live Forever." *The Dubuque Dial*. June-December, 1934, pp. 1-5. Fred R. Miller. "The Go-Cart Race." *The Dubuque Dial*. June, 1935, pp. 53-57. Emanuel Berkenfeld. "Liberty Take a Bow," *The Dubuque Dial*. December, 1935, pp. 81-87.

[7] Thomas Cummings. "Sunday," *The Dubuque Dial*. December 1934, pp. 32-34.

[8] Raymond Kresensky. "Cistern." *The Dubuque Dial*. June-December 1934, pp. 10-12.

[9] Karlton Kelm. "Hat Story." *The Dubuque Dial*. June-December 1934, pp. 20-22. Karlton Kelm. "Greetings." *The Dubuque Dial*. December 1934, pp. 45-49.

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further Johnson's story seemed to say that true knowledge of suffering and misery is better than a life of ignorance and protection In the proletarian atmosphere of *The Dubuque Dial*, higher status was awarded to those closest to the brute realities of life [10]

Although only 12 of the 42 stories in *The Dubuque Dial* were written by women, a large portion of the magazine's stories dealt with the plight of women Some of these stories remained centered on proletarian sentiment, while others seemed absent of such themes Dora Klar's "Three Days at the Zoo," for example, reflected proletarian themes As the woman in the story climbed the ladder of success, she became increasingly superficial and complacent Other stories seemed more concerned with social issues than political issues In David Cornel De Jong's "Autumn is Beautiful" the main character, a woman, is conveyed as strong, capable of overcoming poverty and moral decay in an effort to salvage the family [11]

Perhaps *The Dubuque Dial's* most powerful characteristic, however, rested in its diverse representations of the Depression itself Some writers depicted the strength of the sufferers, while others chose to tell the story of the Depression's demons Some writers saw hope, while others saw despair In the end, *The Dubuque Dial's* short stories revealed much about the various effects a world of mass poverty had on its victims Whether related to proletarian themes, or completely empty of them, *The Dubuque Dial* offered a vivid picture of the Depression's ramifications on humanity

Bruce Minton's "A Farmer Never Learns," depicted the despair of the Depression For the characters in Minton's story, the source of their suffering was not an act of nature, visible and horrific, but a man-made disaster, invisible and insidious In Minton's story, a tomato buyer swindled the poorest, most desperate farmers out of a higher price for their tomatoes The farmers, who toiled all year to keep their land, sold to a market they did not understand before their crops were even planted Minton described the cycle through one farmer's words, "And the farmer believes all your talk about markets and money being tight, and sells his stuff at a loss its stealing bread out of a fellows mouth The harder we work, the harder we get hit"[12]

Alice Sanner's "Spring On an Iowa Hill," however, was clearly rooted in hope. Unrelated to proletarian themes, Sanner's story placed the cause of the Depression in nature, rather than a political system After a farm family watched its economic survival eradicated in a dust storm, the mother placed hope in her unborn child Even though the woman's family believed it was the end of the world, the mother continued to place hope in the future For Alice Sanner, this presence of the unrealized future defied the idea that the Depression signified an end [13]

Unlike Sanner's central character, hope failed to save *The Dubuque Dial*. After the fourth issue circulated, the magazine abruptly ended -- a fifth issue never materialized The most obvious cause of the death of *The Dubuque Dial* could be attributed to the magazine's financial situation Although it did not pay contributors, the magazine's financial records showed that the first three issues of the magazine failed to make a profit The Federal Writers' Project also may have killed *The Dubuque Dial*. Although the project was not put together until the summer of 1935, well into the magazine's run, Iowa was one of the first states to utilize the project The Project lured at least two writers published in the magazine, Meridel Le Sueur and Raymond Kresensky, state director of the project in Iowa. The Writers' Project may have nourished Le Sueur and others, but it spelled trouble for the Kelms The Project probably would not have been willing to support a magazine affiliated with radical, proletarian literature [14]

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[10] Robert O'Erisman "Chart of a New Friendship" *The Dubuque Dial* June 1935, pp 75-78 Josephine W Johnson "Safe" *The Dubuque Dial* December 1934, pp 62-66

[11] Dora Klar "Three Days at the Zoo" *The Dubuque Dial* December 1934, pp 38-41 David Cornel De Jong "Autumn is Beautiful" *The Dubuque Dial* December, 1934, pp 30-32

[12] Bruce Minton "A Farmer Never Learns" *The Dubuque Dial*. June 1935, p 70

[13] Alice Sanner "Spring On an Iowa Hill" *The Dubuque Dial* June 1935, p 75

[14] Income and expenses statistics Box 5 Dates are not listed --statistics on the fourth issue are also not present Papers of Karlton and William Kelm Special Collections University of Iowa, Iowa City Meridel Le Sueur *North Star Country* Lincoln University of Nebraska Press, 1945, p xxi Joseph Frazier Wall *Federal Writers' Project of the Works Progress Administration for the State of Iowa*. *The WPA Guide to 1930's Iowa* Ames Iowa State University Press, 1986, p xi-xii

Kelm's own literary ambitions also played a role in the demise of the magazine. For example, The Federal Writers' Project brought changes to the Kelms. At least one letter regarding a play the Kelms had written passed between the Kelms and Susan Glaspell, Director of the Midwest Play Bureau of the Works Progress Administration. It seems the project appealed to the Kelms--offering new opportunities at the expense of their initial experiment. Sensing a potential for success, the brothers left for New York in 1936, where they produced three plays that made it to the tryout stage in Broadway. Although the play based on Karlton Kelm's novel *Brother*, came extremely close to production, none of the plays ever materialized on Broadway. The Kelms left Dubuque and their magazine for New York, only to abandon writing after the failure of the plays.[15]

In the end, *The Dubuque Dial* proved a worthwhile experiment. It brought to life both the effects of the Depression on the region and the Depression's effects on the nation as a whole. Although Kelm never transformed the Midwest into a literary Mecca, he did awaken the minds of critics and call attention to the plight of the Midwest. Still, *The Dubuque Dial's* explosion into the world and abrupt disappearance resonated only briefly. One of the last comments on the magazine was written May 1, 1935, by Erling Larsen, "It is too bad so many little magazines don't live long, but then many of them don't deserve to. I hope the Dial does. I know it is deserving of life, long life. I am anxious to see the new issue"[16]

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[15] Letter from Susan Glaspell to Karlton Kelm. Apr. 13, 1937. Papers of Karlton and William Kelm. Special Collections. University of Iowa, Iowa City. Catherine Laux. "Second time around better." *The Jersey Journal*. February 28, 1985, and Bill Campbell. "Karlton Kelm: A Good Story." *The Hoboken Reporter*. Apr. 11, 1984, pp. 5, 15. Papers of Karlton and William Kelm,. Special Collections. University of Iowa, Iowa City.

[16] Letter from Erling Larsen to Karlton Kelm. May 1, 1935. Papers of Karlton and William Kelm. Special Collections. University of Iowa, Iowa City.

BIBLIOGRAPHY

Berkenfeld, Emanuel. "Liberty Take a Bow," *The Dubuque Dial*. December, 1935, pp. 81-87.

Campbell, Bill. "Karlton Kelm: A Good Story." *The Hoboken Reporter*. Apr. 11, 1984, pp. 5, 15.

Cummings, Thomas. "Sunday," *The Dubuque Dial*. December 1934, pp. 32-34.

De Jong, David Cornel. "Autumn is Beautiful." *The Dubuque Dial*. December, 1934, pp. 30-32.

Federal Writers' Project of the Works Progress Administration for the State of Iowa. The WPA Guide to 1930's Iowa. Ames: Iowa State University Press, 1986.

Halpert, Stephen and Richard Johns, eds. *A Return to Pagany*. Boston: Beacon Press, 1969 p. 369.

Herbst, Josephine. "You Can Live Forever." *The Dubuque Dial*. June-December, 1934, pp. 1-5.

Johnson, Josephine W. "Safe." *The Dubuque Dial*. December 1934, pp. 62-66.

Kelm., Karlton. "Greetings." *The Dubuque Dial*. December 1934, pp. 45-49.

Kelm, Karlton. "Hat Story." *The Dubuque Dial*. June-December 1934, pp. 20-22.

Klar, Dora. "Three Days at the Zoo." December 1934, pp. 38-41.

Kresensky, Raymond. "Cistern." *The Dubuque Dial*. June-December 1934, pp. 10-12.

Laux, Catherine. "Second time around Better." *The Jersey Journal*. February 28, 1985.

Le Sueur, Meridel. *North Star Country*. Lincoln: University of Nebraska Press, 1945.

Miller, Fred R. "The Go-Cart Race." *The Dubuque Dial*. June, 1935, pp. 53-57.

Minton, Bruce. "A Farmer Never Learns." *The Dubuque Dial*. June 1935, p. 70.

Nikola, Charlotte, and Paula Rabinowitz, eds. *Writing Red*. New York: The Feminist Press, 1987.

O'Erisman, Robert. "Chart of a New Friendship." *The Dubuque Dial*. June 1935, pp. 75-78.

Papers of Karlton and William Kelm. Special Collections. University of Iowa, Iowa City.

Sanner, Alice. "Spring On an Iowa Hill." *The Dubuque Dial*. June 1935, p. 75.

Waite, Camelia. "A Note On Karlton Kelm." *The Blue Pencil*. August, 1934, p.3.

The Stonor Letters and the Wars of the Roses: Violence and Politics in Fifteenth-Century England

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Historians have long been debating the social, economic, and political stability of the late Middle Ages. The Wars of the Roses have been a specific locus of this debate, and the historical representation of the Wars has changed with fluctuating historical attitudes. The paucity of viable sources makes the Medieval historian's task especially difficult, and this in part accounts for the disparity between various interpretations of the later Middle Ages. It is important to keep in mind several distinct questions that are relevant to my discussion. First, was the fifteenth century a violent time generally? Secondly, were the Wars of the Roses the cause or effect of any fifteenth-century violence? Lastly, to what extent were the gentry and members of lower ranks affected by the wars in terms of both politics and violence? These are major questions of debate for late-Medieval historians, and I will demonstrate the ways in which the Stonor letters can help us answer these questions.

A. J. Pollard and other historians have addressed the issue of late-Medieval source material and its affects on historical research. Pollard concludes his discussion of the matter by saying,

> Whatever individual researchers may unearth from record sources, it is likely that the Wars of the Roses will remain one of the more inadequately documented and controversial topics of English political history. (18)

The lack of adequate sources certainly complicates the process of historical recovery and intensifies the debate over the Wars of the Roses. The material that is available is often either unreliable or lacking in sufficient detail or depth. Perhaps the best sources of material available from the fifteenth century are collections of private family letters, such as the Paston, Stonor and Plumpton correspondences. While the Paston Letters have been examined in much detail by many historians, the Stonor letters have received a much less thorough treatment. Most historians use the Stonor Letters in passing to support larger conclusions about late-Medieval society or to date important historical events.

C.L. Kingsford, who also edited the only modern edition of the Stonor Letters, used the letters to argue in favor of a revisionist interpretation of the Wars of the Roses. He asserts that the Stonors led a quiet, country life, that the letters demonstrate "nothing more serious than one or two cases of distress," and that William Stonor experience no real troubles until he went to court (33-34,62-63). Kingsford's analysis of the Stonor Letters has gone virtually unanswered, and the Stonor Letters and Papers continue to be an underestimated source of historical information. I have conducted a close examination of the Stonor Letters and I wish to challenge Kingsford's analysis of the Stonor's experience of violence and participation in political affairs. I will first give an overview of the evidence in relation to the Stonor family's experience of violence, and I will show the ways in which the documents support larger claims about violence in the second half of the fifteenth century.

The correspondence of the Stonor family describes numerous occasions on which they were involved in violence. On several instances family members were directly implicated as either victims or propagators of violent deeds, but other times they were simply consulted or informed of such actions by friends or business associates. In either case, the Stonors were clearly surrounded by a continuing pattern of violence and unrest.

For example, it seems that a threat of disworship on account of the deeds of Stonor's servants led Stonor himself to take drastic action against Thomas Rokes and his wife Alice. On June 9, 1477, the documents record a "riot caused by William Stonor" and suggest only that the trouble was a result of the actions discussed in the previous letter (Stonor Letters, II, No. 182). The text of the juror's findings is in Latin, but it contains references to Williams "perturbations against the King's peace" his "leading of numerous ignoble people...with swords, bows and arrows...to the place of Thomas Rokes...at which place he smashed things to pieces and entered." It seems also that Stonor insulted, or threatened to assault Alice Rokes, so that "she was desperate of her life" (II, No. 182). The document ends by saying that Stonor did "grave damage" to the place of Thomas and Alice Rokes. This is a remarkable incident because it reveals the degree to which members of the gentry, such as Stonor, would be willing to take violence measures to ensure either their own reputation or claims to their land. Perhaps even more interesting is the degree to which William Stonor was personally involved in the violence, yet we do not hear of any serious repercussions levied against him.

Around the same time, William Stonor received a letter from Henry Makney urging him to aid him in his own legal battle. Makney writes, "Colyngerygge and y be at opyne warre: y purpose to entre in the Manere of Makney with Godes grace on Moneday or Wennyseday; and yf y have nede, y pray youe sende me a gode lade or ij that y be note bete owte ayene" (II, No. 190). Again we see two nobles involved in "opyne warre" over a land dispute, and allies, like Stonor, are being asked to provide additional support. This pattern occurs frequently enough in the letters to argue that it was a fairly common practice in fifteenth-century England.

These incidents taken together with numerous others in the letters suggest I think rather clearly a pattern of frequent violence directly connected to legal matters. This reinforces J.R. Lander's conclusion that "Readers of...the Stonor Papers...can hardly fail to notice that a large proportion of the violent incidents and the not infrequent riots which they describe flared up out of disputes over landed property or legal rights" (Conflict and Stability in Fifteenth-century England 170). On the basis of the letters, we can conclude that the Stonor family certainly did experience violence, often at an intense level amounting to "private war." Even the exceptionally vague letters or those in which the violence is only potential or unclear reflect an undercurrent of violence that was continually present in the lives of the fifteenth-century gentry.

However, it is necessary to ask the question, did the Stonors live in a chaotically violent world? Though violence was certainly a constant presence in the Stonors' lives, there is no evidence to support the debauched, chaotic world that the Tudor and Victorian historians endorsed. The letters contain many references to good tidings, peaceful times, and happiness (II, Nos. 176, 223, 252 (etc.), 293). Without assuming too rosy a picture, we can still reject the Tudor and Victorian concepts of the late Middle Ages as extreme and inaccurate.

It is also clear from the letters that the violence that the Stonors experienced did not spring from the Wars of the Roses *per se*; rather, the violence was linked to legal rights, as Lander has argued. Yet, it would be incorrect to say that the Stonors were not involved in political affairs or that the Wars of the Roses did not affect them in any way. I will now give a brief overview of my claim that the Stonor family, and especially William Stonor, was actively involved in politics, even though his involvement did not normally constitute armed engagement or open alliances. I will claim throughout this discussion of the Stonor's political affairs that political "involvement" should not be restricted in meaning to "military involvement." The Stonors demonstrate their concern and direct interplay with politics throughout the letters in many diverse ways.

The Stonors maintained a strong connection with the Neville family, one of the most important families in late fifteenth-century England. Also, the Stonors had connections and interacted with high-ranking nobles and even the king, though of course they did so on varying levels.

For example, on April 3, 1470, we find a letter of the privy seal from Edward IV to Thomas Stonor. Calling Stonor "trusty and welebeloved," the king informs him of Warwick and Clarence's flight into France. Other evidence, such as William Stonor's appointment as one of Edward's knights of the Chamber, suggests that the Stonors were relatively strong allies of Edward IV.

Several letters suggest that Elizabeth Stonor spent the end of 1476 in London (II. No. 168 and others). During the time she often wrote to her husband concerning political matters or court affairs. For example, on October 9, 1476, Elizabeth wrote that, "Syr, the Kyng hys come to Westemester, and I understonde there schalle be a great Counsell, whereffore I wot never" (II, No. 170). A few weeks later she commented in greater detail on her interactions with nobles at court. This particular letter indicates not only that Elizabeth had connections with high-ranking nobles and even the king's mother, but also that she was in a position to accomplish matters of business while away from her husband. She wielded enough individual authority to attempt to make an economic bargain with Elizabeth of York, and the rest of the letter suggests that she spoke with many of Williams' business partner about financial and legal matters. Certainly Elizabeth Stonor used her political connections to aid her husband's business dealing, a form of political involvement that many historians have overlooked or discounted.

William maintained his political connections throughout the next several years. Sometime between 1480 and 1482, he received a letter from Sir James Tyrell, the man who was later suspected as the murderer of the Princes in the Tower. The letter indicates that the two had been conversing and were on good terms. Around this same time we learn about William's connections with Thomas Grey, Marquis of Dorset and son of Elizabeth Woodville, Edward IV's queen.

The last several letters in the collection demonstrate most clearly William's vested interest in political affairs. At this time, William's political involvement was at its highest point. As the last letter in the collection indicates, William was soon to participate directly in Buckingham's rebellion against Richard III.

This final letter is addressed to Sir William Stonor from Francis, Viscount Lovell. It was written on October 11, 1483, the eve of Buckingham's rebellion. Lovell is requesting William to join Richard's army against the impending rebellion, and to bring Lovell's own men with him. Though the letters end here, Horrox and other historians have written conclusive statements about the rebellion. Horrox explains that even though Lovell requested William's aid for the king, "Stonor joined the rebels, and may even have taken Lovell's men with him" (161). William had evidently been doing a great deal of dissembling; Richard and Lovell obviously thought him to be loyal until the very beginning of the rebellion.

The motive behind William's decision to join the rebellion is not clear. Though we do not know William Stonor's feelings about the disappearance of the princes, we do know that he was a dedicated household servant of Edward's. This connection may well have led him into rebellion and eventually to join in the rebels' second effort: to put Henry Tudor on the throne (Ross 113, Gillingham 227). Indeed, several years later William did fight for Henry VII at the battle of Stoke on June 16, 1487 (Kingsford, Introduction, Stonor Letters and Papers, xxxv). Though the Stonor lands were attainted, they were later restored.

This conclusion to William Stonor's career logically follows his political involvement throughout his life. I disagree with Kingsford that the Stonors' political involvement is unimportant for the historian or that it was initiated simply when William "went to court" (Introduction, Stonor Letters and Papers, xxxix, Prejudice and Promise 63). William had political connections of varying degree throughout his life; indeed, he became acquainted with Dorset not at court, but at his own estate during the courtship of his third wife. Further, Kingsford's comment that William had "wit to keep clear of politics" seems both false and naive (Prejudice and Promise 63). The Stonor's political connections permeated much of their lives, as the letters indicate. William especially found it necessary to play along with the political game at various points in his career. I would argue that William had the wit to be involved in politics, at least to be involved as much as it suited his own needs. Clearly the political machinations that comprised the Wars of the Roses affected William Stonor and his family in very basic ways, and the turbulent conclusion to both the letters and to William's career demonstrate the political ramifications of the wars most clearly.

How then have the Stonor Letters answered the questions which I posed initially? First of all, my analysis of the letters in the context of fifteenth-century violence suggests a "compromise" position between the extremes of the Tudor and Victorian historians and advocates of fifteenth-century "peace" such as Gillingham and Kingsford. I demonstrated earlier the ways in which the Stonor Letters refute the Tudor/Victorian concept of a depraved and chaotically violent England in the fifteenth century. However, my reading of the letters does indicate that a great deal of violence permeated the Stonors' lives. This renders questionable such optimistic statements by Gillingham as "the fifteenth century...was a society organized for peace" or Kingsford's claim that people lived in "tolerable ease and prosperity" with little turbulence in their lives (Gillingham, The Wars of the Roses 11, Kingsford, Prejudice and Promise 64,73).

Furthermore, historians who argue for the low level of violence caused by the wars, give a false impression of the "benignity" of the period. The crucial question to be asked here is this: were the Wars of the Roses the cause or effect of fifteenth-century violence? Nearly all modern historians seem to agree that the Wars of the Roses were largely the result, not the cause, of local violence. As my analysis has suggested, and as J.R. Lander has concluded, fifteenth-century violence was due primarily to legal disputes, not to war. This, as we have seen, was particularly true of the Stonors. Carpenter's claim that the Stonor's geographical region was "not a particularly litigious or violent part of England" seems suspect at best (Carpenter 177). Likewise, by claiming that the Wars of the Roses had few or no violent repercussions on people like the Stonors, historians often suggest that there were therefore no violence repercussions at all. They fail to take into account the fact that the very real violence that the Stonors and other families experienced may have resulted from something other than the wars themselves. By ignoring the legal side of the equation, they give a falsely benign image of the age.

It is also important to keep in mind Lander's assertion that "Turbulent, violent, and corrupt the age certainly was, though probably not more so than earlier times" (Conflict and Stability 190). Historians who accept the Tudor or Victorian depiction of the fifteenth century as excessively violent often do not consider fifteenth-century violence in the context of previous centuries. Certainly in the fourteenth century, protest literature and documents in the public record office attest to a great deal of violence, again often resulting from legal disputes or corruption. With this consideration, we can view the fifteenth century as neither much more nor much less violence than the rest of the Middle Ages.

Finally, we must ask about the extent of gentry involvement in the politics of the wars. I believe that the dismissal of the Stonor Letters as lacking in political importance by many historians, including Kingsford and Ross, is both unfortunate and unfounded. Certainly if we define historical importance in terms of textbook dates and major battles, the Stonor Letters may be found lacking. But the Stonors, William especially, were politically involved throughout their lives, both locally and in London. The letters inform us a great deal about the way in which political "news" was conveyed, the way in which women such as Elizabeth Stonor could act as go-between in political and business matters, and the way in which men like William Stonor could manipulate the loyalties of the king's trusted followers to suit his own ends. Though it is dangerous to generalize too broadly about the normalcy of the Stonors' situation, I think we can at least acknowledge that the example of the Stonor Letters should be cause for more detailed analysis of the position of the gentry in the fifteenth century in terms of violence and political involvement. This may very well involve a reexamination of what "counts" as political or violent, a reexamination that will be necessary if we wish to explore these aspects of the fifteenth-century in a thorough and accurate manner. Due to the scarcity of viable documentation from this era, historians will undoubtedly continue this well-established historical debate, and it may be that the Stonor Letters will play a larger part in it than they have thus far.

WORKS CITED

Carpenter, Christine. "The Stonor Circle in the Fifteenth Century." Rulers and Ruled in Late Medieval England: Essays Presented to Gerald Harriss. Ed. Rowena Archer and Simon Walker. London: The Hambledon Press, 1995.

Gillingham, John, ed. Richard III: A Medieval Kingship. New York: St. Martin's Press, 1993.

Gillingham, John. The Wars of the Roses: Peace and Conflict in Fifteenth-Century England. London: Weidenfeld and Nicolson, 1981.

Horrox, Rosemary. Richard III: A Study of Service. Cambridge: Cambridge UP, 1989.

Kingsford, Charles Lethbridge. Prejudice and Promise in XVth Century England. Oxford: Clarendon Press, 1925.

Kingsford, Charles Lethbridge, ed. The Stonor Letters and Papers. London: Offices of the Society, 1919. II. 15.

Lander, J.R. Conflict and Stability in Fifteenth-Century England. London: Hutchinson and Co., 1969.

Lander, J.R. Crown and Nobility 1450-1509. Montreal: McGill-Queen's UP, 1976.

Lander, J.R. The Wars of the Roses. London: Secker and Warburd, 1965.

McFarlane, K.B. England in the Fifteenth Century: Collected Essays. London: The Hambledon Press, 1981.

Pollard, A.J. The Wars of the Roses. New York: St. Martin's Press, 1988.

Roskell, J.S., Linda Clark and Carole Rawcliffe, eds. The House of Commons 1386-1421. Stroud: Alan Sutton Publishing, 1992.

Ross, Charles. Richard III. Berkeley: U of California Press, 1981.

Thomas Becket and King Henry II
A medieval drama with a contemporary application

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Thomas Becket's struggle regarding obedience to the king's authority is a classical example of church-state conflict during the Middle Ages. From Becket's perspective this institutional conflict represented the personal dilemma of how a man can obey both the state and his own conscience as infused by God. This famous medieval episode is not just a story of the distant past, but is part of a turbulent and heroic theme within the western heritage. The triumphant careers of Sir Thomas More and Dr. Martin Luther King brilliantly depict the individual conscience wrestling with state policies. Today in the United States military chaplains confronting the state's position on abortion face Becket's dilemma of reconciling obedience to the government and to the dictates of one's conscience. In my paper I will review the clash between Thomas Becket and Henry II. While their battle over judicial jurisdiction is now anachronistic, what is still relevant to contemporary issues are the ideals that were espoused. As I examine the church-state struggle over the courts, I intend to show how certain principles are still pertinent to the human dilemma of what authority to obey.

Throughout history men and women, in deference to the dictates of their consciences, have stood against the power of the state. Those who would rather give up their lives than compromise their beliefs and principles include Martin Luther, who denied papal supremacy before the German emperor; Thomas More, who accepted execution rather than swear an oath that declared the king of England the head of the church; Mahatma Gandhi, who upheld the rights of Indians in the British Empire with nonviolence; Dietrich Bonhoeffer, who refused to preach Nazi ideology from the pulpit and died in a concentration camp; and the Reverend Martin Luther King Jr., who led the civil rights movement in the United States against state sheriffs and snarling German shepherds. One of the most captivating statements concerning higher law is found in Reverend Martin Luther King's *Letter from a Birmingham Jail* that says "an individual who breaks a law that his conscience tells him is unjust, and who willingly accepts the penalty of imprisonment in order to arouse the conscience of the community over its injustice, is in reality expressing the highest respect for the law" (Andrews, 128). A recent exhibition of those who seek to abide by moral laws of conscience is, in fact, currently occupying news headlines today. The Pentagon has attempted to silence its own chaplains regarding the issue of partial birth abortion. In support of these military chaplains, Kevin Hasson, founder of the Becket Fund for Religious Liberty, views such government actions as "gagging preachers in their own pulpits." One of the plaintiffs, Father Vincent Rigdon, believes he is being prevented from doing his spiritual duties of counseling how his parishioners should practice their faith in everyday living (Christianity Today, 1996). The Becket Fund, founded ten years ago, specializes in cases of religious freedom, and is named in honor of Archbishop Thomas Becket who was martyred by the king's knights for defending the principle of religious liberty. Although Thomas Becket's story comes from the middles ages, its message of the sacredness of the individual conscience over and above the power of the state has contemporary application.

Medieval society rested upon two institutions—the state that provided people temporal security through the power of law and armor, and the church which provided the people eternal security through its role as mediator of God's grace. The power of the church throughout the middle ages was a source of authority to contend with by all. William the Conqueror benefited from the universal power of the church. In 1066 Pope Alexander II gave approval to William the Conqueror's conquest of England and he appointed Norman bishops in English Sees (Latourette, 462). The cost of those papal arrangements made in England was England's recognized constitutional tie to the universal church. William the Conqueror allowed England's spiritual tie to the papacy; however, he strictly reserved all matters of law for royal authority. William cleverly refused to swear an oath of fealty to the papacy by resting on ancient royal custom. Pope Gregory VII demanded King William's vassalage, but the king only agreed to send tithes to Rome. These measures taken by William sought to prevent the invasion of papal authority. However, his endeavor was not completely successful because of the ecclesiastical power within England. Papal authority in England was the avenue by which the pope in Rome could reach directly into England and its spiritual matters.

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The pope commanded spiritual matters across Europe. The church implemented policies that regulated wars. Church laws based on spiritual ideals governed the conduct of war to eliminate brutality on designated sacred days. In 1139, the Second Lateran Council forbade jousts and tournaments, since these encouraged feuds and bloodshed (475). It became evident that the rules made by the pope in Rome had the potential to interfere with matters of state. The pope upheld Christian principles that further differentiated God's laws and "Caesar's" laws. During wartime, the Truce of God forbade fighting from Saturday to Monday morning (473). Such spiritual laws carried the weight of papal authority and were upheld by clergy across Europe. Papal authority was the voice of God on earth. As we shall see, it was God's voice, which Becket sought to defend as archbishop of Canterbury.

King Henry II was a strong feudal king who concerned himself with the enforcement of laws and justice. As king of England, Henry II was the supervisor of the political structure that provided the necessary components of stability and safety for England's developing medieval society. That political structure depended on the personal pledges between nobles that equipped England with a strong military force. The protection and order enjoyed by the nobles was under direct supervision of the king. It was the responsibility of the king to enforce such feudal laws. Therefore, Henry not only assumed command of England through his Plantagenet ancestral claims, he also happened to take his responsibility of law and order very seriously. The success of a strong political institution depended on oaths of personal loyalty by every subject, including the clergy.

The quintessential struggle between this English king and Archbishop Becket was lay investiture. The tool Henry used to undermine church authority was lay investiture. The investiture controversy is the term and issue that is often applied to the dispute that occurred between Pope Gregory VII and the Holy Roman Emperor, Henry IV. This controversy occurred one hundred years earlier than Becket's struggle against King Henry II of England. The central issue for Pope Gregory was the independence of the clergy from control of politically motivated nobles. In Germany, the bishops and archbishops had become great territorial rulers. To control them, Henry IV insisted on appointing the bishops and demanded that they swear allegiance to him. Gregory would not tolerate lay investiture because divided loyalties diverted the bishops from their proper functions. According to Kenneth Scott Latourette, lay invested bishops acted both in "the spiritual oversight of their flocks, and like secular princes with secular interests" (473). The removal of lay investiture strengthened papal authority by upholding the church's role in matter of leadership. According to the Concordat of Worms, which was an arrangement reached between the church and the German Empire, bishops were to be autonomous because the clergy's spiritual power has "been divinely given to them by the grace of the Holy Spirit" (Bettenson, 102). The pope hoped, then, that the Concordat of Worms would enable the bishops to fulfill church priorities based on spiritual ideals.

Church doctrine asserted that papal authority was passed down from St. Peter to each consecutive pope and extended throughout Europe by archbishops, such as Thomas Becket in Canterbury. The pope alone, by means of his identification with Peter, "would always be a true Christian," and thus able to recognize who was of God and who was of the devil (Blumenthal, 118). According to Uta-Renate Blumenthal, this perspective shows why Gregory, firmly convinced of his divine mission, claimed the right to depose not only bishops but also secular rulers. Gregory's action culminated in the excommunication of Henry IV who had defied papal authority. Medieval rulers did not take kindly to excommunication for fear it would lead to a revolt of their nobles against their authority. Such was the case for Henry IV whose royal authority was eroded because of the pope's excommunication that ignited a revolt by Henry's vassals against his imperial authority.

In summing up the investiture controversy, it can be seen that Gregory acted on the fundamental principles of Christianity written by St. Paul. Paul gave direction for temporal behavior in letters to the Romans. Paul said that states should be governed by belief in the omnipotence of God and by the conviction that state and society should serve some divine purpose (Tellenbach, 26). During the middle ages clergymen, like Thomas Becket, presumed to decipher that purpose. Gregory's actions to end lay investiture determined the relationship between royal and priestly authority by implementing canonical principles that regulated ecclesiastical elections. These regulations were devised to prevent the state from trespassing into church affairs. However, one hundred years later, King Henry II of England disregarded these rules and manipulated Becket's elections as archbishop. In doing so, he installed his friend to the post of archbishop to be his tool to dominate the church.

King Henry II's great ability as a ruler was most clearly demonstrated by his endeavors in the English judicial system and the English common law. It was as a result of state judicial expansion that he restored order to England from the period of anarchy tolerated by his predecessor King Stephen. The church courts fell under Henry's sweeping scrutiny as he attacked the benefit of clergy, which was a privilege that allowed them their system of courts. It was this issue that initiated the clash between Henry and Becket. Henry spent the first years of his reign in restoring order in England and destroying the unauthorized castles of anarchic nobles. As chancellor, Becket had worked with Henry to extend royal authority. However, once he became archbishop, Becket did not tolerate the royal infringement on church authority.

Although the bishops of England elected Thomas Becket canonically, King Henry II had arranged and influenced the outcome of that election. Henry's attempt to curb church power failed because of Becket's obedience to canon law. Furthermore, Becket did not cooperate in Henry's endeavor to uproot the authority of the church. Without compromises from the church, Henry's alternative was to restrict ecclesiastical independence. The regulation of church courts was Henry's next step in limiting church power. Henry was determined to place all in England under his law. Without Becket's subservient loyalty, the king was compelled to rise against Becket and the clergy in order to subordinate the church to his will. It can be seen that lay investiture was not successful because Becket acknowledged God's law above royal laws. Becket strongly advised Henry to remember the "paramount jurisdiction of the spiritual power" (Knowles, 111). It is now necessary to consider King Henry's perspective in the development of his vigorous policies. The king's means to control the church courts were based on English custom and feudal obligations.

Since the reign of William the Conqueror church courts had claimed exclusive jurisdiction in all matters concerning ecclesiastical issues. Numerous crimes, such as murder, were committed by clergymen during Henry's reign, but these privileged persons were tried in church courts, where the punishments were mild, rather than royal courts, where the punishments were severe. Once convicted of crimes by the ecclesiastical courts, those clergymen were simply defrocked and released. "Henry complained that such offenders often received absurdly light sentences" (Hollister, 53). To the king the benefit of clergy represented church sovereignty within his own kingdom. According to W. R. Warren, Henry pursued the restoration of a royal authority above all others, including the clergy, just as vigorously as he sought to ensure to every man peaceful enjoyment of property and his protection from crimes (Warren, 448). From Henry's perspective, his attack on church courts was in fulfillment of feudal customs, which assigned earthly lordship to the king.

The enforcement of feudal customs was the premise for the document, the Constitutions of Clarendon. It was written by Henry and ignored by Becket. The clauses that disturbed Becket the most concerned the limitations placed on excommunication, restrictions on appeals to Rome, and the treatment of corrupt priests (Pain, 101). Among the egregious clauses that particularly offended Becket, one stated that the trial of any accused churchman was to be supervised by the king's officer (Bettenson, 160). This clause was an infringement of the bishops' authority, and it would open the door to civil censorship within the church. But the clause that generated the clergy's overwhelming opposition to the Constitutions demanded the sworn allegiance of newly elected bishops. "The person elected shall do homage and fealty to the lord the king for his life and limbs and honor before he can be consecrated" (160). Becket understood this claim to conflict with the bishop's allegiance to a higher spiritual authority. In two ceremonial audiences before Henry, Becket only swore conditional obedience to the king. These conditions upheld God's honor before all and church liberty from the overweening power of the state (Knowles, 120&125). Becket's conscientious conviction to the principle of church independence and his persistence in defying the royal will resulted in his murder.

Devoted members of the king's nobility murdered Becket. Graphically described by J. R. Green, the murder was carried out by nobles who viewed Becket as a traitor to the crown. These nobles were upholding a strict feudal political structure that was to be presided over by the king. Becket died upholding the spiritual authority of the church. As the sword blows slashed through his body in the cathedral on Christmas day, the fallen archbishop was heard to murmur, "I accept death for the name of Jesus Christ and his church" (148).

Conscientious persons opposed to the state are sometimes killed, a few are remembered as heroic martyrs. Thomas Becket is one of those. Becket's defense of God's honor and the church's freedom resulted in Henry II performing public penance, the king abandoning his attempt to control the church courts, the pope proclaiming Becket a saint, and many people traveling to Canterbury Cathedral to Becket's shrine. Sometimes, when ordinary persons take a strong conscientious stand for justice, history's judgment is to remember them for their extraordinary behavior. Today Father Vincent Rigdon is a relatively unknown, ordinary man who has taken a stand against "the threat of criminal prosecution" in obedience to his bishop's directive to speak out on abortion. At this date the historical judgment on conscientious opposition to abortion has yet to be made.

References

Andrews, Pat, 1995, Letter from a Birmingham Jail. Voices of Diversity, Dushkin Publishing, Guilford Connecticut.

Bettenson, Henry, 1963, The Concordat of Worms. Documents of the Christian Church, Oxford University Press, Oxford.

Blumenthal, Uta-Renate, 1988, The Investiture Controversy, (Philadelphia: Pennsylvania Press)

Green, John Richard, 1931, A History of the English People, Volume I, (New York: Funk and Wagnals)

BEST COPY AVAILABLE

Hollister, C Warren. 1996. The Making of England 55B.C. to 1399. (Lexington D.C. Heath & Company)

Knowels, David. 1971. Thomas Becket. (Stanford Stanford University Press)

Latourette, Kenneth Scott. 1953. A History of Christianity. (New York: Harper & Row)

Lawton, Kim. Christianity Today. Military Chaplains Sue Over 'Project Life' Ban. 09 Dec 1996 pg 74

Tellenbach, Gerd. 1966. Church, State, and Christian Society. (Oxford Basil Blackwell)

Warren, W L., 1973. Henry II. (Berkeley: University of California Press)

The Mushroom of Feeling:
American Public Reaction to the Atomic Bomb, 1945.

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After WWII Americans expressed contradictory emotions of excitement and dread: excitement for the end of the war, and dread for having had to open up the nuclear age to achieve it. Recent scholarship also shows this mix of emotion in the scientists and politicians who made the decision. My research in the popular press of *Time* and *Newsweek* brings to light the fact that these same feelings appeared in the American public. A close examination of the popular press of the time reveals that authors, often in the same articles, expressed impending anxiety and fear. Joy and fear coexisted. A one-sided interpretation and understanding of the American response to the dropping of the atomic bomb is therefore both inaccurate and unfounded. The same action that granted Americans the peace they coveted most also created a paradoxical world where peace and potential annihilation tenuously existed hand in hand. The very basis for the American national sense of victory and excitement gave birth to the fear that next time they would mourn devastated cities left reeling from the very nuclear power Americans themselves created.

Though Franklin Delano Roosevelt termed it "a mighty endeavor, a struggle to preserve . . . our civilization and to set free a suffering humanity," WWII changed the way the world viewed war--especially with regard to noncombatants.[1] Historian Barton J. Bernstein portrays an emerging internal struggle among the White House military advisors and cabinet members, pitting an old dying ethic of warfare which targeted only the soldiers against a new ethic where race, nationality, and treaty preference made people uniformed or not the enemy.[2] Gone were Napoleonic chess matches where strategy and movement of troops won. Instead it proved a Darwinian battle of technological evolution. The moral implications of such a paradigmatic shift troubled American political and military decision makers. They struggled.

From the outset, the ethics and morals of using the atomic bomb were controversial. Proposals for a display of power for a Japanese audience and/or limited tactical/military use remained the two most viable options next to dropping it on a populated city. The scientists in the research group initially pushed for a technical display of power to play on Japanese fear until Oppenheimer and others informed higher-ups that a technical demonstration alone would not necessarily suffice in bringing an end to the war.[3] Using the weapons in the scheduled 1 November 1945 invasion of mainland Japan became the new push. Admiral Richard Connoly, who was to provide naval support for this operation, "wanted to put one [atomic bomb] on either side of each landing, [there were three scheduled] before, the troops landed.". The researchers assumed the target to be purely tactical: military sites, industrial areas, troop placements--not cities.[4]

Army Chief of Staff George C. Marshall and Secretary of War Henry L. Stimson likewise pushed for a use limited to military "objectives such as a large naval installation." The thought of using such a weapon on civilian areas was contrary to the long established war ethic founded in "Christian doctrine and in international law." It made them uncomfortable. Stimson, in a conversation with Truman in late May of 1945, assured the President that the weapons would be used so as to spare civilian lives in the name of "fair play and humanitarianism." This sentiment was not deeply held. Voiced concerns that the daily fire bombing of Japanese cities would deprive the new weapon of "a fair background to show its strength" testifies to this. What is more, two days after their discussion Stimson "stipulated that noncombatants would be acceptable targets." Aiming at a "vital war plant closely surrounded by workers' houses" was not merely justifiable but desirable. This idea would proceed unchallenged.[5]

This did not make the decision easy. The moral ambivalence which marked the transition from an old war ethic to total war trapped everyone from researcher to president. On 25 July 1945, however, the moral debate ended when Truman ordered the dropping of the first atomic weapon "as soon as weather will permit visual bombing after about 3 August 1945."[6] The decision was finalized eleven days later when the *Enola Gay* dropped the first "fat boy" on Hiroshima, and nuclear warfare began.[7] Three days later *Bock's Car*, another B-29, released one over Nagasaki. Both caused great destruction and tens of thousands of deaths, but in the American mind this was not emphasized. Peace was, Americans were looking for a release after four dark years of total war. The pages of magazines and newspapers of the era were filled with stories, memoirs, and descriptions of the battlefields. Pictures of the devastated cities of Japan and Germany were constant reminders to the people that there had been a war, and Americans had been killed. In the months following the dropping of the bombs countless stories of countless GI experiences revealed many of the war's cruelest realities. On 10 September 1945 *Newsweek* described liberated U.S. prisoners of war as "frantic prisoners. . . [who]. . . danced stark naked on the shore as American rescue ships approached."[7] Camps where many had been brutally tortured, where many suffered beriberi and dysentery, where many had died, were described in great detail. Giovanni Lomanitz, who had studied under Oppenheimer before the war, expressed the sentiments of the nation when on August 7 he wrote: "You [Oppenheimer] may not know it but today you're about the best loved man in these parts [for, producing the bomb]. The guys. . . are overjoyed."[8] Upon the signing of the treaty, Truman is quoted: "From this day we move forward. . . . We move toward a better world of peace. . . . This is a victory over tyranny." Moments later came the word all Americans had been praying to hear: "I [Truman] report to you that your sons and daughters have served you well. . . . They are homeward bound."[9] The ancient historian Herodotus once said, "in peace sons bury fathers, but in war fathers bury sons."[10] To limit these occurrences as much as possible, Truman brought the "sons" home.

A picture of rubble resting silently at the foot of a dead tree is placed ominously in the 31 December 1945 issue of *Time*. Its caption reads: "For a nation that wanted to use it [the A-bomb], it was a cheap way to wage war."[11] But more importantly it was safe. There is little remorse in the language of the major publications of *Time* and *Newsweek* and even less in the actions of the American people in the three or four months directly following the atomic bombings, because the war was over. The soldiers came home. And the American public rightly celebrated the return of the mighty fleet; they genuinely expressed a relative disinterest in the ethical question concerning the atomic bomb and its use. The major interest was placed in celebrating the end of the war. After Nagasaki, Truman still "[rode] a wave of unprecedented popularity."[12] Two months later a parade "up Fifth Avenue past the flags and the glittering shop windows" celebrated "the greatest Navy in the world in the greatest city in the world."[13] The air reverberated with the echo of one twenty-one gun salute after another, as forty-seven ships in all paid tribute to Harry Truman, "a very plain man indeed, who had never planned on being Man of the Atomic Year."[14] Thundering overhead 1,200 Navy planes displayed aerial power so awesome all present basked in the renewal of peace–and in America's ability to keep it.

The war was over, the men were home. Now it was time to celebrate. *Time* described "the biggest, noisiest, New Year's Eve party in a long, long time," where "bars would be open until dawn, U.S. roadhouses would be neon-lighted after dark, . . . [and]. . . females would have the urge to write with lipstick," and with the "first tock of 1946 . . . U.S. citizens would consume enough alcohol to float a rinkful of ice." This was a time to forget about the war years of stodgy rationing and simple living. The time for social penance and puritanical sacrificing of time, money, and family gave way to a "Democratic Society [in which] there is great room for experiment. . . [and]. . . the free play of economic and social innovation."[15] All eyes were to the future which offered more than reports of death camps and pictures of mushroom clouds. Americans were willing to "guess that the future would be vast and exciting," and merely four months after the end of WWII the populace seemed willing to drown the past in a new year's shot of bourbon and start fresh.[16]

Regret for war-related actions is absent. According to Lifton and Mitchell, authors of *Hiroshima in American: Fifty Years of Denial*, the predominant myth of necessity justified the atomic bombings in the eyes of the American people.[17] There are deeper reasons, however. Many acts of war defy any other explanation than simply "war is war"; we believe our actions are just and moral while those of our enemies are unjust and immoral. Social psychologists termed this reciprocal concept mirror-image perceptions. While applied to all nations in all cases, these "perceptions" see no race. The Allies viewed the Germans and Hitler as evil incarnate. They viewed the Italians with Mussolini the same way, and during the Cold War era Americans held Russia and her Stalin with the same disdain and condemnation. This psychological ability allows a belligerent nation's racially "warped and slanted" views of a co-belligerent's government and leaders to progress to where "perceptions . . . may become so skewed that they entirely misrepresent reality."[18] We are good; the Japanese are "yellow subhumans."[19] Truman, the generals, the soldiers, and many Americans in general believed the Japanese to be ruthless savages, merciless fanatics. Race was an important aspect of the Pacific Theater.[20]

The racist stereotyping of the "Japs" stated most eloquently by Idaho's Governor when he offered that "a good solution to the Jap problem would be to send them all back to Japan, then sink the island" while speaking of Japanese in America no doubt illustrates the anti-Asian animosity so prevalent throughout the 1940's. This was of course applied automatically--without a doubt more forcefully--to Japanese nationals who killed American soldiers.[21] Kamikaze fighter pilots suicidally attacked ships, prison camp horror stories of brutality, the ancient Japanese military code of *bushido* (or way of the warrior) sarcastically presented, and pictures of mystic charms drawn defensively in the sand proved in 1945 that the Americans' stereotypical Japanese was real. All helped create the atmosphere of mocking enmity necessary for *Time* to heroically dub the dropping of the atomic bombs "the greatest of all 1945's greatest events." For the masses of 1945 this was the pseudo-justification: the all-encompassing, nothing-damning psychological distancing from the action which ended the war. This same action, however, produced a deep fear.

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The bomb brought more than merely peace to the homeland. The dawn of the atomic age, wrote one author of a *Time* article, "represented a brutal challenge to the world to keep the peace."[22] With the power of the atom unleashed, the world faced the new threat that an aggressor nation could annihilate with relative ease any nation's power to resist with relative ease. The researchers had come up with the scientific discovery of their generation. However, the problem facing the world was how to restrict its application. Clement R. Attlee, British Prime Minister, refuted the thought that the world could share "scientific knowledge on atomic energy while its applications to weapons are kept secret." Implied was the threat of world domination by those who held the secrets of the technology. The Big Three must "share all atomic secrets . . . [and] . . . appoint a body to study means of control and supervision of atomic developments," Attlee believed; and he believed it so strongly that he would discuss nothing else during "an atomic showdown" early in November.[23] Seeing the U.S.'s monopoly of power, other nations began to be leery. Around the globe nations pushed for equality of knowledge, but Truman and the U.S. government refused until all "possible methods of protecting us and the rest of the world from the danger of sudden destruction"[24] had been thoroughly explored.

One such solution, put forth by Albert Einstein, was to give up secrecy; he suggested "[t]he secret of the bomb . . . be committed to a World Government," an idea previously alluded to by Attlee.[25] Truman did not entirely disagree. The "hope of civilization," Truman said, rested in the organizing of world arrangements "which would renounce the use of the atomic bomb but encourage cooperation on harnessing atomic energy for peaceful humanitarian goals." However, this was only because other countries "would in time catch up with our knowledge of atomic research." The secrets of the bomb would not be turned over to, in the words of House Judiciary Chairman Hatton Summers, a "disorganized and largely psychopathic world," yet proposals for monitoring and controlling the development and expansion of national atomic development were understood. The government as a whole simply disapproved of "American disclosures concerning . . . our exclusive product."[26] And exclusive it was. At the end of the war we were the only nuclear-capable nation on earth. The failure to spread the knowledge could, therefore, be read as an attempt to maintain not just scientific, but also military supremacy. This would place us 180 degrees from the direction we faced at the beginning of the war. We had turned from a strictly isolationist posture to one as world dictator of global military supremacy. This plagued Einstein, causing him to question the justification for maintaining the secrecy of so horrific a power. To the rest of the world secrecy tacitly proved our desire to rule the world with veiled threats.

World sharing of information and retaliatory capability, while being the only cure to aggression and possibly the only solution to nuclear envy, ironically also offered Truman and others cause to fear the downfall and more-than- possible internal fracturing of the post-WWII United States. In a full page article in *Newsweek*, however, Ernest Lindley suggested politicians (like Truman) and scientists (like Einstein) alike were simply "groping" for answers. "Most officials, like most civilians, are feeling their way. Very few are sure enough of themselves to speak dogmatically," he states. Factors of time, maintaining a head start on other nations, outlawing atomic weaponry, and international supervision were simply "trends of thought, and . . . tentative conclusions" for providing at best an unstable and apprehensive international peace.[27] Threats of retaliation, ineffective controls fueling armaments races, and disallowing the world body to inspect nuclear production facilities stood as incentives to maintain secrecy. It was now a question of world peace. The desire was to avoid war on American soil. In other issues of *Newsweek*, proposals to Congress and conferences with Soviet and British leaders all appear under headlines with this explicit concern: "Behind Anglo-U.S. Peace Line-up Lies Horror of Atomic Bomb War," and "With Fingers Crossed" are but two examples.[28]

The problem was obvious and recognizable: "The world had finally found the formula for complete destruction." This statement is ironically found in the last paragraph of the story which ran directly preceding the account of the wild New Year's Eve party. Within the very act which brought peace lay the fetal beginnings of far greater destruction, and in this case we likewise were in danger of witnessing firsthand the devastation of nuclear war. The moral ambiguity of 1945 expressed in the choice between sparing Japanese citizens or using atomic weaponry dissipated with the fire and brimstone of the remaining rubble left behind a powerful sense of relief—and an equally unstable, fearful sense of insecurity. In a comically sarcastic look at the mandatory military changes wrought by the emergence of atomic weaponry, Sgt. Ray Duncan described the training in the Anti-Atomic Corps. The hope for atomic peace, he wrote, now lay in the hands of these men of Second Platoon employed "to neutralize and destroy the enemy's atomic weapons."[29] "[Y]ou're doing a *very* important job, men, keeping them [the enemy] from splitting our atoms," the first sergeant shouts. With the new weapons discussed and the revamped tactics presented, we come to a description of "a ruthless enemy who will stop at nothing, not even *poison gas*!" The feeling of vulnerability is tacitly implied. To end his story, the Sergeant, when discussing the unchanging nature of the Army, states: "There's only one way to escape the Army life, and that's to keep the world at peace."[30]

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Einstein once said that "[a]s long as there are sovereign nations possessing great power, war is inevitable."[31] This fear plagued post-war America. While still in love with the tangible reality of peace found in the taverns and night spots on the eve of the dawning of the new year, people realized the precedent which their nation had set. Death count totals climbed, the pictures carried captions relating the destruction while showing the devastation, and the articles reported children burning to death and dying of radiation long after the A-bombs exploded. The dropping of the bomb symbolized a new era of warfare where technological advancement brought a victory in which no one was safe, and Americans mixed peace and happiness with anxiety and fear under the mushrooming expansion of global military power.

Notes:

[1]. Newt Gingrich, To Renew America, (New York: Harper-Collins, 1995), 37.

[2]. Barton J. Bernstein, "The Atomic Bombs Reconsidered," Foreign Affairs 74, (Jan. 1995) pp. 135-152.

[3]. Barton J. Bernstein, "Eclipsed by Hiroshima and Nagasaki," International Security, 15 (Spring 1991) 157.

[4]. *Ibid.*, There appears to have been a discussion related to this. See author's footnote (21).

[5]. *Ibid.*, 155-6.

[6]. The final directive ordering the dropping of the atomic bomb. July 25, 1945.

[7]. Newsweek, September 10, 1945, p. 33.

[8]. Barton J. Bernstein, "Eclipsed by Hiroshima and Nagasaki," International Security 15 Spring 1991: 162.

[9]. Newsweek, September 10, 1945, p. 30.

[10]. Herodotus, The Histories (New York: Penguin. 1972) 77.

[11]. Time, December 31, 1945, p. 15.

[12]. Time, August 13, 1945 p. 19.

[13]. Time, November 5, 1945, p. 19.

[14]. Time, December 31, 1945, p. 16.

[15]. *Ibid.*, p. 17.

[16]. *Ibid.*, p. 18.

[17]. Robert J. Lifton and Greg Mitchell, Hiroshima in America: Fifty Years of Denial, (New York: A. Grosset/Putnam Books. 1995).

[18]. Robert S. Feldman, Social Psychology, (New Jersey: Pretence Hall, Inc.. 1995). 299.

[19]. Barton J. Bernstein, "The Atomic Bombings Reconsidered," Foreign Affairs vol. 74 no. 1, Jan. 1995: 140.

[20]. For an in depth look at this aspect of W.WII see: John W. Dower, War Without Mercy: Race and Power in the Pacific War, (New York: Pantheon Books. 1986).

[21]. George Brown Tindall and David E. Shi, America: A Narrative History (New York: W.W. Norton & Co., 1992) 1186.

[22]. Time, December 31, 1945, p. 15.

[23]. Newsweek, November 12, 1945, p. 44.

[24]. Time, August 13, 1945, p. 17.

[25]. Time, November 5, 1945, p. 27.

[26]. Newsweek, October 15, 1945, p. 39.

[27]. Newsweek, November 12, 1945, p. 42.

[28]. Newsweek, October 15, 1945, p. 44.

[29]. Time, December 31, 1945, p. 17.

[30]. *Ibid.*, p. 62.

[31]. Time, November 5, 1945, p. 27.

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Henry Laurens:
The Making of a Revolutionary

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During the pivotal years prior to the American Revolution, Henry Laurens experienced several critical events which radicalized his views concerning American resistance to England. Paramount of these events were the questionable seizures of three of Laurens' commercial vessels by British customs officers in 1767 and 1768. These seizures and the subsequent court proceedings triggered a more extreme outlook in Laurens' view of American-British relations. Additionally, Laurens was influenced by several other important factors, such as his growing financial independence of England. These events in Laurens' life would eventually propel him to become a very significant figure in the American Revolution with profound consequences for the future United States.

Despite being one of our country's most outstanding leaders during the American Revolution, the name of Henry Laurens is not well-known.[1] A colonel in the South Carolina militia, a distinguished member of that state's legislature, and a highly successful businessman, Laurens first achieved national prominence in 1777 as a South Carolina representative to the Continental Congress. It was at the Congress where his fellow delegates recognized Laurens' outstanding managerial and leadership abilities by electing him to serve as its President.

Although these were bleak years for our new nation, Laurens' tenure as President were marked with noteworthy accomplishments. Two especially merit comment: the signing of the French Alliance and Congress' approval of the Articles of Confederation, often considered the first constitution of the United States.

Equally important was the personal friendship that developed between Laurens and George Washington, the Commander of the Continental Army. It was their close working relationship which helped to establish the rapport between the Continental Congress and the Army which, in turn, was crucial to the successful military prosecution of the war.

Although Laurens eventually became one of our country's leading patriots, his early business experiences and public life in South Carolina gave no hint of any tendencies toward the separatist stance he would eventually adopt. Instead, he was initially a conservative in outlook.

As late as the 1765 Stamp Act Crisis, Laurens maintained his loyalty to Britain. Unlike more radical patriotic leaders, Laurens counselled against resisting the Stamp Act and other new taxes imposed on the colonies during this period. Though he particularly disapproved of the Stamp Act, he felt that resisting it would only make matters worse--particularly for merchants like himself.[2]

As a result, Laurens was accused of being a supporter of the Stamp Act by more radical colonialists, and an angry mob attacked his Charleston home in a manner similar to the attack on Governor Hutchinson's house in Massachusetts.[3]

His initial conservatism regarding British-American relations and his compromising approach toward new British taxes were shaped during the twenty-five years that preceded the American Revolution. During these years Laurens enjoyed ever increasing success and status--first as a prominent merchant and, later, as a successful planter. Moreover he was a highly respected member of the South Carolina legislature.

This begs the question: What were the events that caused Laurens to make the transition from a politically conservative British subject to an American patriot? This paper will address some events that forced this transition.

In 1744, Laurens' father sent him to London as a mercantile trade apprentice. Laurens clearly learned quickly and well because, upon his return to Charleston in 1749, he soon established himself as a major international trader and shipper. He imported rum and various kinds of foodstuffs from the West Indies, manufactured goods from Britain, and slaves from Africa. He exported such goods as rice, indigo, deerskins, and naval stores. Laurens' business operations depended heavily on British firms and ships. From a financial perspective, this state of affairs was so satisfying that one can easily assume that Laurens would have preferred for it to continue indefinitely. As a consequence, he might have remained loyal to Britain except for four factors which compelled him--perhaps reluctantly--into becoming an American patriot.

The major factor was the unjustified seizure of three of Laurens' ships in 1767 and 1768 by corrupt British customs officials on flimsy charges which should have been dismissed, but when these ship-seizure cases went to the Charleston Admiralty Court, the British judge was anything but impartial. The judge, Sir Egerton Leigh, ruled against Laurens because his judgeship--and his court fees--depended heavily on the support of the corrupt customs officials.[4] Clearly, the outcome of these ship-seizure cases greatly soured Laurens' respect for British justice, and he was transformed from a political conservative into the leading American patriot in South Carolina.[5]

Many historians believe that the ship-seizure cases alone are sufficient to explain Laurens' transition into an American patriot. However, there were three contributing factors which also influenced Laurens' transformation into a patriot. These contributing factors were more subtle, and all were based on Laurens' evolving economic independence from the British.

From his return to Charleston in 1749, Laurens had been a trader and shipper who was, initially, dependent on British business associates as well as British ships. But, by the conclusion of the French and Indian War in 1763, Laurens had begun to dramatically curtail his mercantile operations.[6]

In late eighteenth century South Carolina, it was the custom for prosperous businessmen to invest their surplus wealth in landed estates. When Laurens made this transition from mere merchant--albeit a wealthy merchant--to a planter, he became more economically self-sufficient and, most importantly, less dependent on British business associates and markets. Laurens was now in business for himself, shipping his own produce to various markets in vessels that he himself owned. Henceforth, he was largely master of his own economic destiny.

With the acquisition of former French and Spanish colonies-- especially East Florida-- as a result of the French and Indian War, Laurens quickly expanded his shipping markets to include these new lands.[7] Moreover, with the end of the war, the Georgia frontier had also been made much safer for new settlements--and still more markets. Laurens moved quickly and, by the end of 1764, was already exploiting these new intercolonial trade opportunities.

In fact, Laurens played a very significant role in the settlement of this new colony of East Florida. He was a very close friend of James Grant, the colonial governor, and acted as Grant's agent for shipments of foodstuffs, tools, slaves, and other items needed for the development of the new colony. His East Florida venture was so successful that, for the first time in his life, Laurens was presented with a lucrative alternative to trade with Britain or the West Indies. In one instance, Laurens sent Governor Grant a bill for 2,300 pounds--a very large sum in the 18th century.[8] A further illustration is provided by a quantitative comparison of two different periods of Laurens' business activities. From January 1, 1756 to April 1756, Laurens wrote 87 letters of business correspondence to mercantile firms in England and the West Indies, compared to only six with his fellow Americans concerning intercolonial trade.[9] However, this dramatically changed after Laurens began his involvement with the new settlements in Georgia and East Florida in 1764. From November 23, 1767 to February 16, 1768--one of Laurens' busiest mercantile periods with England after the French and Indian War--he wrote 28 business letters to Grant and his associates in East Florida, 17 to the new markets on the Georgia frontier, and only 49 to England and the West Indies.[10] In comparing these two periods, the percentage of Laurens' business correspondence with British firms dropped from 93.5 percent to 52 percent. While these numbers may fluctuate over different periods, it is clear that trade with England and the West Indies was not nearly as dominant over his business after 1764.

More importantly, Laurens' new intercolonial trade with the southern coast was almost entirely independent of British shipping. During this time period, Laurens only arranged for one shipment directly from Britain to East Florida.[11]

A third contributing factor which led to Laurens' transformation into an American patriot was also economic in nature. This was his decision to abandon his involvement in the African slave trade after 1763.

When he returned to Charleston from his London apprenticeship in 1749, Laurens had immediately become involved in the slave trade, which was a very lucrative business. Laurens became increasingly skilled in the importing and the selling of slaves. In time, he earned a reputation as an expert on identifying the proper types of African slaves--based on their origins along the African coast--for particular agricultural tasks. However, in 1763, Laurens revealed for the first time that he believed slavery to be morally wrong.[12] David Duncan Wallace, author of The Life of Henry Laurens, could find only one occasion after 1763 in which Laurens took part in the slave trade and only after strong pleas from a friend to serve as his agent.[13]

During his career as a merchant, Laurens made tremendous profits from the slave trade. Indeed, it is probable that most of Laurens' business earnings as a merchant came from the trade.[14] However, the slave trade was heavily dependent on British ships. It has been estimated that 90 percent of the slaves imported into Charleston came on British slave ships.[15] During this period, American slave ships were highly inadequate for carrying slaves from the African coast; there was very little headroom and the ships "were cheaply built and barely seaworthy".[16] Laurens was fully aware of the overwhelming percentage of British slave ships that entered Charleston harbor as opposed to American. He often wrote letters to the ship captains of the slave vessels and personally greeted many of the ships that pulled into harbor.[17] Thus, when Laurens gave up the slave trade, he knew he was giving up a great deal of his dependence on British shipping.

Although Laurens was the first prominent Southerner to denounce slavery, he never did it publicly. Later in life, in defending himself against attacks from other Southerners for giving up the slave trade, he indignantly declared that he had not given it up "out of the goodness of his heart,"[18] but that he was too preoccupied with the management of his plantations. This reveals that even a man of as strong a character as Laurens was susceptible to intense social pressures, and these same social pressures may partially explain why he eventually became a strong supporter of the Revolutionary cause.

A fourth significant factor in Laurens' transformation into a patriot was indirectly related to the ship-seizure incidents and his disputes with British customs officials and the Admiralty court. This fourth factor was his decreased dependence on the Royal Navy after the end of the French and Indian War.

During the war, French and Spanish privateers were a serious threat to both colonial and British shipping. As a consequence, colonial merchant ships often sailed in British convoys under the protection of the Royal Navy on trade routes to Europe and the West Indies.[19] This Royal Navy protection was very important to Laurens, and he often expressed concerns about privateer raids.[20] Early in the war, British and colonial trade had suffered greatly from privateers, but by the end of the war, the Royal Navy dominated the seas[21] and privateering along the colonial coast had been greatly reduced.

After 1763, Laurens never expressed any concerns about the need for Royal Navy protection of his shipping, and it is quite possible he now took the safety of the sealanes for granted. This situation may also have caused Laurens to question whether Royal Navy protection was really worth the irritations he faced with customs officials, Admiralty Courts, and the stricter navigation laws--including higher import duties--which the British had recently enacted. Thus, if Laurens felt the British were now going to be detrimental to his mercantile operations, this would be ample reason for him to favor a parting of ways.

These four factors combined to make Laurens the acknowledged leader of the patriot crusade in South Carolina after 1768. A man who was against a non-importation policy during the Stamp Act crisis now became and enthusiastic supporter of the plan in 1769.

As was mentioned earlier, Laurens remained hopeful that a peaceful compromise and reconciliation could be reached with Britain. He objected to thoughts of "separation and independence," as expressed in Thomas Paine's Common Sense.[22] This is the main reason he has always been considered a "conservative Revolutionary." A very practical man, he continued to disapprove of "zealots," believing that the extreme, war-like behavior they advocated would "have ruined Charleston."[23]

Despite these conservative tendencies, Laurens was without question one of the leading advocates of American rights after 1768. Thanks largely to Laurens' leadership, non-importation was as effective in Charleston as in the more radical coastal towns of the

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North.[24] When war with England became imminent, Laurens was elected President of the First Provincial Congress of South Carolina in January 1776. He began his service as the Commander of the Council of Safety and, over the next twelve months, played a crucial role in planning for the fortification and defense of Charleston against a possible British attack.

In June of 1777, Laurens went to Philadelphia as a South Carolina representative to the Continental Congress, where he would play an even more prominent role on the national scene.

Although a man of great integrity, Laurens was susceptible to the same watershed experiences and periods of personal transition that could change the national loyalties of any man. While his anger over the seizure of his ships is, perhaps, the major reason for his conversion to the cause of the American Revolution, his diminished financial dependency on Britain as well as his loss of dependency on Royal Navy protection, were also contributing factors. All these ingredients would prove to be highly important for the future of the young United States, as Laurens would ultimately become one of her most valuable and outstanding leaders.

BIBLIOGRAPHY

PRIMARY SOURCES

Laurens, Henry. The Papers of Henry Laurens. Edited by George C. Rogers and David R. Chesnutt. 14 vols. Columbia, S.C.: University of South Carolina Press, 1968 - 1988.

SECONDARY SOURCES

Dickerson, Oliver M. The Navigation Acts and the American Revolution. Philadelphia: University of Pennsylvania Press, 1951.

Hofstadter, Richard. America at 1750. New York: Alfred A. Knopf, 1972.

Marcus, G.J. A Naval History of England. 2 vols. Boston: Little, Brown, and Company, 1961.

Sellers, Leila. Charleston Business on the Eve of the American Revolution. New York: Arno Press & The New York Times, 1970.

Wallace, David Duncan. The Life of Henry Laurens. New York: Russell & Russell, 1915.

ENDNOTES

1. Much of the material in this biographical summary, over the next three paragraphs, has been gleaned from the introduction of volume 1 in The Papers of Henry Laurens. Philip M. Hamer and George C. Rogers, eds., The Papers of Henry Laurens, 14 vols. (Columbia, S.C.: University of South Carolina Press, 1968-94).

2. Laurens, The Papers of Henry Laurens, 5:24-25.

3. Laurens described the attack many times himself; Ibid., 29-31.

4. The sequence of events concerning these ship seizures and the subsequent court proceedings are described in Oliver M. Dickerson's The Navigation Acts and the American Revolution (Philadelphia: University of Pennsylvania Press, 1951), 225-31.

5. Ibid., 231.

6. George C. Rogers and David R. Chesnutt, eds., The Papers of Henry Laurens, 4:xvii.

7. Philip M. Hamer and George C. Rogers, eds., The Papers of Henry Laurens, 3:xvii.

8. Laurens, The Papers of Henry Laurens, 5:524.

9. Ibid., 2:57-176. 69 letters were written to England and 18 to the West Indies.

10. Ibid., 5:472-596. 41 letters were written to England and 8 to the West Indies. Only letters involving payments or transporting of goods have been tabulated (for both footnotes #9 and #10).

11. Ibid., 535.

12. David Duncan Wallace, The Life of Henry Laurens (New York: Russell & Russell, 1915), 88.

13. Ibid., 88.

14. Leila Sellers, Charleston Business on the Eve of the American Revolution (Arno Press & The New York Times, 1970), 146.

15. Richard Hofstadter, America at 1750 (New York: Alfred A. Knopf, 1971), 72.

16. Ibid., 74.

17. Laurens, The Papers of Henry Laurens, vol. 1 passim.

18. Hofstadter, America at 1750, 75.

19. G.J. Marcus, A Naval History of England: The Formative Centuries, vol.1 (Boston: Atlantic Monthly Press, 1961), 335.

20. Laurens, The Papers of Henry Laurens, vol. 2, passim.

21. Marcus, A Naval History of England, 335.

22. Laurens, The Papers of Henry Laurens, 11:115.

23. Ibid., 163.

24. Sellers, 217.

Beyond The Imperialist V Anti-Imperialist Dichotomy: American Intellectuals And Fin De Siecle Expansionism

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INTRODUCTION

Most historians of fin de siecle American expansionism have divided intellectuals who addressed the matter into two distinct categories--imperialists and anti-imperialists. Although historians effectively support their arguments, documentation exists to contradict their dichotomous framework and convey ambivalence in the writings of American intellectuals.

The expansionists are represented by the two theoretical instruments of justification, Darwinism and Manifest Destiny. Darwin's theory of the survival of the fittest appeared to be the logical justification for the imperialist school of thought. Intellects including Josiah Strong, Frederick Jackson Turner, William Graham Sumner, Brooks Adams, and John W. Burgess, politicians including Albert J. Beveridge, Theodore Roosevelt, and Woodrow Wilson, and the back-seat Admiral, Alfred Thayer Mahan presumable provided the nucleus of late nineteenth century imperialist thought. The "community" of expansionist thinkers are portrayed as having "commonly shared ideas."[1] A commality exists amongst the historians interpreting late nineteenth century expansionist fervor. Each historian attempts to draw direct links between the above men to display conspicuous internationalist tendencies and to construct a definitive categorization.

Historians have conveniently categorized anti-imperialists as those individuals who "were gentlemen of the old school, representatives of a past era, [and to whom] imperialism did not appeal." Anti-imperialist intellectuals and politicians represented the minority position in the debate, which may account for the limited publication of late nineteenth century anti-imperialist thought. The anti-imperialist was not that dissimilar from the expansionist, in viewing the state of American "character" as pre-eminent. This minority group's refutation of the popular policy of expansionism was, historian Frederick Merk Notes, "strong enough to discourage" some imperialistic legislation. The forces guiding the various enclaves of the anti-imperialist movement were diverse, but two individuals are presented by historians as the most vocal opponents of the rising 1890's imperialist temperament--William James and Henry Adams.[2]

EVALUATING THE INTELLECTUALS

Analysis of the individual works of intellectuals helps to unravel the historiographic dichotomy to reveal the vagueness and ambivalence of most intellectuals on the topic of extra-continental expansion, and helps provide an alternate framework for categorization of the intellectuals. This more complex and non-dualistic model better illustrates the complex circumstances influencing the core of late nineteenth century intellectuals and the complex principles guiding a nation.[3]

Two distinctive intellectual groupings--ardent imperialists and ardent anti-imperialists--do appear to conform to the dichotomy. However, a third intellectual aggregation seems to prevail as the "mean" of intellectual thought during the imperialist 1890's. The remainder of this study is devoted to the presentation of a three layered framework for categorizing intellectuals. The three layers are: Those intellectuals who devoutly pursued imperialist ends; those concerned with the consequences of interventionist policy who expressed absolute anti-expansionist positions; and, thirdly, the larger aggregation of intellectuals who do not share a common position, but instead share a common ambivalence.

The imperialist interpreted the acquisition of non-contiguous territory as a necessity and a right. The individuals providing the justification for imperialist activity normally based such assertions on the absolute will of a pro-Anglo-Saxon Christian God. Josiah Strong's Our Country (1885) foresaw the "limited" unoccupied arable lands available due to the proliferation of "surplus populations" and urged God-fearing Anglo-Saxons to procure the available lands.[4]

As a reverend and missionary during the period of American westward expansion, Josiah Strong experienced the settling of a nation. His preachings resembled the Manifest Destiny that led Americans westward; yet, his ideas were further justified by Social Darwinism.[5] Strong viewed the "dispossess[ing of]...weaker races" and "assimilat[ion of] others" an inevitable consequence of an "Anglo-Saxonized manking."[6] Others, in accordance with Josiah Strong's philosophical leanings, would advocate imperialism, but due to extensive circulation of Our Country Strong remained one of the foremost pioneers of the position.[7]

Drawing on the "Heaven directed purpose" theory, established by Josiah Strong, Albert J. Beveridge wrote a speech entitled "The March of the Flag" for the 1898 Indiana Republican Congressional campaign. Beveridge's speech further emphasized Strong's notion of a preordained American future. The process of accumulating territory under the guidance of "God" was beginning to come to fruition in the year Beveridge wrote "The March of the Flag," for the Catholic "Spanish sloth" contributed to his brazen advocacy of American acquisition of previously Spanish territory. From this vehemently pro-Anglo rhetoric one may see a pattern of Old World continuity between Strong and Beveridge. Since the Anglo was presumably predestined by God to inherit the Earth, advocates of non-contiguous expansion were able to justify Old World imperialist ideologies through the word of the Lord.[8]

A deviation occurs, though, in the work of the standard evangelical expansionist--Theodore Roosevelt. Roosevelt's ideology represented a reduced dependence on religious imperial political thought. Anxiety over the closing frontier and over European imperialism influenced Roosevelt. He would find solace in the theories of Brooks Adams, Alfred Thayer Mahan and Frederick Jackson Turner. Roosevelt commented extensively on the works of Brooks Adams. He found Adams's The Law of Civilization and Decay "not merely interesting but solestirring."[9] Roosevelt also criticized what he believed were particular historical generalizations within Adams's text. Roosevelt was concerned with Adams's emphasis on the "fall of the soldier"--or the decreasing spirit of American virility. Roosevelt denied that this decline was imminent. "The life of action" remained in the spirit of Americans, Roosevelt exclaimed. The threat to the American spirit was only at "risk of wearing out" and far from a reality. According to Roosevelt, the proper course to avert this "rusting out" would be expansionism.[10]

Roosevelt seemed to view Adams's work as an ominous warning. Furthermore he interpreted Frederick Jackson Turner's writings as a justification for the commencement of non-contiguous expansion in the wake of the frontier's closing. Although a direct relationship between Roosevelt and Turner is difficult to establish, Roosevelt certainly heeded Turner's closing frontier thesis, and was concerned over the eventual "evil days" of stationary America.[11]

Perhaps a greater influence on Roosevelt was his correspondence with Alfred Thayer Mahan. The foreign and naval policy advocated by Mahan was viewed positively by Roosevelt, because it furnished the means through which America could expand. The theories of Adams and Turner may have affected Roosevelt's views on internal issues, but Mahan's ideology impressed on Roosevelt a sense of foreign urgency. Although Roosevelt was, from the outset an imperialist, his utilization of Adams's, Turner's, and Mahan's theories does not render those thinkers "imperialists by assocation." Roosevelt found the justification he needed in their works, but had to read them selectively to do so.

The anti-imperialists conception of overseas land acquisition agreed with the prevailing isolationist policy of the previous decades. The reason for refuting imperial initiatives was actually similar to the imperialist goal--to protect "our permanent ideals and character." William James along with the majority of prominent literary figures, and social activists, including Charles Francis Adams, E.L. Godkin, and Jane Addams sided with a domestically focused, anti-imperialist policy.

William James, as noted earlier, best embodied and expressed the movements's various positions. His vocal attacks on Theodore Roosevelt's famous "Strenuous Life" speech displayed an intolerance for the war hawk imperialists. James represented the antithesis of the often militant "competitive passion[s]" of the expansionists.[12] James's explanation for imperialist tendencies appears in an oration he delivered in 1897 entitled "Robert Gould Shaw." According to James, the imperialist symbolized one's "exaggerated" dependence upon the supposed virility of war, and the inability of "history...[to] breed the battle-instinct out of us."[13] James and the anti-

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imperialist camp agreed that war and the acquisition of territory were archaic Old Word methods used to destroy the "moral fruits...of a pacific civilization."[14]

While there were clearly imperialists and anti-imperialists, many of the interpreters of domestic social and economic upheavals and/or external commerce concerns provided explanations mired in amvivalence. The dichotomy established by historians fails to exhibit the uncertainty of this third grouping. With the inclusion of this third element the complexity of the American intellectual and political framework during the 1890's is more accurately depicted.

Brooks Adams's, first work, The Law of Civilization and Decay (1885), describes the process of a state's decline. Adams's views on imperialism were distorted by various prominent American figures who were involved in crafting an expansionist policy. Although Adams's work may be a prediction of the future of American society, Adams himself noted that "American history is not brought into purview" in The Law of Civilization and Decay.[15] Even in his more focused work America's Economic Supremacy (1900), which appeared after the war with Spain, he remained ambiguous. According to Adams "the United States must provide sure and adequate outlets for her products, or be endanger of gluts."[16] Even though he referred to the war with Spain as an economic benefit, Adams continued to present the notion of imperialism as an option and not a necessity. He would note that "if expansion and concentration are necessary...then America must expand and concentrate until the limit of the possible is attained."[17] Adams seemed to be suggesting an increased governmental responsibility for the economy in order to foster international commercial "competition" by trade, not force. Adams's final option was to "fight our adversary" to obtain commercial pathways, and this was a last resort. Adams's expansionist outlook has been exaggerated and misinterpreted as advocacy of militant imperialism.

Brooks Adams' brother Henry Adams is also categorized as an imperialist by historians. Henry Adams's argument was complex. He questioned the position of the Western world's future, in part because of the influence of Brooks Adams's The Law of Civilization and Decay. Along with the acceptance of his brother's work came a distinctive ambivalence towards imperialist oriented causes. Henry Adams would "approve the war to free Cuba," while expressing disdain over the Philippine War. Even though he supported a war for a free Cuba he felt the conflict was the result of motives, certainly imperialist. Furthermore, his skepticism over the war in the Philippines was not the position of an imperialist.[18]

Alfred Thayer Mahan understood the potentially dangerous consequences of a small navy in a world where shifting dependence on larger naval systems was dominating. His article "A Twentieth Century Outlook" (1898) advocated American inclusion in the international arena. The type of inclusion, however, depended on who was interpreting his writing. Though Mahan believed "the Caribbean Sea, with its isthmus, is the nexus...[where] the United States has asserted a special interest," the type of action used to obtain access to these interests was only described as "an outward impulse," and nothing else.[19] Mahan may have used a militant tone in the article, but its actual emphasis is on the enhancement of commercial interests through naval superiority. The Influence of Sea Power Upon History, published in 1880 by Mahan, essentially examined the importance of naval forces in respect to previous European endeavors. Though he does allude to the circumstances of late nineteenth century commerce, the book offers no clear advocacy of extra-continental territorial expansion.[20]

In contrast to Mahan's empahsis on naval interventionism and overseas commerce, Frederick Jackson Turner's writings, particularly his most influential essay "The Significance of the Frontier in American History" (1893), emphasize domestic issues. Only one statement in Turner's 1893 essay suggests the author's support for future expansionist endeavors, and even that statement is an ambiguous one:

> American life has now entirely ceased. Movement has been its dominant fact, and, unless this training has no effect upon a people, the American intellect will continually demand a wider field for its exercise.[21]

This "wider field" mentioned by Turner may be interpreted as overseas expansion, or as countless other "field[s]" relating to domestic developments. it should be noted that the purpose of Turner's frontier thesis was to warn of the frontier's closing, not to remedy the consequences of that development.

William Graham Sumner is presented by some historians as the archetypical imperialist intellectual. William Appleman Williams, for example, viewed Sumner as a thorough-going imperialist. However, Robert Beisner emphasizes Sumner's association with the Mugwumps (a group with anti-imperialist leanings), and argues that he was an anti-imperialist. Both Williams and Beisner may actually have the right answer to Sumner's role in the 1890's imperialist debate. Sumner was a Social Darwinist who, according to his work Earth-Hunger and other Essays, justified imperialism when related to economics, but found imperialism for political reasons "a pursuit of great follies." It is complicated to distinguish between the two types of imperialism for the reason that "political earth-hunger" (as Sumner describes political imperialism) can be justified for economic reasons very easily. Earth-Hunger and Other Essays explicitly demonstrates Sumner's ambivalence concerning imperialism. Sumner, the harsh Social Darwinist, and, one would presume, the most likely intellectual advocate of American imperialism, is not so easily categorized.[22]

CONCLUSION

The imperialist versus anti-imperialist dichotomy presented by historians is only effective in categorizing some American intellectuals. Although extremists clearly voiced imperialist and anti-imperialist ideologies the actual mean in American intellectual writings was less radical and more engaged in questioning the consequences of both imperialist and anti-imperialist actions. Many of the questions confronting Americans remained unanswered even after the Spanish-American War. Even devout imperialists found non-contiguous territorial acquisition problematic following the war. Theodore Roosevelt explained in a letter to Frederic Coudert that the Philippines remained America's "achilles heel." The Platt Amendment is further testimony to the national skepticism concerning imperialism for the sake of national interest. The amendment suggested, or, at least, was intended to suggest, that American foreign policy was other-centered, not self-centered. The debate over non-contiguous expansion, though, had centered around whether imperialism would be beneficial or detrimental to the national character. The debate over America's fin de siecle expansionism is so complex because intellectuals were formulating their positions in response to the European powers' race for colonies. United States intent was not nearly so other-centered as the Platt Amendment implied but it was not as clear as critics of American expansion have argued, either. Indeed, American's fin de siecle expansionism was marked less by a great debate then by a great deal of ambiguity and uncertainty.

ENDNOTES

1. Robert L. Beisner, Twelve Against Empire: The Anti-Imperialists (New York: McGraw-Hill Book Company, 1968), 15; Walter LaFeber, The New Empire (Ithaca, New York: Cornell University Press, 1963), 63.
2. Beisner, Twelve Against Empire, 10 and 15; Frederick Merk, Manifest Destiny and Mission (New York: Vintage Books, 1966), 234.
3. Henry Steele Commager, The American Mind (New Haven, Connecticut: Yale University Press, 1950), 41.
4. Josiah Strong, Our Country (New York: Baker Co., 1885), 173.
5. Dorothea R. Muller, "Josiah Strong and American Nationalism," Journal of American History 53 (December 1966: 487-503, 489.
6. Strong Our Country, 178.
7. Muller, "Josiah Strong and American Nationalism," 503.
8. John Fiske, "Manifest Destiny," Harpers's New Monthly Magazines 70 (February 1885): 578-90, 588; Albert Beveridge, The Meaning of the Times and Other Speeches (Freeport, New York: Books for Libraries Press, 1968), 4.
9. Theodore Roosevelt, "Duties of a Great Nation," The Works of Theodore Roosevelt 16 (New York: Scribner's Sons, 1926), 291; David Burton, Theodore Roosevelt: Confident Imperialist (Philadelphia: University of Pennsylvania Press, 1968), 30.
10. Beveridge, The Meaning of the Times and Other Speeches, 49; Wayne Andrews, ed. The Autobiography of Theodore Roosevelt (New York: Charles Scribner's Sons, 1958), 112, Peter Novick, That Noble Dream: The "Objectivity Question" and the American Historical Profession (New York: Cambridge University Press, 1988), 21-86; Novick emphasizes the profound influence of English and especially German scholarship on intellectuals (such as Josiah Strong and Albert Beveridge), and the intellectuals' reverence for the "Teutonic germ" theory.
11. William Appleman Williams, The Tragedy of American Diplomacy (New York: Delta Books, 1959), 25.

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12. Andrews, The Autobiography of Theodore Roosevelt, 144 and 142; Ralph Barton Perry, The Thought and Character of William James (Cambridge, Massachusetts: Harvard Univeristy Press, 1948), 245-246; William Gibson, "Mark Twain and Howells," The New England Quarterly (December 1947), 435-436.
13. William James, "Moral Equivalent to War," Memories and Studies (New York: Longmans, Green, and Co., 1917), 288.
14. Ibid., 288.
15. Brooks Adams, The Law of Civilization and Decay (Freeport New York: Books for Library Press, 1971), 40.
16. Brooks Adams, America's Economic Supremacy (New York: Harper & Brother, 1947), 97, 103, and 104.
17. Ibid., 104.
18. David Contosta, Henry Adams and the American Experiment (Boston: Little Brown and Company, 1980),95.
19. Alfred Thayer Mahan, "A Twentieth Century Outlook," Harper's New Monthly Magazine, 568 (1898): 521-533, 521.
20. Gibson, "Mark Twain and Howells," 436; Osgood, Ideals and Self Interest in America's Foreign Relations, 34-5.
21. Frederick Jackson Turner," The Frontier in American History (Tucson, Arizona: The University of Arizona Press, 1986), 88.
22. William Graham Sumner, Earth-Hunger and Other Essays (Freeport, New York: Books for Libraries Press, 1913), 64 and 46.

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"BEING MADAME IS A MISERABLE JOB"
The Letters of Liselotte von der Pfalz, 1672-1722

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Elisabeth Charlotte, Duchess d'Orleans, came to Versailles in 1672 to marry the King's brother, Philippe d'Orleans. Almost immediately upon arriving, she began a correspondence in which she kept a running commentary on life at this celebrated court. Her descriptions merit examination because they provide insight into how frustrating life was for her at Versailles. In her letters she was highly critical of how women were treated at Louis XIV's court. Her opinions and attitude differed greatly from that of her contemporaries. Unsatisfied with the proscribed role for women, she related her attempts to redress the inequitable treatment accorded her gender. For a women of this time to openly criticize and challenge gender roles is rare and her letters merit close examination.

It was partly her background which lead Elisabeth Charlotte, or Liselotte as she refers to herself in her letters, to such unconventional attitudes. She was born in 1652 into a royal family at a small court in Heidelberg, Germany. There the attitude was much less pretentious.[1] The relaxed customs and habits of her home were in stark contrast to the pomp and ceremony that characterized Louis XIV's Versailles. Most importantly, though, the women in Liselotte's childhood enjoyed a great deal of freedom. Her aunts, in particular, were all intelligent, learned women who lead quite illustrious lives. One carried on a life-long intellectual correspondence with the eminent philosopher René Descartes. Another was a scandalous Carmelite nun who, according to Liselotte, "had so many bastards that she swore by 'this belly that has born fourteen children'."[2] Liselotte was closest to her Aunt Sophie, who instilled in Liselotte a love of learning and the habit of letter-writing. It was to Sophie that Liselotte directed the bulk of her correspondence, writing and receiving letters on a weekly basis for over forty-two years. Growing up with such active and independent-minded women as role models and in such a down-to-earth environment left a lasting impression on Liselotte. She was never able to reconcile the values of her childhood with what she termed the "debauchery," "restrictiveness," and "ridiculousness" of Versailles.

When she came to Versailles in 1672, she assumed the title of *Madame*. She made her feelings plain on how she felt about her role: "Being Madame," she wrote in a letter dated 21 September 1700, "is a miserable job." (123)[3] She suffered because she found that women at Versailles were expected to perform certain roles which conflicted greatly with what she had anticipated, given the independence enjoyed by her female relatives in Germany. She rebelled against these expectations by pursuing an extremely unconventional lifestyle. Eventually she completely dissociated herself, from court society, retreating into a self-imposed state of isolation, devoting most of her time to writing letters.

Her unusual position at court has caused her letters to be dismissed as novelties or anomalies as she was an outspoken critic.[4] In my analysis I explore how her letters reveal the thoughts and opinions of a woman who has often been overlooked in histories of Versailles. Liselotte's writing contributes much to our understanding of the role that seventeenth-century court society envisioned for women and how it compared to the role they envisioned for themselves. I begin by addressing the significance of letters to women in the seventeenth century. I then examine the content of Liselotte's letters, focusing on her critique of court life and the evidence she gave to demonstrate that women were subject to greater constraints than men. Her critique of the women around her indicates that she felt their behavior contributed to their inequitable treatment. Finally, I analyze the challenges she raised to this system of gender construction and show that through her writing she defied the conventional notions of womanhood.

As my sources, I examined a selection of letters edited and collected by Elborg Forster. Published in 1984, Forster provides the most recent and complete English translation. This compilation contains letters written upon Liselotte's arrival at court in 1672 through her death in 1722. Liselotte was, to say the least, a prolific letter writer. According to the writing schedule she gave in her letters, she devoted four days of every week entirely to writing. She wrote primarily in German, producing over 100,000 letters during her lifetime. As she admitted in 1719, after forty-eight years of letters, "writing is my chief occupation."(231)

SIGNIFICANCE OF LETTERS TO LISELOTTE

For a woman in seventeenth-century France, letter-writing was the only acceptable medium she had to express herself. Margaret Cavendish, though writing from slightly different circumstances in England, explained their situation clearly: "...since all heroic actions, public employments, powerful governments and eloquent pleadings are denied our sex in this age, or at least would be condemned for want of virtue, is the cause I write so much."[5] Liselotte and her contemporaries were writing for personal reasons and received no financial compensation for their work, yet, these women did make a kind of "profession" out of correspondence. Like any other profession, their writing consumed a great deal of their time. If the letters were circulated, they could earn the authoress fame and respect. The letters of Mme. de Sevigne, for example, were so well-written and in tune with the latest happenings of the French nobility, they were circulated at court.[6]

Although equally informative, time-consuming, and intelligently written, Liselotte's letters differed from those of her contemporaries in several respects. She did not write with the intention or the option of having her letters circulated--no member of the royal family was permitted to publish.[7] Liselotte's purpose in writing was two-fold. She used her letters to provide her audience (primarily her female relatives in Germany) with a realistic portrayal of her frustrations with life at Versailles. Letters enabled her to put to paper "what lips cannot say,"(100) for the women around her did not share her frustrations. In a letter dated 1683, she lamented to Sophie, "If only there were a single soul to whom I could open my heart."(42) Liselotte also used her letters to indirectly announce her unhappiness to other members at court. As early as 1682, Liselotte was "quite certain that my letters are being read and opened."(34) She took advantage of the fact that her letters were being intercepted to use them to call attention to the status of women. In 1702, she wrote: "I have been warned that the people who read my letters are making rather strange comments about them... Will the gentleman who translates from the German please translate this carefully, so that the ministers know exactly how I feel."(146) Liselotte was intent on making her dissatisfaction known.[8]

LISELOTTE'S FRUSTRATIONS WITH COURT LIFE

Forster suggests that one of Liselotte's greatest frustrations was that she was not born a man. Although she explicitly stated this only once, in a letter dated 1718, it is evident that she felt life would have been significantly easier had she not been a woman. Women were expected to defer to men, to be demure, and to occupy themselves with gentle-work, not intellectual pursuits. At Versailles, there is no place for tomboys, or "leaf-rustlers" as she referred to herself and her daughter. Liselotte realized her daughter was as vivacious as she and worried that she would be in for a difficult time at Versailles. For her daughter's sake she stated: "I wish that she and her brother could swap temperaments, for while he is also bright, he is as staid and proper as a girl should be, and she is as wild as a boy."(42) Liselotte learned the hard way that life is difficult if one does not adhere to the commonly held notions about what a woman should do.

Her description of her dispute with her husband over his choice of their son's tutor is a compelling example of the consequences she faced when challenging the expectation of female deference. Her husband had chosen a close friend of his, a man of whom Liselotte heartily disapproved. In a letter to her Aunt Sophie, Liselotte described how she first tried to reason with her husband: "This man is one of the most disreputable and debauched characters in the world... there is no greater sodomist in all of France than he, and it would be a bad beginning for a young prince to start his life with the worst debauchery imaginable... I also pointed out to Monsieur (her husbands's official title) that I had other reasons to ask him not to entrust my son to his man..." But her husband refused to be reasoned with. He warned her that if she "should remain stubborn and say that this is being done against my will, it would happen anyway, the only difference being that he would make life miserable for me... and thereby show that he was master in his own house." Evidently, her husband considered her actions and her attempt to assert her opinion to be a threat to his manhood. Liselotte realized this and was conscious of the fact that, as a woman, she had little recourse. She continued, "I granted that Monsieur is the lord and master and that he can place my son in the hands of anybody he sees fit... there is little I can do."(65-67) In order for her to exert influence, she depended upon a man to intercede on her behalf. She took her case to the King, first in writing, then in person. She managed to convince the King of the significance of the choice of her son's tutor and ultimately she succeeded in having another man appointed to the position.

Liselotte described her situation at Versailles as one of "continuous constraint." Her chief complaints were "always having to do what others want...not being able to travel without the king...never having any money." Aside from the restriction on travel, which was applied to everyone at court,[9] Liselotte listed restrictions that applied only to women. Society was constructed so that a man's interests were put before a woman's. She explained to Sophie: "French marriage-contracts are drawn up in such a way that whatever comes to the wife during the husband's lifetime also belongs to the husband, [he] can do with it and manage it as he sees fit, and the wife has no right to get upset."(50) But, Liselotte did get quite upset. She lamented, "Whenever the King gives me something, I must pay my old debts, and he never gives me anything except at New Years, and Monsieur never gives me a single ducat."(64) In a later letter she wrote, "I seem destined to lose everything that I should get from my family...all the money Monsieur has taken unto himself without giving me a red farthing of it."(68)

Liselotte also encountered difficulty in expressing herself and related how she was "chastised for speaking too freely."(43) She stated, "I don't know how to dissimulate, but I do know how to keep quiet. Therefore, if I am not to say what I think, I must not be made to speak."(60) She was even warned by the court censor that certain topics were inappropriate for letters. She managed to circumvent this by bypassing the official post, whenever possible she sent letters with Germans who were visiting court. In these she is much more free with what she writes. "In the mail I should not dare to put down such outrageous things as are written in this letter." (35)

As she related her experiences as a woman, she portrayed herself as subject to censorship, constraint, and a great deal of discrimination on the basis of her gender. She was very aware that males and females were subject to different standards. She wrote of a world in which women must spend their time "being bored and pregnant," husbands are acknowledged as "master," of a world in which "among ten thousand, one barely finds [a husband] who does not love someone other than his wife." She deplored the double standard of morality which was the norm at Versailles. "Does the young Duchess not know that a woman's honor consists of having commerce with no one but her husband, and that for a man it is not shameful for a man to have mistresses?"(87)

LISELOTTE'S CRITICISM OF THE WOMEN AT COURT

According to Liselotte, the other women at court willingly complied with these expectations and double standards, and she repeatedly expressed her frustrations with them. She criticized their 'loose' morals and preoccupation with their appearance. She poked fun at their elaborate costumes, penchant for wigs, and their preoccupation with being *a la mode*. Liselotte's criticisms stemmed from her desire to disprove the negative stereotypes attached to her gender. While the courtesans sought to exert influence though their feminine wiles, Liselotte viewed such behavior as reinforcing the beliefs that women had a stronger sex drive, were less able to control it, and that women were ruled by their emotions instead of by reason.[10] Liselotte felt that the behavior of the women at court compromised any chance for her gender to be taken seriously. Instead of sensuous creatures, she wanted women to be viewed as sensible beings. Liselotte's conception of what a woman's role should be was in direct conflict with how other women viewed that role. In fact, her call for greater independence and equal status threatened their greatest area of influence--the bedroom. These threatened women constitute a large part of those to whom she referred as her "enemies at court."

Liselotte considered her "greatest enemy" to be the King's mistress, Madame de Maintenon. For her Liselotte reserved her most scathing criticisms and insults. She wrote of de Maintenon, "I do not believe that a more wicked devil can be found in the world than she is, for all of her piety and hypocrisy, and I find that she is a fine example of the old German proverb 'Where the devil cannot go, he sends an old woman.' All the trouble comes from this slut."(68) Liselotte was referring to the influence that de Maintenon exercised over the King via her role as his sexual partner and religious confidante. Liselotte gave several examples of how his mistress influenced the King's decisions. He received his ministers and conducted affairs of state from her apartments. Liselotte wrote, "The King does only what his old trollop wants and will hate even those whom he loves most if she says so." In fact, Liselotte repeatedly claimed that de Maintenon hated her and used her influence to turn the King against her. Because she operated in the traditional realms of feminine influence, it would stand to reason that de Maintenon had a great deal to lose from Liselotte's attempts to change the status of women. As discreet and well-behaved as Liselotte was conspicuous and unconventional, de Maintenon's lifestyle was in every way antithetical to Liselotte's. It represented the very epitome of what Liselotte criticized. Their mutual animosity comes through in a letter Liselotte wrote to her aunt: "She cannot do me any worse harm than she has already done me and I hope it will be enough to make her go to hell."(87)

Although Liselotte would never openly admit to it, it is obvious she considered de Maintenon competition for the King's attention. Liselotte was not interested in the King as a love-object, as some historians have suggested, but rather as an instrument of power.[11] As seen in the example of the dispute over her son's tutor, Louis XIV was her only recourse, and she was extremely concerned with maintaining access to him. Openly disdaining religion and sex as a means of feminine influence, she sought to win the King's favor through activities normally associated with males! She gave many examples of hunting trips she took with him, the bawdy stories she exchanged, and her frequent attempts to engage him in stimulating conversations. Liselotte's contempt and frustration with the traditional options given to women, led her to disdain the feminine, not because it was ineffective, but because it kept women in a subordinate position.

Liselotte felt women were treated as being less valuable and less important than men in part because they were not permitted to live fulfilling lives. In Liselotte's world there were only several options open to a woman: wife, mistress, nun, or old maid. All were defined according to their relationship to men and none were a satisfactory option to Liselotte. She was very critical of the institution of marriage: "One who is eager to marry had better not consult me, for I never advocated the married state." In her eyes, women seemed to get the raw end of the deal. It is rare "if a spouse is given a comfortable livelihood and if she is not pestered."(92) She viewed convents as a type of banishment. Upon learning of her husband's death, she went into hysterics, shrieking "no convent, no convent!"[12] She feared that she had lost her position at court, was now unwanted, and would be sent to a convent where she would be out of the way. Liselotte saw convents as a place where women were sent in times of crisis, when either they are too much for the outside world or the world is too much for them. Society did not esteem unmarried women. She wrote that her father "had me on his hands and was afraid I'd become a little old maid, and got rid of me as quickly as he could."(137) Being someone's mistress was absolutely intolerable to Liselotte, who observed a strict morality. According to her, the options open to women did not allow them to serve any useful function.

LISELOTTE'S SUGGESTIONS FOR IMPROVING THE STATUS OF WOMEN

In an especially revealing letter written on the occasion of her son's becoming regent, Liselotte made several statements regarding what she felt the proper role of women should be. "I am extremely concerned that it might be thought that my son is ruled by women and therefore, in order to set an example to his wife and daughters, I have announced loudly that I will not meddle in any of his affairs." She concluded the letter by stating "It's time to let menfolks have their way."(204) Her remarks are puzzling because they border on misogynistic. In a sense they are, for she did harbor a great deal of ill-will towards the type of women found at court. But Liselotte did not harbor ill-will towards womankind in general. If we consider the context in which the statement is made, we realize that she was actually urging women to find alternative means to assert themselves. She wanted women to exert influence in areas that were not, as politics was, hopelessly male-dominated. She intended her legitimate and insightful observations to be taken as constructive criticism.

How did Liselotte make her sentiments known at Versailles? It is somewhat ironic that her letters, normally private documents, became a public forum. She took full advantage of the fact that her letters were being read by censors. Instead of deterring her from speaking her mind, this knowledge lead Liselotte to put in asides such as this one addressed to Madame de Maintenon: "I have no reason to treat her gently, and if she should open this letter, she will find a few home truths."(87) Contained in Liselotte's letters is a very definite message to the women at Versailles. She exhorts them to do as she does: to assert themselves, to be independent, and to exercise individuality.

Liselotte's observations lead her to take an active role in trying to correct how gender was constructed at court. She sought to discredit the current system, challenging the traditional expectations of women with her unconventional lifestyle. Perhaps the most obvious means she used was to exhibit decidedly unladylike behavior. In speech she was coarse and bawdy. She would not dance or play cards, complained about the endless official functions, and schemed to get out of attending them. Her love of hunting was accompanied by her lack of interest in gentle crafts. "I have no skill and desire for fancy-work and nothing in the world bores me as much as sticking in a sewing needle and pulling it out again."(231) Liselotte prided herself on being "hideously ugly, but fortunately for me I do not care one whit."(217) Not considered beautiful by court standards, she even refused to make efforts to enhance her appearance. Despite being the second-highest ranking woman at court, she owned only three dresses![11] Nor did she enjoy associating with her contemporaries after hours. "I never go to the salon where all those who are at court assemble."(196) These were just a few of the ways she dissociated herself with from the typical conception of how women at Versailles were expected to behave.

Eventually, Liselotte retreated, in both a physical and a figurative sense, from court life into a world she could structure to her own liking. In 1698, she wrote, "Here at this great court, I have well nigh turned myself into a hermit, and there are not many people in the country with whom I keep steady company, and I spend long days all alone in my sitting room, where I occupy myself with reading and writing."(108) In contrast to the context of Versailles, her letters afforded her a world with familiar customs and whose inhabitants shared similar sentiments. It was a world in which she was able to express herself which much less inhibition.

Liselotte's letters testify to her struggle to be an individual in an atmosphere which insisted upon conformity. She did not wallow in the misery of being *Madame*. In fact, she was not even a very good one, according to seventeenth-century standards. But Liselotte lived her life according to her own standards, and not the standards that were normally imposed upon her gender. Her letters reveal how confining life was for women at Versailles. Through them, she attempted to broaden the spheres of activities traditionally open to women and to create an existence for herself, independent of the influence of men. Liselotte's letters contain the testimony of a woman who refused to conform to the lifestyle of Versailles. Her correspondence was a means of escape, a means to retain her dignity, and the only way she had to express herself.

Notes

1 Harold Donaldson Eberlein, The Rabelaisian Princess, (New York: Bretano's Publishers, 1931), 7.

2 Ibid., 17.

3 The page numbers following the quotations refer to pages in the collection of letters edited by Elborg Forster. A Woman's Life in the Court of the Sun King. Letters of Liselotte von der Pfalz, 1652-1722, (Baltimore: The Johns Hopkins University Press, 1984).

4 Historically her letters have not been treated seriously. See books such as Secret Memoirs of the Court of Louis XIV and the Regent. Extracted from the German correspondence of the Duchess d'Orleans, Mother of the Regent, (London: G and W.B. Whitaker, 1824).

5 quoted in Olwen Hufton, The Prospect Before Her: A History of Women in Western Europe, 1500-1800 (London: Harper Collins Publishers, 1995) cited 435.

6 Ibid., 535, footnote.

7 Forster, xxix.

8 I do not believe that a language barrier inhibited Liselotte's self-expression. To have such intimate knowledge of court life required at least proficiency if not fluency in French.

9 Ibid., xi.

10 Merry E. Wiesener, "Nuns, Wives and Mothers and the Reformation in Germany" in Women in Reformation and Counter-Reformational Europe ed. Sherrin Marshall (Bloomington: Indiana University Press, 1989), 13.

11 Eberlein, Mme. de Sevigné, and Nancy Mitford all suggest that Liselotte was secretly in love with the King, and that this, unbeknownst to her, was the motivation for her actions. Forster disagrees, attributing their statements to idle gossip.

12 Both Mitford and Eberlein refer to this incident.

13 Nis A. Peterson, "Madame: Elisabeth Charlotte of Orleans", History Today, (Great Britain) Vol. 27, No 2, (Feb. 1977): 101-107.

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FENCING OUT THE FOREIGNER: INFLUENCES ON THE EIGHTEENTH LEGISLATURE OF WYOMING AND ITS EXCLUSION OF FOREIGN PHYSICIANS

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THE NATIONAL SITUATION IN THE 1920'S

Many Americans became intensely isolationist in their political philosophies during the interval between the World Wars.[1] The fear of the foreigner that had been held in *some* abeyance before World War I came into full bloom in the heartland of America in the 1920's. Wyoming did not escape the influence of this national paranoia, and indeed, had its own proselytizers of opposition to immigration and of the 100% American movement. The propagators of mistrust and prejudice did not do so under the guise of a secret organization, although there is some evidence of Klan activity in Wyoming at the time.[2] Rather, they were confident that they formed a majority, and confident of the propriety of their insular movements within Wyoming and the nation.[3] These movements led directly to the banning of foreign physicians and to the unintended exclusion of the children of "undesirable" foreigners from medical practice in Wyoming.

Of primary significance in this period was the re-organization of the medical profession begun in the earlier part of the century under the auspices of the Rockefeller Foundation.[4] John D. Rockefeller authorized what is known as "The Flexner Report," which gave a scathing account of the situation in the medical schools, and advocated a blueprint to upgrade the quality of medical education in the United States. It advocated that only the allopathic or biochemically based branch of the medical profession to be considered legitimate, and favored the banning of chiropractors, homeopaths and natropaths. With this end in mind, the American Medical Association (AMA) began to rate medical schools, and classify them according to stringent rules.[5] There was also a media campaign to expose quackery (which was anyone in disagreement with the medical profession as they saw it) and to organize the pharmaceutical profession.[6] The plan entailed prohibiting patent medicines and what was at the time traditional herbal medical treatment that did not involve payment to an AMA approved physician.[7] This push by the AMA led to the lobbying of the state legislatures to enact medical licensing laws.[8]

The AMA was also concerned in this period with what they called the "quality" of the medical students and physicians. This is where the pseudo-science of Social Darwinism and Biological Determinism so prevalent and widely publicized in the history of Europe, but ignored by many of the historians of the United States, came into play.[9] For example, in the 1920 keynote address of the AMA convention by the then Surgeon General of the United States W. C. Braisted, who was also President of the AMA, there is much evidence of the philosophy of Social Darwinism and Biological Determinism. He discussed the "physical integrity" of the American race as a necessity for "survival in its struggles with its rivals" for example, a direct line of thought in the "survival of the fittest" philosophy.[10] He went on later to say that owing to the World War I draft law, medicine had discovered that the "white" race was weakening due to its low birth rate and physical defects found. He also advocated an investigation into the background of medical school applicants to ascertain their fitness for medical education. This, he stated, was to keep diplomas from being awarded to " physical or moral runts." He finished with a diatribe against medical students whose main disqualification is that they did not speak "proper English." The qualification of English as the primary language of a student, spoken without an accent, would exclude many applicants of foreign extraction, and some of their descendants, and would also exclude Americans not of the "privileged class" that the medical schools were now aiming at recruiting.[11]

Medical schools also began to institute quotas based on the ethnic backgrounds of their applicants during this period.[12] It was part of the effort to "upgrade" the practice of medicine in America, and limit what was to them the undesirable element admitted to their profession as well. The quota system had devastating effects on the children of immigrants. These second generation Americans were virtually ostracized from the medical profession. For instance, at Columbia University Medical School 40% of its 1920 graduates were of Jewish and Eastern European lineage. By 1922, this percentage decreased to 20%. By 1930, the medical schools and universities across America had effectively barred the "undesirables" except a small percentage.[13] It was not the immigrants themselves that these Protestant white Anglo-Saxon Americans were ultimately discriminating against, but their children, American citizens all. Many applicants who were turned down did not give up their dream of becoming physicians. Instead, they went to Europe to study. When they came home to the states, they were once again considered a competitive threat within the medical profession, and this is one of the central reasons for excluding foreign physicians and foreign educated ones in various states. It came down to who was going to acquire the American citizens enduring medical dollar.

THE SITUATION IN WYOMING IN THE 1920'S

Wyoming was not nearly as impacted by immigration as some other states, but it still felt similar pressures. There were many enclaves of foreigners in places like Rock Springs and many of the mining communities around the state.[14] Some of the other towns, such as Laramie, had large (for Wyoming) immigrant populations. This led to the undertaking by the University Of Wyoming of what came to be called Americanization classes, taught by Grace Raymond Hebard, then head of the Political Science department.

Grace Hebard was the most influential woman in Wyoming at the time. She was head and founder of the Wyoming chapter of the Daughters of the American Revolution,[15] and had many other influential connections in the state. She was also close to many of the Republican leaders in the state. Her opinions were sought after by the state and the national representatives of the people of Wyoming. Legislation was submitted to her for comment well *before* it was even considered by the Senate or the House in Wyoming. [16]This included the legislation passed in the Eighteenth State Legislature concerning the citizenship of physicians.

Miss Hebard had much to say in many forums around Wyoming about the "racial characteristics" of the recent immigrant population.[17] She believed that the Nordic race was the bearer of the superior attributes needed by America, and that the people of the "alpine" and "Mediterranean" stock were much less desirable.[18] This belief system was first outlined in William Z. Ripley's *The Races Of Europe*.[19]The undesirables included Jews, Italians, Russians, Poles, and other Slavic nationalities. For example, in a talk given on the Nordic races, she cited many good characteristics of these Norsemen, and implied that the other peoples were "less compatible' with American ideals. She used Charles Lindbergh as the example of the desired "racial blood." His combination of Swedish, English and Irish blood made his "courageous deeds" possible, in Dr. Hebard's view.[20]

Miss Hebard instructed many classes especially designed for immigrants, but most of the immigrants she seemed to deal with were Canadian, Australian, English or German, all of the supposedly "better" races. Perhaps, as one researcher of Miss Hebard's life says, if she "knew more of them"[21] (the other nationalities) she would have changed her prejudicial bias. As it was, she actively supported the 1924 Reed-Johnson Bill in the U.S. Congress to limit the already restricted immigration even more.[22]

This prejudicial bias was encompassed by the nationwide idea of 100% Americanism. The 100% movement was put forward to preserve what was considered the "original" ideas and concepts of the founding fathers of America. It meant more than being native born. Catholics, Jews, and Negroes were not considered to be 100% Americans, no matter how long they had been living here.[23] The movement fed on many of Wyomingites fears. With the expansion in the mining industry came foreigners who were not assimilated, who spoke no English, and who were "different" from the small town provincial sons of the West. They were also in direct competition for jobs with limit foreign involvement in medicine was designed to solve in Wyoming.

Another critical aspect of the problem in Wyoming was powerful personages wanting the state's laws to be seen as being reciprocal with the laws in other states who were passing similar legislation. This push for standardization of medical licensure laws had been instigated by the AMA and the Rockefeller Foundation in the earlier years, and was coming to fruition at this time.[36] It remains to be investigated whether the Rockefeller Foundation had any influence in Wyoming on this matter. But there is evidence some doctors seemed to be well connected with the oil companies of the time. For instance, Dr. Earl Whedon of Sheridan was the secretary and head of the Medical Defense committee of the Medical Society Of Wyoming, a branch of the AMA. He also was heavily involved with then Rockefeller owned Standard Oil Company (until the TeaPot Dome scandal). He was also involved until the 1950's with many other oil related ventures.[37] These kinds of connections lead to speculation that more than the medical profession may have been considered when passing licensure laws in many states, not just Wyoming.

The new statutes also allowed for the "grandfathering" in of many physicians not practicing traditional medicine in Wyoming, such as chiropractors and homeopaths. This inclusive position had been adopted by the AMA as they imposed stricter standards on medical schools and encouraged more inflexible licensing laws.[38] In Wyoming, it obtained passage of a law requiring the physician to be a U.S. citizen. Six months later the Board Of Medical Examiners added a qualifier to the law: that the person seeking licensure must have graduated from a class "A" medical school.[39] It enabled the physicians in Wyoming who were non-traditional to become licensed, thereby squelching much of the opposition, and then it slammed the door on any new chiropractors and homeopaths.

It was just this type of law that prevented the children of immigrants, who had been virtually excluded from U.S. medical schools and been educated abroad, from the practice of medicine here in the United States. Their degrees would not be accepted in Wyoming or many other states because of these statutes. With these seemingly necessary statutes, Wyoming prevented a significant segment of the foreign born and their children from becoming physicians to the people of Wyoming.

THE SIGNIFICANCE OF STUDYING THE BACKGROUND OF LEGISLATION

It has been seventy odd years since this legislation was passed, and it has been revised many times since. Some Americans still evidence suspicion and alarm toward newly immigrated peoples and foreigners in general. The quota system instituted in the medical schools at the time does resemble the affirmative action quotas of the past twenty years, although they were instituted for differing purposes. Could they not have the same result? The affirmative action program in California has severely restricted Asian Americans from attending many schools, for example.

Immigration is once again being heavily attended to by the media. Legislation against the children of illegal aliens has been proposed in many forums in this country, including the U.S. Congress. California's Proposition 187 passed with an overwhelming majority. Our senators from Wyoming have sponsored new immigration laws in Congress. The reasoning behind many of these new laws bears a remarkable resemblance to the same sort of bias evidenced in the anti-immigrant arguments of the 1920's.

For example, in 1924 Senator Warren was on the committee to restrict immigration of the Japanese to this country. In a letter to M.C. Brown, he speculates on who will pick California's agricultural crops if the bill passes, as Americans are too busy and lazy to do this sort of work themselves.[40] This same sort of argument, only with the word Mexican substituted for Japanese can be heard today.

Wyoming's stricture against physicians who are not citizens, and who are not graduates of a class "A" medical school seems very provincial to people who think in terms of world economies and modern technologies. People are beginning to join together in a global village, one where nationalities may become insignificant. It remains to be seen what sort of village it will be, and who will remain outsiders to the general populace of a new form of American society. One lesson that studying this law of Wyoming may teach us as we become more diverse is that we must consider closely and returning soldiers after World War I. This led to culture conflicts in most of the places where large numbers of foreigners were working. It also led directly into the support given the 100% movement by the Ku Klux Klan.[24]

The Klan of the 1920's was indeed an "Invisible Empire." It had extended its grasp well beyond the deep South into the West and small town America. It was very influential to the south of Wyoming, with much of Colorado being controlled by the Klan in the 1920's.[25] It has been estimated that there were up to a million or more members in the west at the time.[26] It is very difficult to track its predominance in Wyoming, however, because it was less widespread and not as overtly organized.

Wyoming did have representation at some national Klan gatherings.[27] The women in the Klan felt secure enough to incorporate their organization in Cheyenne in the 1920's also.[28] So there were some indications that the Klan had an organization in Wyoming. They were also well enough accepted by mainstream Wyoming society to engage in correspondence with the then senator from Wyoming, Frances E. Warren. He was on the committee that was considering immigration law in the 1920's, and the Reed-Johnson Bill to limit immigration to 2% of the nationalities based on an 1890 census, or the 1910 census. The Klan was in favor of the 1890 census, as it was before large scale immigration from Eastern and Southern Europe began. Warren even said in a personal letter to Hiram Evans, Grand Kleagle of The Klan, that there was much "good food for thought" in the Klan's position on immigration.[29] Many other people in Wyoming also wrote the senator in support of the 1890 date for limits on immigration.[30]

Most Wyoming people would become familiar with the Klan's opinion's through the newspaper coverage of the Klan's trials and tribulations in other states.[31] Trials of Klan members for terrorism in Oklahoma and other localities were widely covered, with Wyoming newspapers allocating space to entire speeches by the leaders of the Klan. In one such article, the Klan position on immigration is given by the head of the Klan, the Grand Kleagle Hiram Evans:

"Our Cause is true Americanism. Our destiny is the common welfare, materially and mentally, physically and spiritually, upon a plane high above any mankind has ever known.... the time has come to look far beyond... to this greater American problem of our composite people. That is the bedrock of every national danger and hope. The streams of population that have been and are pouring in upon us are ages old in racial character and capacity. We are the melting pot. Into it has been poured, almost promiscuously, perhaps in recent years designedly, every dross ingredient of citizenship the earth produces, the good and the bad. Monthly the immigrant stream is more and more inferior...."[32]

Hiram Evans goes on in the article to describe Negroes as "savages," Jews as "never emerging for a real intermingling with America." Catholics are undesirable because they are "illiterate" and owe allegiance to Rome. This list of "undesirable aliens" given in the article according to the Klan creed also includes Greeks, Serbs, Rumanians and Bulgarians. Klan doctrine was obviously right in line with Grace Raymond Hebard's notions of nationalities and of the 100% American viewpoint. This anti-foreigner bias did carry over to the Wyoming legislature and the national legislature, as many anti-alien laws were passed in 1924-25.

Despite such pressures, there was no surplus of physicians in Wyoming or the nation, foreign or otherwise, during the 1920's.[33] At the same time the license requirements were being debated, the Wyoming legislature also was considering passing a requirement that three doctors be required to examine persons being admitted against their will to the state asylum for the insane at Evanston.[34] Meanwhile, judges in various counties protested that they did not have the resources or physicians available to them. The law was then changed to having the county coroner, one physician, and a disinterested party sign commitment papers.[35] If counties had problems finding three doctors to commit the insane, it did not make sense for the medical professionals of Wyoming to be in favor of laws limiting licensure. This was also the predicament in most of rural America, as many of the articles in the 1924-1925 AMA journals discuss. So a plethora of physicians that needed regulation was not a significant aspect of the reasoning behind the legislation or part of the genuine problem that the legislation to carefully whom our laws are designed to affect, and what powers they are constituted to protect. Indeed, such laws may reflect another agenda that is not as obvious or as encompassing of the various Wyoming constituents as it seems.

Notes

[1] David H. Bennett, *The Party Of Fear: From Nativist Movements To The New Right In American History* (Chapel Hill: The University Of North Carolina Press, 1988), Part III. Anti-Alien Movements In Recent History.

[2] Lawrence Cardozso, "Nativism In Wyoming: Changing Perceptions Of Foreign Immigrants." *Annals Of Wyoming History* Spring (1986): 31. Also, the *Cody Enterprise*, January 7, 1925 edition, a Klan proposition for prayer in schools that made it in front of the school board.

[3] William H. Moore's, "Progressivism And The Social Gospel In Wyoming: The Anti Gambling Act Of 1901 As A Test Case." *The Western Historical Quarterly* XV (July 1984): 299-316.

[4] Richard E. Brown, *Rockefeller Medicine Men: Medicine And Capitalism In America* (Berkeley: University Of California Press, 1979)143-188.

[5] *Journal Of The American Medical Association*, publishes a yearly ratings guide to the medical schools. A good example of this periods ratings is in the April 17, 1920, vol 74, No. 16 issue.

[6] Samuel Hopkins Adams, *The Great American Fraud* (New York: P. F. Collier & Sons, 1905, 1906), in great detail exposes many of the patent medicine industry's secrets, and de-bunks many medical cults of the time. An example that Wyoming's populace may have seen is in the *Laramie Republican-Boomerang*, Tuesday December 4, 1923, in an article on the closing down of a "nature school."

[7] JAMA also had an ongoing campaign against the patent industry and chiropractors, and it is in evidence in almost all of their journals. See *JAMA* issue for July 3, 1920, Vol 75, No. 1, Editorial Pages, where chiropractors are lumped in with medical cults, for example.

[8] One of many examples is in the "Current Comment." section of the *JAMA*, August 16, 1924, Vol. 83, No 7, where they specifically call for the strengthening of state medical laws against the "menace" of non-traditional practitioners. This issue also has an anonymous article by the editors that describes the "progress" made in the previous 24 years of medical education (pp. 532-534).

[9] After World War 2 and the discovery of the Holocaust, the finger of self righteousness was mainly pointed in the direction of Germany, with little acceptance of prejudicial beliefs being prevalent here in the home of the "free."

[10] JAMA, *The Obligations Of Medicine In Relation To General Education*, May 1, 1920, Vol. 74, No. 18. p. 1205-1213.

[11] Henry Pratt Fairchild, *The Melting-Pot Mistake* (Boston: Little, Brown And Company, 1926), gives an authentic view of a contemporary educator and many other influential men of the period, such as Henry Cabot Lodge, that compares succinctly with Braisted's speech, and gives a more in depth account of the mongrelization feared by white, middle-class America of this period. Also, for a discussion of language and the part it plays in discrimination, see Margaret Wetherell and Jonathan Potter's *Mapping The Language Of Racism: Discourse And The Legitimization Of Exploitation*, (New York: Columbia University Press, 1992).

[12] Arthur Hertzberg, *The Jews In America: Four Centuries Of An Uneasy Encounter* (New York: Simon And Schuster, 1989), 246-247.

[13] Marcia Graham Synnott's "Anti-Semitism And American Universities." in David A. Gerber, Ed., *Anti-Semitism In American History* (Urbana: University Of Illinois Press, 1986), 233-271.

[14] Cardozo, *Nativism In Wyoming*,22.

[15] The Grace Raymond Hebard Collection, Collection 8, Box 37, file folder 2. American Heritage Center, Laramie, Wyoming. Article discussing immigration and Hebard lecturing at the D.A.R. meetings. File folder 1, article stating she is "State Regent For Life" of D.A.R. 1925.

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[16] McCollough Collection, Letter to Grace Hebard, January 26, 1925. Box1, American Heritage Center, Laramie, Wyoming. Also, Hebard to McCollough, February 27, 1925.

[17] Hebard Collection, AHC. Folder 2.

[18] Hebard Collection, AHC. Article from the Laramie Republican Boomerang, May 18, 1925.

[19] William Z. Ripley, *The Races Of Europe: A Sociological Study* (New York: 1899), quoted in Robert Singerman's "The Jew As A Racial Alien," in Gerber's *Anti-Semitism*.

[20] Hebard Collection, AHC. Article in Wyoming State Tribune and Cheyenne State Leader. Friday, September 2, 1927.

[21] Frank Van Nuys, "My One Hobby: Grace Raymond Hebard And Americanization In Wyoming," *Wyoming History Journal* Autumn (1995): 3-15.

[22] Frances E. Warren Papers, Letterbooks, American Heritage Center, Laramie, Wyoming. Letter from Warren to Hebard, April 11, 1924.

[23] David M. Chalmers, *Hooded Americanism: The First Century Of The Ku KLux Klan, 1865-1965* (New York: Doubleday & Company, 1965), 57.

[24] Julia Johnson, Ed., *The Ku Klux Klan*, 10 ed., vol. 1 (New York: The H. W. Wilson Company, May, 1923).

[25] Robert Allan Goldberg, *Hooded Empire: The Ku Klux Klan In Colorado* (Chicago: University Of Illinois Press, 1981), and Larry R. Gerlach, *Blazing Crosses In Zion: The Ku Klux Klan In Utah* (Logan, Utah: Utah State University Press, 1982).

[26]Goldberg, *Klan In Colorado*, says 3 to six million! p 5

[27] Chalmers, *Hooded Americanism*, p. 221

[28] Cardozo, *Nativism In Wyoming*, footnotes

[29] Warren Letterbooks, AHC. Letter to Hiram Evans, December 20, 1923.

[30] Warren Letterbooks, AHC, letters 1924-25.

[31] *Laramie Republican-Boomerang*, had heavy coverage of Klan trials in October and November, 1923 Notably, October 25, 1923, November 9, 1923, November 7, 1923.

[32] Hiram Evans in Associated Press, "Ku Klux Klan Ideas About Admitting The Foreigners," *Laramie Republican-Boomerang*, October 24, 1923, 1,8

[33] William Allan Pusey, "Medical Education," *JAMA* 84.4 (January 24, 1925). Also see the letter to the editor in the *JAMA*, February 14, 1925 Vol.84, No.7

[34] McCollough Collection, AHC. Letters from Spaulding, February 4, 1925.

[35]*Ibid;* Letter from Hamilton, head of the Wyoming Medical Society, February 11, 1925.

[36] Jeffery Lionel Berlant, *Profession And Monopoly: A Study Of Medicine In The United States And Great Britain* (Berkeley: University Of California Press, 1975) 237-240.

[37] Earl Whedon Collection, AHC.

[38]Brown, *Rockefeller Medicine Men*, Chapter 5

[39]*JAMA*, July 18, 1925.

[40]Warren Letterbooks, AHC. Letter to M.C. Brown, April 21, 1924.

A Woman's Place:
Female Tavern and Inn Keepers in Early Pennsylvania

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ABSTRACT

Drawing extensively upon handwritten 18th century court records and other original documents, as well as upon important recent works in early American women's history, this paper explores the lives and work of women who operated taverns in early Pennsylvania. What were these women's lives like? What was the nature of their work? What advantages and obstacles did they encounter as a result of their gender? In what ways did their lives of relative independence challenge prevailing attitudes about women's "place" in society? And how did their circumstances change with the profound changes that marked 18th century America? This paper explores these intriguing questions.

Focusing on 18th and 19th century Chester County, Pennsylvania, this paper explores taverns and inns in early America and women's roles within them. The work draws upon a wide range of secondary sources and original, handwritten court records from the period.

In early America, taverns provided food, alcoholic drink and lodging for travelers, all for a price. Depending upon the particular tavern and the season, visitors ate pork, fresh fish and fowl, eggs and cheese. Liquor of all kinds was available as well, from flip (a mixture of wine, sugar and molasses), to whiskey, beer, and grog (a mixture of rum and water, and perhaps the origin of our term "groggy").

Taverns also generally functioned as the center of the community. In addition to providing entertainment, taverns were commonly the site of local auctions and government proceedings, including court trials and town meetings. Most importantly, these establishments were gathering places where the latest news could always be learned. Colonial laws typically required each town to build and maintain a tavern. As William Penn noted, in early America taverns were "a public service."[1]

Of course, as Penn also observed, such establishments had to "be regulated by law to prevent abuses."[2] Authorities limited, for example, how long an individual could remain in a tavern and how much one could consume. Prices were regulated and adjusted annually, and courts standardized the amount of alcohol per drink.[3] Perhaps the most obvious and important regulation came with licensing. In licensing taverns, authorities considered not only the personal character and financial stability of the prospective operator, but also the suitability of the proposed location.[4]

There were various types of taverns, each with distinctive names indicating specialized functions. "Ordinaries" were primarily eating establishments. "Inns," usually located in rural areas, provided lodging for extended periods of time, longer than the typical one or two night stay. "Tippling houses" were shady establishments operating at the edge of the law. A good example is the Chester County tippling house operated by Hannah Thompson. During the 1760s, she appeared in court a total of ten times in just three years for the activities there. When licensed at all, such places were often closed down because of gambling, raucous behavior and the like.[5]

Regardless of the type of establishment, each had its own character which reflected the clientele. The names of the taverns were often revealing in this regard. The "Royal Standard" and the "Rose and Crown" catered to upper class Philadelphians. A roost for the lower sort was provided by the "Hen and the Chicken," another Philadelphia establishment.[6] Bright, colorful signs were hung outside of taverns to catch the eye of those passing by and to help individuals who were illiterate.

What role did women play in the taverns? In early America, as in England, married woman were completely subordinate in law. They could not make contracts, own businesses, or even call property their own without special arrangements. In the words of Sir William Blackstone, married women were in a condition of *feme covert*, whereby "the husband and wife were one person in law," and that person was the man, "...under whose wing, protection, and cover she performs everything."[7] This did not apply to single women, whether divorced, widowed, or never married. Their status was known as *feme sole*. Such women enjoyed the same legal rights as men, including the right to have their own businesses. A good case illustrating the difference between *feme covert* and *feme sole* status is that of Mary King. A resident of Radnor, Pennsylvania, she twice petitioned for a tavern license in 1786. During her first try, she did not mention that she was a widow and the court denied her request. Later that year, Mrs. King noted that she was a widow and authorities immediately granted the license.[8]

Widows in particular owned and operated taverns. Authorities were especially concerned that such women would not become public charges after their husbands died. Tavern operation required cooking, cleaning and serving - skills presumably possessed by women, especially those who had once been married. Given these circumstances, it is perhaps not surprising that in early New England 71% of the taverns were operated by women, and that women owned at least one in five Philadelphia taverns at the time of the American Revolution.[9]

Thus, women were thought to be well-suited to tavern keeping and for the most part they fulfilled the definition of a positive and successful tavern owner, one who was "orderly, honest, temperate and an outstanding citizen."[10] However, not all of the women tavern owners in Chester County lived up to this model. Between 1700 and 1860, approximately 100 women went to court for tippling, selling alcohol without proper licenses, running disorderly houses, or selling liquor on Sundays or to minors. While few licenses were revoked, most of these women did pay fines, and a few even went to jail.

Sometimes women were charged simply with tippling - operating a tavern without a license. The widow Priscilla Robertson, for example, was charged in 1828 with keeping "a Tippling-house, without any License so to do," where she "did retail... to sundry Persons, divers Quantities of Rum, Wine, Brandy,... and other Spirituous Liquors...." Several witnesses testified against the widow Robertson and the court convicted her. She was fined $20 and paid court costs.[11]

Other women were charged with offenses that occurred within licensed taverns. In 1814, for example, Jane Mercer was given the choice of jail or a fine after being convicted of selling spirituous liquors in quantities "by less Measures than one Quart." Avoiding jail, she paid $26.60 to the Commonwealth of Pennsylvania. The case was unusual because she was a married woman, yet the tavern license was in her name. *Feme sole* status would ordinarily have precluded that, unless she had owned the tavern before marrying John Mercer.[12]

In early America, as now, selling alcohol to minors was a problem. In July of 1854, Catherine Russell went to court in Chester County for this offense, eventually paying fines and court fees totalling $100. She also lost her license to operate a tavern. Two years later, her husband was charged with the same offense, but was acquitted.[13]

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Mary Cook and Sarah Sperry were involved in other offenses. In 1741, Cook was arrested and fined for her excessive hospitality. It seems that she kept a disorderly tavern that was frequented by "whores, vagabonds, and idle men."[14] A warrant went out for Sarah Sperry's arrest in 1814 after she sold liquor on Sunday "against the Peace and Dignity of the Commonwealth of Pennsylvania." Rather than face the charge, she ran away, but returned the following year and paid her fine.[15]

Some women had a long history of offenses related to tavern operation. The widow Ann McCaffery was such a woman. She appeared in court at least ten times during the 1850s, paying hundreds of dollars in fines and bonds. She repeatedly sold strong drink to minors, and ran her tavern without a license as a gathering place for drifters and women of ill repute.[16]

Taverns had an interesting impact on life in the early colonies. From the evidence obtained in Chester County, in addition to what scholars have learned about other areas, in many ways women's experiences were remarkably similar to men's. Like men, they owned and operated taverns. Like men, they found themselves in trouble with the law from time to time. And like men, they were punished when they disobeyed the law. The patterns of prosecution were much the same from 1700 to 1860, regardless of gender. Most years brought relatively few tavern-related prosecutions, but these escalated dramatically during the 1850s in response to reform pressures related to drinking and drunkenness.

Women tavern owners also shared daily life experiences with men - buying, selling, trading, keeping accounts, dealing with rules and regulations, and so on. To this extent, they differed from most of their female counterparts who did not find themselves so deeply or directly involved in the "world of men."

As the nineteenth century progressed, women operated fewer taverns. As one scholar has noted, "there were more women merchants and tavern owners, proportionally, [in the 18th century] than there were in the 19th...."[17] This reflected trends that steadily narrowed women's opportunities in the 19th century, and increasingly created for them "a woman's place" more exclusively in the home.

ACKNOWLEDGMENTS

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REFERENCES

[1] Frances May Manges, "Women Shopkeepers, Tavern Keepers and Artisans in Colonial Philadelphia," (Ph.D. Dissertation, University of Pennsylvania, 1958), 74. For a discussion of laws requiring taverns, see Kym S. Rice, *Early American Taverns: For the Entertainment of Friends and Strangers* (Chicago: Regery Gateway, 1983), 23.

[2] Manges, "Women Shopkeepers," 74.

[3] Rice, *Early American Taverns*, 35, 96.

[4] Ibid., 63.

[5] For the Thompson case see Chester County Criminal Court Dockets, Chester County Archives, West Chester, Pennsylvania (hereafter cited as CCD), 7:(1762). See also May 1762, August 1762, November 1762, May 1763, August 1763, August, 1764, February 1765. The case papers are identified with CCM.

[6] See Elisabeth A. Dexter, *Colonial Women of Affairs: A Study of Women in Business and the Professions in America before 1776* (Boston: Houghton Mifflin Company, 1924), 9, and Manges, "Women Shopkeepers," 76.

[7] Eirlys M. Barker, "Princesses, Wives and Wenches: White Perceptions of Southeastern Women to 1770," in Larry D.

Eldridge, ed., *Women and Freedom in Early America* (New York: New York University Press, 1997), 45.

[8] Rice, *Early American Taverns*, 52.

[9] Ibid., 51.

[10] Ibid., 47.

[11] Robertson, CCD-16:83 (1828), CCM-August 1928. For other examples see Hannah Thompson, CCD-7, (1762), CCM-February 1762, August 1762, November 1762, February 1763, August 1763, August 1764, February 1765.

[12] Mercer, CCD-13:26 (1814), CCM-October 1814. For another example, see Sarah Hoy, CCD-21:181 (1857).

[13] Russell, CCD-20:464 (1854). See also CCD-21:57, 152, 201, 202, 291. For other examples, see Julia Shea, CCD-21:217 (1857), Ellen Green, CCD-21:220 (1857), Mary Norris, CCD-21:365 (1859).

[14] Cook is discussed in Rice, *Early American Taverns*, 55.

[15] Sperry, CCD-13:97 (1814).

[16] For McCaffery's convictions, see CCD-21:286, 302, 351, 358, 412.

[17] See Richard B. Morris, *Studies in the History of American Law* (New York: Octagon Books, 1974), 129.

The Debates and Arguments Leading to the Passage of the Seventeenth Amendment

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The Seventeenth Amendment provides for the direct election of United States senators by popular vote. Prior to this amendment, the State Legislatures chose the senators to represent the state. The debates on the issue of directly electing U.S. senators has existed in the House of Representatives since 1893. This paper will describe the various arguments made for and against the proposed amendment between 1893 and 1913. This paper will focus in particular on the reasons why this amendment succeeded in Congress in 1912, and how the Progressive movement ideals factored into the final passage.

The Seventeenth Amendment of the United States Constitution was an important change in the structure of the federal government. Before the Seventeenth Amendment was passed, each state legislature chose the United States senators to represent their state in the federal government. The Seventeenth Amendment, which was ratified in 1913, allows for the direct election of United States senators by popular vote. This method puts control into the hands of the people.

At the time of the passage of the Seventeenth Amendment, the Progressive Era was a major movement that was sweeping the country. Within this movement, the push for more democracy and a return of the government to the people was what finally inspired passage of the Seventeenth Amendment.

The Progressive Era focused on restoring good government, giving the government back to the people, and taking corruption and political machines out of the political process that ran the country.[1] The early 20th century was the reform era that generated the idea of giving the people more say in their government, in part through the direct election of their senators.

Although the idea of direct election of senators was not in the forefront of political reform thought, the concept of it had been in existence since the late nineteenth century. Some form of popular election of senators was introduced into Congress every year since 1893. So, the idea was not solely a Progressive one. It came about as a result of people questioning state sovereignty and its role in the protection of democracy.

An amendment to the Constitution of the United States to provide for the direct election of United States senators was debated in the House of Representatives as far back as 1893. In actuality, the idea had existed since 1826. It was not until 1893, though, that the notion to propose an amendment to the Constitution in regards to electing senators came to the House floor. In each year thereafter, the House introduced and passed such a resolution, which was then sent to the Senate, where the matter was not acted upon, and thus did not become an amendment.[2]

The early mentions of such an amendment appearing in 1894, from the Congressional Records of the House, indicate that Congressman DeArmond from Missouri argued that the very idea of proposing an amendment to change the way the election of senators was conducted should come from the people and not from party factions. DeArmond argued that the people should have the right to choose their senators, which would result in a far more representative body.[3]

In the debate on July 20, 1894, it was argued that the notion of direct election of senators was already debated and resulted in the Constitutional Convention of 1787.[4] The method that was used to elect senators was a compromise agreed upon by the founding fathers and not to be meddled with. In particular, it was argued that it was against the founding fathers' principle of separation of powers.[5] Never before had the present government gone against the very set-up of government that was developed in 1787. Due to that fact, many did not directly favor the proposed amendment.

A rebuttal to this argument was made by Senator Turpie, from Indiana, in December of 1894. He argued that the country does not have to stick to what the founding fathers devised. They gave the House of Representatives to the people, why should they not give the Senate as well. "The people are the source of all power," he said. "Why should not we as lawgivers spring directly from that source?" Mr. Turpie argued on behalf of the amendment to allow for direct election of senators by the people.[6]

Mr. Turpie furthered his argument in support of the amendment to the Constitution to directly elect senators by the people by presenting the fact that several times state legislatures spent their entire sessions attempting to elect a senator and, therefore, neglected their duties to the state. Sometimes, the state legislature even failed to elect a senator.[7] The new method proposed would eliminate the need for state legislatures to give up their primary responsibilities to focus on national matters.

Even two years later, Mr. Turpie was still arguing his case for this amendment. In 1896, on the Senate floor, he argued that the time had come to diverge from the founding fathers' set-up of government:

> It is now time for us to pay a rational deference and respect to the memory of our ancestors, not by adhering to what they under different and other circumstances did, but by doing what they would have done under our present conditions.[8]

The founding fathers developed a government that would grow with time and advance with the people. In order to do this, the amendment process was developed to change the government to allow for it to grow and advance with modern times. The concept of an amendment to allow for the direct election of senators is exactly the type of change that the founding fathers allowed for in creating the amendment procedure, Turpie said.[9]

The same arguments were still around in the early 20th century that existed in the late 19th century concerning the resolution to directly elect senators.

In 1908, on the Senate floor, all the reasons to support the direct election of senators that had come up in the House through the years were brought into the light once again. This time, it was Senator Owen from Oklahoma who brought to the attention of the Senate all the states that had passed resolutions in favor of electing senators by direct vote:[10]

> Mr. President, here are the legislatures of twenty-seven States of this Union who have requested this reform, ... I call upon you ... to respond to the will of the people of this country, and more, to respond to the principles of righteousness which ought to prevail and which will prevail when the great people of this country are allowed a free expression of their will in electing Senators by direct vote of the people.[11]

Mr. Owen pointed out the obvious fact that this amendment was something that the people wanted and were asking for. The states were responding to the people; the federal government should do so also.

The argument that arose in 1908 against the resolution to directly elect senators was that it would give the power to elect the senators to the people, and it was not known whether the people were capable of such a task. Many were still afraid to allow the people to have a direct say in the way the government was run.

This proposed amendment would create a drastic change in the set-up of government and naturally it was confusing to the public, as well as to the congressmen themselves. In order to help explain this proposed amendment and to keep the public informed, *The New York Times* covered the progress and the debates concerning this issue. The amount of coverage the newspaper devoted to this issue increased as popular support for it increased in the early 1900s.

The public stayed informed about this issue through magazines as well. Articles in popular magazines took the ideas that came from the arguments and debates in Congress, expanded them, and used them to further educate the public on this matter.

This can be seen in an article written in 1902, which favored taking the election of senators off the agenda of state legislatures. Charles Fox's words echo the argument made in 1894:

> This new method of electing Senators would be very beneficial to the State legislatures. These are elected primarily to consider local and State affairs, and it is better that they should not be hampered with national obligations.[12]

Not only did magazines express support for the amendment, they also printed the arguments against such an amendment, much the same way as the debates went on in Congress. In 1911, as the final push for the passage of this amendment was underway, there still was opposition coming from Congress as well as from the public. Public opposition dealt with the notion of whether the average citizen was capable of making an intelligent choice if given the chance to actually elect a United States senator.

The road to passage of the amendment to directly elect senators by popular vote was a long, controversial one. It is evident by all the arguments made either in support for it or against it. It took many years for each house of Congress to pass the resolution, and then to finally agree on the same principle and language of the resolution to finally pass the amendment by both houses.

It was a resolution added to the direct election of senators resolution that was holding up the passage of this amendment. In 1912, an agreement was reached, called the Bristow Amendment, which allowed for the amendment to get passed. The Bristow Amendment affected section 3 of Article 1 of the Constitution; it provided that "The Senate of the United States shall be composed of two Senators from each State chosen at a general election by the electors thereof for a term of six years."[13]

The House and the Senate agreed on the same resolution, after going through numerous amendment processes on the resolution. After much debate over the issue and what exactly should be included in the amendment to allow for the direct election of senators, it was passed by both houses of Congress on May 13, 1912.[14]

The Seventeenth Amendment, which it was to be called, outlined the process of directly electing United States senators by popular vote of the people. This amendment gives the people the right to vote directly for their United States senators. This amendment also gives the power of conducting U.S. senatorial elections to the states and gives them the authority to set qualifications for those who want to run for the Senate, as well as fill any vacant seats that might occur due to death while in office or if someone resigns his office.

In essence, the Seventeenth Amendment at the same time took power away from the states, but also gave them power. This happened in different forms, though. It took power away from the state legislatures and gave more power to the state executive branch.

This amendment took power away from the political machines that had a huge influence within state politics, that carried onto the national level. As John Buenker interpreted in his analysis of the passage of this amendment:

> Representing one of the major constitutional changes in twentieth-century America, the direct election of United States Senators is usually depicted as a victory of middle-class progressive reformers over the immigrant-dominated, boss-controlled urban political machines.[15]

After much debate and after several decades, the 62nd Congress passed the Seventeenth Amendment. Once the amendment was proposed by Congress on May 13, 1912, it then had to go to the states for ratification. The ratification process took a little less than one year, in which thirty-six of the forty-eight states ratified the amendment. This occurred by April of 1913. On May 31, 1913, the Secretary of State declared in a proclamation that the Seventeenth Amendment was now a national law.[16]

The public appeals for this amendment are quite obvious throughout the twenty-year push for the direct election of senators. The reasoning behind the reluctance of the government to act on these appeals is not quite clear on the surface. Below the surface there are reasons why the government would not want to change its structure. One of the main reasons, I believe, is that those in government would not want to make a law changing the way they are elected. This reasoning is probably most evident in the Senate, since it is the senators who were most affected by this amendment. The Senate was reluctant to act on the early public appeals due to this fact. It is not until the Progressive Era, in which public support and appeals grew, and it was obvious that some change would take place, that the Senate reluctantly agreed to this amendment.

The House of Representative members really pushed for this amendment because it did not truly affect their role in government. They were elected by the people, and subjected to them, so they supported the notion that senators should be subjected to the same things the House was subjected to. The Senate debated this issue for a long time and tried to put it off as long as possible, for fear that they would have to appeal to the people and be held accountable to them.

The Seventeenth Amendment was passed in 1912 because it was during the height of the Progressive movement, and Congress was acting responsibly towards the people. Since the debate over this proposal existed for twenty years and more, the logical conclusion that I can come up with as to why the amendment was passed in 1912 and not in any other year, is that it was a by-product of the reform movement in America in that decade.

Through the twenty-plus years that this issue was thought of and debated, the arguments for this proposal grew in strength and culminated in the first decade of the 1900s with a very strong argument for the passage of such an amendment. Because in the end the issue had such a strong argument and a solid case, and almost nation-wide support, Congress really had

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no other choice. Popular choice of senators was becoming the rule in many states, even without a constitutional amendment. There were many states in 1912 that already had some form of popular choice of senators enacted.[17]

This constitutional amendment gave the government back to the people. It made Congress more accountable to the public, and it further restored the confidence and prestige that people had once held for their government.

On April 8, 1913, the Seventeenth Amendment was successfully ratified. On May 31, 1913, the Seventeenth Amendment was the successful culmination of twenty years of debate over the issue as to whether the fundamental set-up of Congress should be altered.

1. Benjamin Parke De Witt. The Progressive Movement: A Non-Partisan, Comprehensive Discussion of Current Tendencies in American Politics. (New York: The Macmillan Company, 1915): 4-5.

2. Leonard W. Levy, ed., Encyclopedia of the American Constitution vol. 4 (New York: Macmillan Publishing Company, 1986): 1665.

3. Congress, House, Congressman DeArmond of Missouri speaking on the Joint Resolution to Directly Elect Senators, H. Res. 20. 53rd Cong., 2nd sess., Congressional Record (19 July 1894) vol. 26, pts. 6-8, 7726.

4. Congress, House, Debate on the Joint Resolution to Directly Elect Senators, H. Res. 20. 53rd Cong., 2nd sess., Congressional Record (20 July 1894) vol. 26, pts. 6-8, 7765.

5. Congress, Senate, Senator Turpie speaking on the Resolution to Directly Elect Senators, H. Res. 20, 53rd Cong., 2nd sess., Congressional Record (6 December 1894), vol. 26, pts. 1-2, 73.

6. Ibid., 73.

7. Congress, Senate, Senator Turpie speaking on the Resolution to Directly Elect Senators, H. Res. 20, 54th Cong., 2nd sess., Congressional Record (6 February 1896), vol. 29, pts. 1-2, 1384.

8. Congress, Senate, Senator Turpie from Indiana speaking on the Resolution to Directly Elect Senators, S. Res. 66, 54th Cong., 2nd sess., Congressional Record (6 February 1896), vol. 29, pts. 1-2, 1383.

9. Ibid., 1385.

10. Congress, Senate, Senator Owen from Oklahoma speaking on the Resolution to Directly Elect Senators, S. J. Res. 91, 60th Cong., 1st sess., Congressional Record (23 May 1908), vol. 42, pts. 5-7, 6803-6806.

11. Ibid., 6804.

12. Charles J. Fox, "Popular Election of United States Senators," The Arena 27 (May, 1902): 461.

13. Joseph L. Bristow, "Resolution for the Direct Election of Senators," (Washington: Senate of the United States, May 15, 1912): 5-7.

14. Congress, House, Debate on the Resolution to Directly Elect Senators, H. J. Res. 39, 62nd Cong., 2nd Sess., Congressional Record (13 May 1912), vol. 48, pts. 6-8, 6346-6362.

15. John D. Buenker, "The Urban Political Machine and the Seventeenth Amendment," in Bosses and Reformers, eds. Blaine Brownell and Warren Stickle (Boston: Houghton Mifflin Company, 1973): 183.

16. Albert P. Blaustein and Gisbert H. Flanz, eds., Constitutions of the Countries of the World: "The United States of America," vol. 19 (New York: Oceana Publications, Inc, 1990): 16-17.

17. Levy, Encyclopedia of the American Constitution, 1665.

Jane Addams: Woman-Based Political Actor as Role Model

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Jane Addams' vision of women's community spanned from the formation of Hull-House in 1889 to her Nobel Peace Prize in 1931. The women's community of Hull-House was made up-of white, college-educated American women, and newly arrived immigrant women. The unification of these two groups was her basis for creating the community at Hull-House. In this paper I examine the links between Jane Addams' experiences at Hull-House and women's community, with the inception of the Women's International League for Peace and Freedom. I focus on the relationship between her creation of community, her active role as a peace leader, and her support of the idea of the League of Nations.

Jane Addams stands in the "Octagon room" of Hull-House surrounded by maps of the districts' racial lines and numbers, surrounded by the rooms of ethnic divergences, and surrounded by the echoes of displacement and the creative energy of voiced change. In the parlor near the kitchen, children play, but the lines that distinguish their identities diminish, and their play alleviates the residue of tension. And outside the wind howls long, unrelenting, and the stale air in her lungs goes unnoticed for there are more important things to do; the year is 1915, and her mind is filled with the upcoming peace activities she and her female colleagues are planning--colleagues, surprisingly, in twelve countries, women planning peace as they breathe the fear implicit in war. Remembering a time when the conception of Hull-House seemed radical enough to her, she sighs, and feels the immensity the Hague will represent. She envisions the many women convening for peace, organizing minds to put words onto paper and create a resolution to suggest to President Wilson. And this is new, an international voice of women moving together and supporting each other.

Wind from the opening door rushes by her legs, and her thoughts of Europe and the women's movement are interrupted; her other "job" calls. The newly arrived guests look cold and in need of food; Jane greets them and buries the red-faced child in her arms. The parents look frightened; it's the usual scared look, though, and Addams barely notices instead she moves them into the next room where a couch invites and books line one wall. Other women come in and begin to talk with the newly arrived, and Addams heads back into the kitchen to check on a screaming child scalded by water. The activity never ceases; the travel of people in and out means one must always be alert and flexible, compassionate and strong. Addams finally sees all is in control and returns to her planning. The room is darker, the light outside has shifted. She turns around, stout bodied, her strength manifest, and looks towards the window, her eyes sketched with the workings of a mind embodying the intelligence of the severely just and radical.

Generally Jane Addams is looked at through the lense of a dull historical perspective, a past social worker skimmed briefly in a textbook. Or if not "briefly," then she is denounced as unimportant; in Daniel Levine's book on Addams he writes of her triumphs, but ultimately derides and dismisses her, as can be seen here, " Jane Addams was not an original thinker of major importance" (Levine, x). But my interest in her focuses on Jane Addams as a living being "of importance," and in Elshtain's words, "I shall reflect on hers as a lived life" (257). I am not interested in confining her to her past, boxing her into the stereotypical "social worker" or "settlement worker" description; nor will I "buy" Levine's reductive response to her work. I also want to suggest my place in looking at Addams, in learning who Addams really was. As I reflect on her life and her part in history, my need to push for the acknowledgement of her political and social work grows. She was not only a settlement worker, she was not only a voice for the many immigrants first coming to America, she was not only a fighter for people's rights in work and housing. We cannot sum her up easily and quickly, and if nothing else I want to open as many "valves" of her being in this paper to propel interest and understanding of how much she did and was. The great many articles and books she wrote and the fact that she won the Nobel Peace prize in 1931 show how ridiculous it is to shore her up by saying, "Jane Addams the settlement worker" or "Jane Addams the social worker." Did you know she and the other women working for peace presented President Wilson with the most comprehensive plan for peace; some of which was later appropriated into the President's famous "Fourteen Points" for peace? In Wilson's words: " 'I consider them by far the best formulation which up to the moment has been put out by any body' " (Addams, Balch, Hamilton, Intro. 11). But still she has been left out of our history. Is she taught in classes examining the first World War in depth, in major universities? Is she acknowledged as playing a significant and real role? I ask rhetorically; I ask because I want us to think about the possible gaps in our history lessons because *these gaps are the lives of women*. My unwillingness to formally define her work and her self allows room to reflect on her ingenious life, mind, and proactive politics. I look to her as a role model; I look to her hoping to pay her the due she has not received.

Jane Addams was born in 1860 in a small Illinois town. Her family was upper middle class, and her father had been involved with politics himself, being a friend of Abraham Lincoln. In a sense it was the images of these two men that held steadfast in her mind as she grew to be a political actor herself; these role-models were what she had access to, whom she could idealize in order to later have the courage to imagine and create a more ideal world. At the age of seventeen Addams went to Rockford Seminary, one of the first institutions of higher education for women (Lundblad 662). Although her life initially was sheltered from the changes in America--the industrial growth, movement into cities, the growing women's movement, the Civil War, and the estimated 35 million Europeans who immigrated to America--later her social and political activities would be compelled by how these changes took shape (Abbott 111; Frost-Knappman 159).

It was on a trip to London that Addams first conceived of Hull-House. Confronted with the poverty-stricken area of East London, Addams found a certain kinship in the settlement house Toynbee Hall; Toynbee Hall was created to bridge the gap between the rich and poor and to symbolize "hope" in an area of great poverty. Addams found a sense of meaning here in a place which brought together disparate parts of society. As Addams explained:

> I am not sure that we succeeded in our endeavors 'to make social intercourse express the growing sense of economic unity of society and to add the social function to democracy.' But Hull-House was soberly opened on the theory that the dependence of classes on each other is reciprocal; and that as the social relation is essentially a reciprocal relation, it gives form of expression that has peculiar value. (91)

She did not know it at the time, but this trip would change the direction of the rest of her life and the lives of so many.

And so it was Hull-House that provided Addams with the meaning she sought in life and the means to create a community, of sorts, of women. Hull-House was designed to be a place where immigrant women and families could get help; where they could get food, limited shelter and eventually, as it grew, political protection through social legislation. But it also provided women like Addams, those educated, wealthier women, with purpose, freedom and a creative outlet outside of marriage and children. Along these lines, Carson suggests the radical freedom of Hull-House: "In the social and intellectual ferment of the late 1880's and 1890's, the 'service ideal' became androgynous" (26). So these women were creating a space and energy that provided care, meaning, and freedom from traditional female roles. Again to reinforce this sense of "difference" for women, Elshtain sums up: "Hull-House aims explicitly to meet the needs of Addams and others like her to put their beliefs into practice, to lead lives of action. She and her comrades needed Hull-House and that is why it was created--to open up a life of humanitarian action to young women" (264). In stressing the importance of Hull-House and women's roles I mean to set-up the idea that this was the nascent step for their future political work.

As I said, Addams and her "women for peace" were directly involved with President Wilson's peace policy and also were supporters of the not-yet formed League of Nations. This was the impetus for radical action: war was not subtle; therefore, action needed to be more proactive. I find it awe-inspiring that these women who had not yet won the vote were becoming international political activists, were creating forums to express their collective beliefs and were directly creating power at a time when power was not only not offered, but kept from them. I picture this tug-o-war style; I picture this and feel tears well--if this is not a positive model for political action, I don't know what is. These women were creatively engaging politics although the realm of politics still chose not to directly engage them. Ironically enough, when Addams and her co-workers were offered attention, it was often negative, as if in hopes of dismantling their power.

She was often accused of trying to isolate the United States outside of the rest of the world's politics, and here she profoundly disputes this false claim:

> We were of course urging a policy exactly the reverse, that this country should lead the nations of the world into a wider life of coordinated political activity; that the United States should boldly recognize the fact the vital political problems of our time have become as intrinsically international in character as have the commercial and social problems so closely connected with them. (Addams 111-112)

This "urging" came from the group of women who made up the Woman's International Committee for Permanent Peace which later became The Women's International League for Peace and Freedom. The basis of their beliefs is clear here and also conjures images of how determined they were in articulating these beliefs to President Wilson:

> The Women's International League for Peace and Freedom is made up of people who believe that we are not obliged to choose between violence and passive acceptance of unjust conditions for ourselves or others; who believe, on the contrary, that courage, determination, moral power, generous indignation, active good-will, can achieve their ends without violence. We believe that experience condemns force as a self-defeating weapon although men are still so disposed to turn to it in education, in dealing with crime, in effecting or preventing social changes, and above all carrying out national policies. We believe that new methods, free from violence, must be worked out for ending abuses and for undoing wrongs, as well as for achieving positive ends. (Addams 254)

And the circle, not completed, but touched, comes to some kind of closure; in

1931 Jane Addams won the Nobel Peace Prize for her concerted and "active" efforts for peace (Frost-Knappman 8). Though this is my closure to her circle in order to go on, Addams' political profundity continued--consider this essay an opening, a beginning, not an end. It is a lesson for us to use today. Let us use Addams "political dialectic" between women and humane action as a model for today.

There are two parts to my analysis, but they are intimately linked. Women have been struggling for their rights in an organized manner since the suffrage movement, yet we still have much "path" ahead to achieve. How can we use Jane Addams' community-based action to create a larger political meaning? How can we redefine "political space" using women as models for what politics could and perhaps should be? And, finally incorporating these questions, how can we make humane-action in the political arena a serious concern? I may not be able to answer these questions now, but posing them is the first step and exploring ways to answer them the next.

In thinking about our world today, conceptualizing a true community is important. The "information" age, as it's deemed, is here; we are interconnected now in ways we have never been. If we do not begin to consider the world as a community within many communities and thus respecting those considered foreign as our "community," as Addams did, and brought forward with her International peace efforts, we will not be able to sustain our internationally-related advancements. If we view the world outside of our personal sphere in only hostile terms, we will further hostilities in general. These are my thoughts that come from trying to live with a compassionate-based belief system and from trying to understand "politics" outside of the (male-formed) "Realist-paradigm" (Gurtov 19), our traditional political frame of military build up justified to secure our national interest.

What can we learn from women? What can we learn from reinvoking Jane Addams history? There are many groups of women involved in political pursuits similar to Jane Addams. These women are also incorporating community, shared commitment, equality of treatment, humane interaction, and a sense of support into their work. Women have proven tirelessly that peaceful action is possible and beneficial to human-kind. As the women of Chile express their grief creatively over lives still missing since the rule of Pinochet, women in Kenya plant trees to preserve the environment. As Tibetan nuns remain dedicated to peace despite explicit violence towards them, women at CASA in downtown St. Petersburg, Florida provide care and advocacy for battered women's rights, and women in Peru band together to try and secure any sense of rights. How do these examples relate to Addams' work? She was a true advocate for women's roles in the public/political sphere; we must listen to her history, study her in "world politics" in order to begin to disseminate and redefine the roots of what politics can mean.

Is humane-based action a serious concern to us? We must all consider this individually and give time to thinking about how to be proactive and work with others. Humane action means upholding International Human Rights as William Felice outlines in his book Taking Suffering Seriously. It means listening to the "voices" of those referred to as the "minor" groups--the "groups" that Jane Addams strove to help and protect. These were the immigrants and women. Our world--our "community"-- is still in need of these same protections and advocates; those at the bottom layers are still trampled on, and we need to begin de-layering. We need to include in our political framework a method to secure humanity, and hence to secure peace. Jane Addams' life, ideas and peace-making can be used as a source of inspiration and as a basis for envisioning change. As Elshtain writes, "Though Jane Addams has had her day, she has yet to receive her due" (267). Thus we must acknowledge "her due" and utilize her ideas and concerns. If it is "history" to learn of President Wilson's League of Nations, then it is also "history" to learn of Addams part in it.

Jane Addams' life and politics have left me in awe, it has left me inspired in that deep way that does not cease when the book shuts. And I intend to, in my small way, to follow in her "footsteps." As Sklar concludes her article: "And it is this collective quality that women need to nurture in their peace activism today" (45). It is this "collective quality" I believe not only women need to embrace, but also "politics" needs to embrace.

Her mind shifts as a hurdle of children surround her; she smiles and tells them of her imminent travels and the necessity of the women's peace ideals. They listen and calmed by her authority, are beckoned to sit, to convene and give her the floor.

REFERENCES

Abbot, C. Urban America. In Luedtke, L.S. (Ed.), Making America, the society & culture of the United States. Chapel Hill & London: The University of North Carolina Press, 1992.

Addams, Jane. Peace and Bread in Time of War and Patriotism and Pacifists in War Time. New York & London: Garland Publishing,1972.

Addams, Jane. Twenty years at Hull-House. New York: Macmillan, 1910.

Addams, Jane, Emily Balch and Alice Hamilton. Women at the Hague: The International Congress of Women and its Results. New York: Garland Publishing , Inc, 1972.

Carson, Mina. Settlement Folk. Chicago: The University of Chicago Press, 1990.

Elshtain, Jean B. "A Return to Hull-House: Reflections on Jane Addams. Cross Currents. 1988: 257-267.

Felice, William. Taking Suffering Seriously: The Importance of Collective Human Rights. Albany: State University of New York Press, 1996.

Frost-Knappman, E. Women's Progress in America. Santa Barbara: ABC-CLIO, 1994.

Gurtov, Mel. Global Politics in the Human Interest, 3rd Ed. Boulder: Lynne Riener, 1994.

Levine, Daniel. Jane Addams and the Liberal Tradition. Connecticut: Greenwood Press, 1971.

Lundblad, Karen S. "Jane Addams and social reform: a role model for the 1990's." Social Work. Sept. 1995: 661-669.

Sklar, Kathryn K. "Jane Addams peace Activism, 1914-1922: a model for women today? Women's Studies Quartely. Fall/Winter 1995: 32-47.

LESBIAN PERSPECTIVES ON LOVE, SEX AND RELATIONSHIPS: ADULT VS YOUTH

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Adolescent sexual behavior is characterized as experimental and non-committal. Whereas adult sexual behavior is characterized as responsible and preferably monogamous; based on societal norms. Little Frida's is a coffeehouse which allows for a broad spectrum of lesbian clientele, specifically adolescents and adults; contrary to a bar which attracts only lesbians of the legal drinking age. This particular coffeehouse offers bout a unique and comfortable environment for lesbians to gather and provided the arena from which this research was conducted. Through dialogue a comparative study of adolescents and adults was performed, on the lesbian perspective of sex and relationships.

INTRODUCTION

The study was conducted in order to identify the social, emotional, and intimate model lesbians use in order to exist in society. The subjects were clientele at a West Hollywood lesbian owned and supported coffeehouse. The perspectives presented were the perspectives of older lesbians and the perspectives of younger lesbians. Heterosexuals have been presented with a model which guides them through the process of attaining and maintaining an intimate relationship. This guidance comes from societal values present in schools, homes, and the social environment. Heterosexual adolescents are provided an arena in which they may explore sexuality by means of dating, courting, and often marrying. Marriage, the union of males with females, is accepted. The ritual of this union between the male and female is rewarded and celebrated by all aspects of society. Adolescent sexual behavior is characterized as experimental and non-committal. Whereas adult sexual behavior is characterized as responsible and preferably monogamous; based on societal norms.

This celebrated union is not found in the homosexual society. The absence of an accepted equivalent union within the homosexual community leaves lesbians and gays solo with respect to the procurement and maintenance of intimate relationships. This paper breaches this issue from perspectives on love, sex , and relationships through the experiences of adolescent and adult lesbians.

Sarah Murray defines the lesbian community as a visible group who gather together as lesbians, create organizations focused on lesbian issues or depend on lesbian identity for membership, and in the process actively represent lesbians (Murray 1994:344). Sub-culture in this context is to be defined by the crowd and the participants in the Little Frida's coffeehouse. This subculture is dominated by lesbians that either live in the community or travel to be a part of the community.

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METHODS

The method of research chosen by the researcher was in form of an ethnographic study. The subjects were asked to participate in the project and informally had dialogue with the researcher. Dialogue took the form of group discussion as well as one on one conversation. Many of the subjects were informally interviewed in the same setting throughout a four week period. Other subjects were interviewed on one occasion.

Little Frida's provides a safe environment for young lesbians that do not have many choices as to where they can gather. This coffeehouse replaces the bar scene for young lesbians. Little Frida's is located in West Hollywood which is characterized as a predominately gay and lesbian area. The assumption is that there are a lot of places for lesbians to gather and socialize. This assumption proves false. There are not many gathering places for adolescent lesbians or adult lesbians to gather. These lesbians are in search of a place in which they can exist as well as a place that "belongs" to them. The word "belongs" is representative of shared ideals, styles, values and perspectives. These women are claiming a space. The comfort of a physical space being dominated by people with shared experiences provides a certain consolation. The women that go to Little Frida's all go for different reason, some go to play pool, some to do their homework and others to meet friends and "check out" the scene. Within the "checking out" of the scene it is almost impossible to go unnoticed: there are not little corners in which to hide. Many youth, since they are under age and do not attend bars, use the coffeehouse to meet other women for possible relationships, friendship etc.

The need for one's own space is crucial when trying to define one's place in society. The struggle for lesbians to be "out", openly gay is a struggle that presents itself daily. The struggles are presented at school, at home and as a member of a homophobic society. At Little Frida's there is a sense of freedom, the act of "passing" introduced by feminist writer, Cherrie Moraga is left behind. It is as if the performance is over and the facade lesbians must maintain during the day can be dropped in this comfortable setting. Yet, Little Frida's is not devoid of dramatics. The drama can be witnessed in the conversations that are overheard, the rough play that is viewed, and the slight bit of tension that permeates the room. This tension is that of "fitting in," different however, than "fitting in" society, it is "fitting in" on a micro level.

The cast of characters that frequent Little Frida's are women rebelling, consciously or sub-consciously, against heteronormativity. The perception and perceived role of a woman, defined and modeled by society, is being challenged at Little Frida's. The escape from what is "normal" is admired.

The walls at Little Frida's are decorated with portraits of the Mexican artist Frida Kahlo; she is the coffeehouse's namesake. The idea of naming a lesbian coffeehouse after Frida Kahlo, in itself, says something about the intentional luring affect it may have on strong, "different" women. Frida Kahlo's unconventional presence and person is admired and respected. A lesbian qualifies as "different" in our society by the mere stereotypes with which she is labeled. The clientele that gather at Little Frida's can easily be defined as " different" by a tolerant heterosexual witness.

Little Frida's, offering a comfortable environment, provided a forum by which informal interviews were conducted. These interviews were with both adolescent and adult lesbians. Adolescents were defined as lesbians between the ages of 17 and 24. Adult lesbians were defined between the ages of 30 and 40. For heteronormativity to present itself the adolescent lesbians would be less committed to intimate relationship.

Adult lesbians, on the other hand, would be more committal and monogamous. This assumption was not exhibited in this research.

RESULTS

The older lesbians tended to be more cynical and defeatist with respect to intimate relationships of present or past. The dialogue with the older women was difficult to document in that the conversations often turned into a comedic session. In attempt to find the ideal relationship from the adult subjects, there was hesitancy in sharing. The adolescent subjects were more prepared to answer the question, as if they had been thinking about the topic outside the interview situation.

The ideal relationship that was be grudgingly presented by the older women was different from the actual relationship they having or have had. The reality seems to stem from the fact that many lesbians are compromising their ideals for the quick passing, one night stand. This was modeled by a19 year old who was in the company of two older women. She isolated herself from the other two women during the interview. She described her experiences and said that, "she was looking for something more then sex, but finds herself having sex in exchange for a moment of caressing" (what she actually wanted in the first place.) The cycle then becomes unstoppable. What these lesbians are in search of is often misrepresented as sex it is not until after the fact that they reflect on what it was they wanted, but did not get. Experience after experience, the same feelings result; emptiness "it isn't worth it" says Beth. The hope and promise that the next person will give her what she needs is a thought held every time she her Levi's, relaces her boots and walks out the bedroom door. The story is similar to a song by Tori Amos, a well-liked female musician in the lesbian community. Her lyrics as a representation of the feelings that many women feel, when encountering a false hope. Crucify by Tori Amos.

> Every finger in the room is pointing at me, I wanna
> spit in their faces. Then I get afraid of what that
> could bring. I got a bowling ball in my stomach a
> desert in my mouth. Figures that my courage would
> choose to sell out now. I've been looking for a savior
> in these dirty streets, looking for a savior in
> these dirty sheets. I've been raising up my hands drive another
> nail in. Just what God needs another victim. Why do we crucify
> ourselves? Everyday I crucify myself. Nothing I do is good enough
> for you, crucify myself everyday and
> my heart is sick of being in chains. Got a kick for a dog
> beggin' for love.

The words to this song are potent and confessional, confession heard throughout the research. The guilt and blame that one puts on themselves for compromising themselves was recognized. When Beth told her story, she did not tell it with pride, but with a tinge of embarrassment. She had also confessed that she never viewed sex as sacred, because it had never been presented as such. She had experienced sexual abuse as a child and had a hard time differentiating between the sexual encounters she participated in and those she was forced into having, both lift her feeling worthless. "I am trying really hard to see sex as sacred, I want it to be, but I'm not perfect," Beth replied.

The discussion of promiscuity was a great focus in the research. The older lesbians did not react negatively to questions of promiscuity. The lesbians that saw no consequence to having promiscuous sex, they viewed promiscuity as normalcy among lesbians. There was no dissuasive speech that followed their bolstering about their accumulated experiences. The feelings that were mentioned were to the effect of judging the night, the determiner of whether it was a success or not was based on whether the sex was "good" or "bad".

The perspective presented by the researcher about promiscuity was that of viewing promiscuous behavior as a constant search for validation, a search for depth and connection which leaves one feeling shallow and empty. The perspective was reconfirmed by one of the subjects. Beth confesses that she feels, "empty" the morning after.

The two other women in the company of Beth were the women who had no problem with casual sex. One women asked whether the question was, "Would you go home with someone tonight if the situation arose?" That was not the question, but if she did answer that very question, what would her answer be? She replied, "Yes, yes I would." Shortly after that comment, the conversation somehow turned into a recital of how many women they had slept with, they laughed and joked. Any laughter from the researcher would have fueled the fire and their ego. The conversation was somewhat similar to the conversation a group of stereotypical teenage boys would have as they shared and exaggerated their experience.

The description of their exploits was quite graphic. The objectification of women, whether it be by a woman or a man, carried the same negative effect. Detaching emotion and feelings from a person takes away their humanness. As humans are defined by ability to feel.

With this attitude and perspective, where does a relationship fit? What is the definition of a relationship? The term relationship carries a great deal of interpretations with it. The other perspective that was presented was from the adolescent lesbian. The perspectives presented from this group in regard to the "ideal relationship" was different than that of the older lesbians. What was "ideal" how did it start and how would it be maintained? "The relationship would begin initially with an official date, an invitation to dinner a show etc.," says Nicole. Through a continual effort and frequent conversations, a friendship would blossom. The blossoming would carry the relationship to a new level of trust and intimacy. One month seemed to be the compromise as to when sexual intimacy was appropriate. "Ideally, a month is a good time, but that doesn't always happen," confessed Trina.

The competition and self-doubt for maintaining a relationship presents a struggle for the young single lesbians at Little Frida's. The societal perception of lesbian relationships is that of negativity, hopelessness and inescapable failure, these perceptions linger in the minds of the youths at Little Frida's. Although at this time the perspectives of the adolescents were optimistic, the threat of taking on the negativity from their elders is present.

The examples of positive healthy relationships do not present themselves in this environment. Where are the examples? The examples have taken themselves out of the singles scene and taken refuge in the arms of their new partners. Their time is now invested into their relationship, which also is somewhat ridiculed by other lesbians. Through envy or plain jealousy, the single lesbian might refer to the new couple as co-dependents. Healthy lesbian relationships do exist and are out in the community, but the commentary from their own peers creates a tension that many would rather avoid.

The maintenance of a relationship presents itself with great obstacles: societies non acceptance, family rejection, inter-lesbian competition, and personal identity conflicts. Lesbian relationships have been discredited by means of non-acceptance. The process of attaining a relationship has a history of secrecy, promiscuity and failure. Some jokes that circulate in the lesbian community play on the reality of lesbians moving in together the first week of meeting, and six months later experiencing "lesbian bed death." This is characterized by the physical intimacy that dies out after six months in the relationship. The relationship then being unable to sustain itself due to the fact that the relationship was fueled by sexual energy and nothing more. The reality and reoccurrence of this story is what fills the air and lingers in the minds of these lesbians at Little Frida's, the ideal relationship becomes a bit flawed.

This fear of failure is based on the self-doubt or "internalized homophobia" that lesbians have about themselves. Many lesbians feel that being a lesbian limits your future to having several monogamous relationships, each with a future of 6-12 months. What happens to the dream of "being together forever?" The short lived relationships usually result from the self-fulfilling prophecy of, "this probably won't last long" to a "friend" interfering in the relationship. The idea of a lifelong partnership does not seem real, although most hope to attain. The tools for attaining this, are not easily acquired. Societal homophobia keeps the fatalistic ideology alive. Fear and ignorance keeps the fire burning and the hearts of lesbians empty.

The confidence and overt affection that heterosexuals display is suppressed by lesbian couples, in this environment. The idea of possession and ownership does not present itself within lesbian couples at Little Frida's. This lack of possession makes it difficult at times to distinguish the friends from the couples. The public display of non-possessiveness may be a conscious rebellion against the heterosexual exhibition of "ownership." This rebellion might actually be depriving lesbians from expressing their needs and affections towards their partners. This affection can potentially normalize the presence of two women being physical and loving toward each other.

CONCLUSION

This project is still left somewhat unresolved. The perception of love, sex, and relationship has been jaded by the discussion that travel on the wire at Little Frida's. The hope for that "special" relationship is still alive, but is analyzed and dissected with a cynical tone. The older lesbians owned the cynicism. The adolescents believed that they would be able to attain a relationship, but did not necessarily have role models in that arena.

After having done the research, the researcher proposes a model for lesbians be established. The model that has been presented to heterosexuals and homosexuals is that of the patriarchal family. For lesbians, trying to mimic the lives of heterosexuals, does not work, the privileges are not the same. The proposal is to encourage lesbian visibility, women in relationships with other women must be visible and serve as role models. The new model must be created by lesbians whose relationships are unique and different from the heterosexual model provided and encouraged in society. Visibility creates an awareness which in turn can create recognition of existence.

REFERENCES

Moraga, Cherrie 1992. Loving in the War Years. Boston: South End..

Moffat, Michael. "Coming of Age in New Jersey: College and American Culture." Rutgers University Press. New Brunswick, New Jersey. 1988. pp. 3&48.

Murray Sarah, E. "Public Culture." University of Chicago, 1994. pp. 344.

Women's Body Image: Effects of Media Imagery and Anorexia Nervosa

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This paper explores how media representations of women's bodies has had an effect in the increase of anorexia nervosa cases and what the media fails to address. As a result of contradictory media messages about female body ideals, women have become increasingly prone to developing eating disorders. In the last few decades, anorexia has become an epidemic among American women. While the disease is a common topic in all forms of mass media, representations of anorexia are often misleading and glamorized, using only the most extreme cases as examples. This portrayal of the affliction is detrimental because it does not address the borderline anorexic.

Anorexia Nervosa is a disease which has become an epidemic among the American female population. According to Catherine Baker's pamphlet The Perfection Trap, 90% of those diagnosed with an eating disorder are women (6). As a result, media of all kinds have devoted much time, paper, and research to this disorder. In this paper I argue that American media images of women work to eliminate women's self-esteem, often leading them to drastic measures such as eating disorders in order to meet the cultural ideal of what a woman should look like. The main audience for these periodicals is white, middle-class teens, the portion of society that research has shown is most susceptible to this type of eating disorder. Although these media produce articles about the dangers of the disease, they also perpetuate it by running ad after ad emphasizing that American women must be thin to be successful and attractive to society. The message sent out by these types of periodicals is reinforced daily by similar images in commercials, movies, and even news programs such as Sixty Minutes, which in trying to address the issue, only wind up making a spectacle of the women who suffer from the disease.

Because it would have been impossible to survey all teen magazines for this paper, I focused on the more popular ones which included Seventeen, Sassy, Mademoiselle, Dance Magazine, and McCall's for the past ten years. In all of this material there seemed to be not only contradictory messages about women's bodies, but missing information. It is apparent that on the one hand society feels it is essential to address the issue of eating disorders so that young women will be aware not only of the disease's symptoms, but of the consequences of neglecting to nurture their developing bodies. On the other hand, though, these publications neglect to see that on the page next to the article about a girl who is/was anorectic, is a picture of Kate Moss, one of the country's top super models who is even thinner than the 1960s waif, Twiggy. And on the cover of the same magazine is a picture of a model in a midriff shirt with a flat stomach and jutting collar bones.

A perfect example of the subtle, yet conflicting messages is the Milk campaign that has been running in numerous magazines over the last year. The point of the ads is to promote the health benefits of milk by picturing celebrities with captions under their picture explaining why they drink milk. Although most of the captions are sending good messages, the Milk add with Kate Moss is questionable; her caption states: "Bones. Bones. Bones. Maybe so, but unlike 85% of girls today, there's one way I'm taking good care of mine. By getting lots of calcium... And besides, haven't you heard the waif look is out?" The combination of the visual (what appears to be a nude and thin Moss) and the textual (her claim that the waif look is out) messages is a perfect example of how the media tries to deal with the issue of eating disorders, but only succeeds in confusing the reader more by picturing the opposite of its words. Even more interesting is that Moss claims 85% of girls do not get enough calcium. While that is no doubt true, it is ironic because for a female to be considered medically anorexic, she must weigh 85% of her "normal" body weight

These messages are extremely problematic because they contradict each other, saying that women come in all shapes and sizes. However, the visual images prove that "glamorous" bone-thin women are the ones idolized by society and against whom girls measure themselves and are compared to by their peers.

Women and girls often take the message to be fit to the extreme, they feel they must meet the ideal set by one model instead of being fit for their body type and age. Thus, through what is considered typical feminine practice, dieting and exercising, anorexia begins. Ironically, this is the woman's way of trying to conform to her society while at the same time rebelling against it. In Unbearable Weight, Susan Bordo explains that in order for the patriarchy to maintain power and control over the female gender, women's bodies and women's perceptions of their bodies must be controlled (178).

Society is bombarded by advertisements about commodities. Most of these ads use images of women in scanty clothing to sell their items, giving a clear message that a woman's body is a commodity as well. As Susan Willis says in "Work(ing) Out," even exercise itself becomes a product and commodifies women's bodies because it puts women in competition with other women for the best body (710-711). The ultimate product then, becomes the woman's body. Such cultural messages create what Bordo labels as a mind/body dualism for the woman in which society gives the body priority over the mind.

With a disease like anorexia, the woman is often attempting to make her femaleness less conspicuous by decreasing body size and to punish desires which she considers bad such as hunger, sexual yearning, and elimination of waste. She persists in her denial because will power is a value traditionally associated with men and one for which women are criticized for not being able to exercise (Bordo 178). Therefore, to the anorexic, control over her body means having a type of control usually associated with men which makes her a more valuable commodity.

It is interesting that although women and men are subjected to the same societal messages about how bodies should look and how they should be seen, they are affected differently (Mahowald 242). Men apply the standards to women; women apply the guidelines to themselves. Thus, American females suffer from double jeopardy. In order to overcome this double analysis, women ironically try to conform to the male standard (i.e. looking like Barbie) by starving themselves which creates a more masculine look (of less body fat and a flatter chest). Hence, the female's education to be resistant to bodily desires and to practice self-restraint continues.

One of the most dangerous mistakes media continue to make is to sensationalize eating disorders. In every article surveyed, the patient weighed less than 100 pounds. Technically, though, a person only has to be fifteen percent below her standard body weight (for height and bone structure) to be considered anorectic. And while fifteen percent may sound minimal, it is still an extreme. For example, consider a woman who is five feet nine inches and has a medium/normal bone structure. According to the American Medical Association (AMA), she should weigh between 140-155 pounds. Eighty-five percent of 145 pounds is 123 pounds, the appropriate weight for a woman who is five feet four inches to five feet five inches. Yet, if this five foot nine inch woman were to tell her friends she weighed 123 pounds, the thought that she was anorexic would never cross their minds. After all, she is still well over 100 pounds, and everyone knows (from media information) that anorexics are so thin they barely weigh 100 pounds and must be hospitalized.

One of the most extreme examples of the sensationalized anorectic was found in a 1995 issue of Sassy. In Joanne Levine's article "Eaten Alive" the anorectic/bulimic woman, Terry Sweeny, was five feet four inches and weighed fifty-five pounds at her lowest. The extremity of Sweeny's case is typical of those found in the media. Once again, the woman who does not have a skeletal appearance would not make it into these publications. Thus, the borderline anorectic reading the article would not be able to identify her own illness because of her "healthy" appearance.

I remember as a young girl reading many articles in Seventeen and other teen magazines about girls who had or were struggling with anorexia. I distinctly remember reading an article about a girl who told of how much satisfaction she got out of watching her family eat ice cream while she lay on the couch feeling her hip bones jutting out. When I read this, I couldn't believe it; I felt exactly the same way! However, it never occurred to me that the reason I could relate so well to these girls was because I was also anorexic. That is one of the major problems with a disease like anorexia: the afflicted person has no idea that what she is doing is harmful and abnormal.

Although the media makes attempts to portray the disease accurately, they often fail, making it more 'glamorous' and only emphasizing the extremity of the problem. This is dangerous because it leaves behind the "hidden anorectic," the girl who is more than fifteen percent below her normal body weight, yet she is not in the hospital and is able to cover her obsession from even the most scrutinizing eyes. The borderline-anorectic, like the full fledged anorectic, has no idea what her body truly looks like, she is convinced she's overweight and knows she's not too thin because she still weighs over one hundred pounds. Although some of the articles make an attempt to address the mental issues and thoughts associated with the disease, they fall short because they use extreme examples of anorexic women as a way of gaining the reader's attention. For the borderline anorectic, it appears that she simply has a bad body image, not an eating disorder. However, it is the bad body image, often launched by the exact media in which the article appeared, that frequently influences the development of eating disorders. Thus, the emergence of the hidden anorectic. Because she still looks "healthy" to others, it is easy to hide her extremely warped thoughts and cover her abnormal eating habits.

I often read in pop magazines about girls who were anorectic, saw the TV spots on 60 Minutes and watched all the made for TV movies. However, they were all cases of the extreme; it never occurred to me that I was one of them mainly because I still weighed over 100 pounds. Just because I skipped meals, ate minimally at others, added my daily calories to make sure they did not exceed 500 per day meant nothing to me. I was not in the hospital nor was I close to that point. I didn't fit the anorectic "profile" outlined by the media. I was like all my other friends, simply concerned about my weight, wanting to be healthy and attractive.

Yet another feature of anorexia pop culture refuses to address is the fact that it is a mental disorder. Therefore, recovery becomes a life-long struggle. In this way, anorexia is very similar to alcoholism. For just as with alcoholism there is no cure for anorexia, only times of remission. However, unlike alcoholics who can remove themselves from situations involving alcohol, anorectics can never escape food because it is literally essential to their survival. That is why half of all recovering anorectics will relapse a least once.

As members of the drill team, we had to meet a weight requirement. Consequently we were weighed every Monday morning. Even though I was never in jeopardy of being over weight, I always feared I would be. As a result, I would close my eyes when I got on the scale and tell the coach not to tell me what my weight was unless I was over. One morning our coach asked me to wait to be weighed until all the other girls had weighed in. After I had been weighed, my coach asked me to come into her office so she could speak to me. I just knew she was going to tell me I was over weight. But instead, she told me I looked like a rail, that if I lost any more weight she would put me on probation for being too thin. I thought she was out of her mind and got very mad. I could not understand how she could say that to me. But the fact that I was in trouble for being too thin actually made me proud.

Although pop culture magazines strive to inform young women about the eating disorder from which one in two of their readers suffer, they often manage to do the exact opposite, functioning as models or handbooks about how to *be* anorexic, rather than how to *avoid* anorexia. The media repeatedly show women in the roles of giving food, preparing it for others, and feeling guilty when they occasionally allow themselves an indulgence. Thus, it is not surprising to find that in their quest to conform to these standards and rebel against them at the same time, anorectics become obsessed with food. In her article "To be or Not to be a Woman: Anorexia Nervosa, Normative Gender Roles, and Feminism," Mary Mahowald explains that, "characteristics of anorexia nervosa include a tendency to spend considerable time around food, preparing elaborate meals for others, while insuring one's own intake includes only a narrow selection of low-calorie foods" (237).

Although pop culture often uses the fact that many women are food obsessed in their anorectic profiles, they neglect to understand why this is happening. Consequently preoccupation with food often becomes a model for the anorectic and borderline anorectic reader. The fact is, according to Marian Horosko, that in the brain's effort to reject self destruction of the body, it becomes obsessed with food, demanding that the woman eat

(89). Therefore, refusing to eat is the woman's way of rebelling while continuing to cook and serve allow her to conform at the same time without compromising her rebellion.

One of the most important problems explored by feminists and psychiatrists is the fact that underlying the common issue of rebelling against cultural constructions of feminine bodies, anorexics are also struggling with gender identity issues. Therefore, it is no wonder that the disease surfaces during adolescence for one in one hundred girls. However, this is also an aspect of the disease that is never addressed by pop culture and rarely by "old school" physicians (Mahowald 240-41). So, even though many feminine traits have led to the oppression of women, they are also crucial to their success in society. That is why the anorectic has such a struggle. She realizes that she must embody the very qualities she hates to be accepted and successful in her society. Yet by taking on these characteristics, she must go against what she believes in, resulting in the mind/body dualism introduced by Bordo and the tendency to starve herself while feeding and serving others.

Although many of the stories I read about anorectic girls and women were disturbing and painted the picture of a frail being barely hanging onto life, I kept returning to the same questions: What about the hidden anorectic? How is she going to identify with this? How will she know she is headed in this direction? It is obvious that the media is trying to use shock value to pull readers in and possibly to scare people out of falling into the same trap. However, this is a defective strategy, because it creates what Bordo calls a "freak show" which allows the reader to see the sufferer's condition as outside the norm (186). This also "normalizes" the disorder and creates a numbness among society so that they too ignore the borderline anorectic.

Kim Chernin feels that the glamorization of the anorectic has created a new cultural heroine: the anorectic girl (47). This heroine is seen in ad after ad, on TV programs and in magazine articles, there is no place to hide from her image. As a result, she has become the societal norm instead of the exception. And with the current emphasis on dieting and exercise, society has provided the perfect breeding ground for this new "heroine." Sadly, her glamorization gives women the idea that being anorexic is about being an exhibitionist; most American girls and women know they will be respected for the ability too display control over their bodies (Chernin 46).

The sources surveyed were very quick to designate *the* anorectic model, but gave no heed to the fact that although there are certain symptoms and characteristics that seem to be found in the majority of anorexia cases, there are also many other sufferers who do not fit the stereotypical profile. By giving only one or two symptoms to look for, borderline girls and women are in danger of being overlooked. Because one-half of all anorectics relapse and ten percent will die from the disease, it is essential that the American public is correctly informed about the disorder.

In "Eating Disorders and Sex," the author explains the physical health risks of anorexia. Yet, there is no mention of the lasting emotional effects, and these are often the most difficult to overcome because there is no escaping the brain. For those afflicted with an eating disorder, food evokes all sorts of feelings. Every meal time is a major ordeal. The main feeling I associate with food is guilt. Even though I am in "recovery," issues of food are something that can easily become consuming and destructive. Living with an eating disorder and the after effects is a constant battle. Even when I feel I've conquered the problem, it comes sneaking back; what do you do? Do you give in? You want to, but you know so much more this time, you know both sides of the coin, but this knowledge only adds to your guilt. Guilt, that's the best way to describe anorexia to another person. Guilt about eating, guilt about not eating, guilt about hiding the fact that you're not eating, guilt about not hiding it.

In Where the Girls Are, Susan Douglas makes some insightful observations about the effects of media, saying that "In a variety of ways the mass media helped make us the cultural schizophrenics we are today, women who rebel against yet submit to prevailing images about what a desirable, worthwhile woman should be" (8). Because the media has the ability to influence us on conscious and subconscious levels, whether we like to admit it or not, it is imperative that the media begin taking responsibility. That means magazine editors and advertising executives need to pay closer attention to the detrimental effects their ads and articles may have on their readers. Publications aimed at women and teenagers need to be especially critical. These publication should not run articles about the epidemic of eating disorders and how dangerous they are not only to the physical well being of women but to their position in society and then an ad of Kate Moss on the next page.

As consumers, we also have a responsibility. Instead of buying into the images we hate, we must become resistant to them. This does not mean that we rebel by starving ourselves, but that we take action. Protest against offensive and potentially harmful ads, write letters to editors and executive producers. But most of all, we must not encourage the abnormal food attitudes and behaviors among our friends, female and male.

REFERENCES

Baker, Catherine A. The Perfection trap. North Carolina: DUMC Health Education, 1995.

Bordo, Susan. Unbearable Weight. Los Angeles: University of California, 1993.

Chernin, Kim. The Obsession. New York: Harper and Row, 1981.

"Eating Disorders and Sex." Seventeen Oct. 1993: 105-106.

Douglas, Susan. Where the Girls Are. New York Times Books, 1995.

Horosko, Marian. "Eating Disorders, Part One, Consuming Too Little." Dance Magazine January 1982: 88-89.

Levine, Joanne. "Eaten Alive." Sassy August 1995: 76-9(+).

Mahowald, Mary Briody. "To Be or Not to Be a Woman: Anorexia Nervosa, Normative Gender Roles, and Feminism." Journal of Medicine and Philosophy April 1992: 233-51.

Willis, Susan. "Work(ing) Out." Ways of Reading. Eds. Bartholomae and Petrosky. Boston: Bedford Books, 1993: 705-724.

Testing the Effects of Sample Composition and Context On Radiocarbon Dating from Mammoth Cave, Kentucky

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Mammoth Cave, located in southwestern Kentucky, is the longest karstic system in the world. More than 100 years of archaeological research demonstrates that Early Woodland peoples explored almost 20 km of the cave. A suite of 42 radiocarbon dates suggest that this activity took place sometime between 4,000 and 2,000 years ago. Recent studies have shown that both sample composition and archaeological context are crucial to accurate interpretations of radiocarbon assays. Radiocarbon dates from Mammoth Cave have been obtained on a variety of materials including charcoal, human feces, human tissue, and uncarbonized plant remains from contexts such as hearths, mineral mines, and the surfaces of remote chambers. A statistical evaluation of composition and context shows that the prehistoric activity in Mammoth Cave occurred in less time than previously thought.

BACKGROUND

Caves have long fascinated peoples around the world. They are passages into the depths of the earth, as well as bountiful sources of minerals and lithic materials for tool manufacture. Caves were also natural shelters available to people and exhibit a variety of traces of human activity. Because of their stable atmosphere (generally constant mild temperature and humidity), millennia-old materials are often preserved, and look as if they were dropped yesterday. This scenario holds true for portions of the Mammoth Cave System of southwestern Kentucky.

Salts and Mammoth (both a part of the Mammoth Cave System) were dissolved from limestone characteristic of the Mississippian period, and together they constitute the longest karstic system in the world. The two modern entrances lie 4.8 km apart, but the caves themselves are connected subterrainally. Both caves are usually divided into "upper" and "lower" levels. The upper levels were created during a time span ranging from approximately 1 to 2 million years ago (Palmer, 1981). Although shaped by water, the upper levels have remained dry since the lower levels were formed (100,000 to 10,000 years ago), allowing for the excellent preservation of materials.

HISTORY

Archaeological investigations have been conducted in the Mammoth Cave System for more than 100 years. Through all these investigations, researchers offer one recurring temporal theme - that people explored the system during a period from 2,000 to 4,000 years ago, a span largely coincident with the Late Archaic (ca. 5500-3000 b.p.) and Early Woodland (ca. 3000-2000 b.p.). However, my evaluation of radiocarbon sample composition and context shows that prehistoric activity occurred in a far shorter time span - in fact, less than a millennium.

Mammoth and Salts Caves have been under scrutiny from cave archaeologists the world over. Due to excellent preservation, there is an abundance of material to be dated and investigated, leading to many publications on patterns of exploration and exploitation of the cave and its mineral resources (e.g. Benington, Melton and Watson, 1962; Carstens, 1980; Gardner, 1987; Munson et al., 1989; Smith, 1993; Schwartz, 1960; Tankersley et al., 1994; Watson ed., 1974; Watson et al., 1969; Watson and Yarnell, 1966; Young, 1910). These investigations resulted in the accumulation of a large sample of radiocarbon assays. When viewed from oldest to youngest, the radiocarbon age determinations suggest that the deepest areas of the caves were used first. However, the issues of radiocarbon sample composition and context have never been systematically addressed. In this paper, I will formally evaluate the sample of dates, based on these two criteria and test for relationships between (1) distance from the entrance and (2) depth below the surface.

EVALUATION

Two issues must be addressed in the consideration of every radiocarbon sample: context and composition (Kuzmin and Tankersley, 1996). Good context occurs in three situations. A sample may be taken from the same stratigraphic level as cultural artifacts (stratigraphic association) from the immediate proximity of the target materials (direct association) or through the direct dating of an artifact or human feces. Poor contextual association, on the other hand, can be identified with samples having no primary relations (i.e. found on the surface with a mix of other materials) or a sample of questionable origin.

While some (e.g. Taylor, 1987) advocate the dating of wood charcoal samples, the best compositional substance for ^{14}C determinations is short-lived plant remains. In dating short-lived plants, the heartwood problem associated with wood charcoal is avoided and it is safe to assume that the organic carbon was formed in a specific year. At Mammoth Cave, "bad" compositional samples would be those coming from long-lived plants (such as trees) or those possibly contaminated by microbial activity (skin tissue) (Watson & Yarnell, 1988).

A total of 48 dates have been obtained from the Mammoth Cave system. I separated these dates into 6 groups: A) wood charcoal; B) short-lived plants in the form of artifacts; C) human paleofeces; D) human skin tissue; E) uncarbonized ecofacts; and F) soot.

Group A (n=13) was created because the age of wood charcoal is not a direct indicator of human activity, nor does it provide consistent data. Some of the charcoal could have washed in from outside the cave and it has no cultural context. These samples cannot be accepted as accurate scientific data, because they have bad context and composition.

The samples of Group B (n=14) were placed in a separate category because they are short-lived plants (good composition) and are more precise and reliable in dating than wood charcoal. They are all artifacts, ranging from woven fabric, gourd bowl, slipper, cedar climbing pole, digging stick, to charcoal from cane torches. Thus Group B samples are directly linked to a cultural activity and have good context.

Group C (n=12) is the direct result of human activity and is consequently contextually sound. There appears to be no major compositional anomalies inherent in the feces that might give biased dates. Group D (n=3) has very good context as well, but lacks compositional quality. Due to microbial activity on the decaying flesh, carbon is still produced even after the individual's death, potentially resulting in skewed dates. This phenomenon is supported by Watson & Yarnell (1988), who have experienced "young" dates as a result of microorganism activity. Group F (n=5) is simply wood, bark and twigs found in various areas of the cave. These samples have mediocre compositional value and no substantial cultural context, due to uncertainty of their origins and mode of transport into the cave.

Finally, there is Group G (n=1) which contains one sample - "soot". This specimen was placed in a category alone because of its dubious nature. Scraped from the cave wall in Upper Salts, this sample holds little scientific worth. It is from an area which has long been open to the public, and could be a result of any of the forms of illumination used - kerosene lamps, oil lamps, torches, etc. Therefore in this study, "soot" has been eliminated as useful data. Based on my evaluation of the sample composition and contexts, it appears that only two of my original six groups remain as suitable data for analysis: Group B - short-lived plants, and Group C - paleofeces.

After my assessment, slightly more than half of the original radiocarbon dates are included in the category of good composition and context. Of these remaining 26 dates, all fall within a range of 2190 b.p. to 2980 b.p., 890 years of prehistory. When shown in comparison with the time span of all 48 dates, the difference is clear. Taken at face value, all 48 dates reveal a range of 1920 b.p. to 4120 b.p., a 2,200 year time span. This age range is inclusive of all the radiocarbon samples taken thus far, regardless of sample composition or context. The range is more than two times the period resulting after my evaluations, suggestive that elimination of "bad" radiocarbon dates offers a more accurate view of cave use, as opposed to the earlier hypotheses.

In a second effort to increase the usefullness of certain ^{14}C dates, I use the concept of "chronometric hygiene" (Spriggs, 1989, Taylor et al., 1996). According to Taylor et al. (1996), any ^{14}C determination with a $\sigma > 80$ should be taken out of the data group used for investigation. This test serves to eliminate dates which potentially show laboratory error. Nine dates were removed as a result of this test. The final seventeen dates that meet all the criteria (good composition, good context, and small sigma) once again range from 2190 b.p. to 2980 b.p.

Finally, I offer a hypothetical model of the pattern of exploration by Early Woodland peoples in the Mammoth Cave System. For this model, I consider two groups of data: all radiocarbon dates versus 17 dates shown to have good composition, good context and a small sigma. Initially, the findspot of each sample was located, and its distance in meters from the closest natural entrance was determined. Each sample was also assigned a number (1, 2, or 3) representing the subsequent levels of the cave (1 being the youngest, 3 the oldest).

I calculated multivariate regression statistics for all the radiocarbon dates (n=48) and compared them to the group of 17 dates shown to have good context, good composition and small sigmas. The dependent variable was the radiocarbon dates and the independent variables were distance from the entrance and depth below the surface. The resulting R^2 values are comparable: 0.854 (all dates) and 0.933 (good dates). Each independent variable was then subjected to a P two-tailed test. For depth below the surface, both sets of data were statistically significant. Compare all dates (P= 0.0001) to good dates only (P= 0.001). However, the P scores were drastically different for the dependent variable of distance from the entrance. All radiocarbon dates and their distance from an entrance is not statistically significant (P= 0.458). In a test of the good dates, a statistically significant number was calculated: P=0.019. This test is evidence that the question of distance from a cave entrance, leading to a temporal layout of exploration, was greatly affected by the use of radiocarbon dates of less than ideal composition and contextual content in the data group.

CONCLUSION

In conclusion, my investigation of the Mammoth and Salts Cave radiocarbon dates show that prior chronometric interpretations may have been biased. Through the use of multivariate statistics, one can obtain a more clear and accurate temporal placement of human activity at the site. I have demonstrated that prehistoric activity within the Mammoth Cave System actually took place in less than a millennium. Previous investigations postulated that exploration and mineral exploitation occurred in more than twice that amount of time, on the basis of radiocarbon samples of questionable composition and context. This study highlights the drastic effects "bad" radiocarbon dates can have on the chronometric analysis of a site.

Importantly, these tests can be applied to other sites anywhere in the world that have been radiocarbon dated. As shown here, they will prove useful in removing erroneous data, allowing for a more concise temporal view of the site, and will aide in drawing correct cultural associations between sites and the activities that created them.

REFERENCES

Benington, F. M., Carl Melton, and P. J. Watson, "Carbon Dating Prehistoric Soot from Salts Cave, Kentucky", American Antiquity, Vol. 28 (1962) pp. 238-241.

Carstens, Kenneth C., Archaeological Investigations in the Central Kentucky Karst. (1980) Ph.D. dissertation, Department of Anthropology, Washington University, St. Louis.

Gardner, Paul S., "New Evidence Concerning the Chronology and Paleoethnobotany of Salts Cave Kentucky", American Antiquity, Vol. 52 (1987) pp. 358-367.

Kuzmin, Yaroslav V. and Kenneth B. Tankersley, "The Colonization of Eastern Siberia: an Evaluation of the Paleolithic Age Radiocarbon Dates", Journal of Archaeological Science, Vol. 23 (1996) pp. 577-585.

Munson, Patrick J., Kenneth B. Tankersley, Cheryl Ann Munson, and Patty Jo Watson, "Prehistoric Selenite and Satinspar Mining in the Mammoth Cave System, Kentucky", Midcontinental Journal of Archaeology, Vol. 14 (1989) pp. 119-131.

Palmer, A.N., 1981, A Geological Guide to Mammoth Cave National Park, Zephyrus Press, Teaneck.

Smith, Bruce D., "Reconciling the Gender Credit Critique and the Floodplain Weed Theory of Plant Domestication", Archaeology of Eastern North America: Papers in Honor of Stephen Williams, ed. by James Stoltman, Archaeological Report No. 25 (1993) pp. 111-125.

Spriggs, M., "Chronometric Hygiene", American Antiquity, Vol. 63 (1989) pp. 587-613.

SYSTAT, 1992a, Statistics, SYSTAT, Inc., Evanston, IL.

SYSTAT, 1992b, Graphics, SYSTAT, Inc., Evanston, IL.

Schwartz, Douglas W., "Prehistoric Man in Mammoth Cave", Scientific American, Vol. 20 (1960) pp. 130-140.

Tankersley, Kenneth B., Samuel S. Frushour, Frank Nagy, Stephen L. Tankersley, and Kevin O. Tankersley, "The Archaeology of Mummy Valley, Salts Cave, Mammoth Cave National Park, Kentucky", North American Archaeologist, Vol. 15 (2) (1994) pp. 129-145.

Taylor, R.E., 1987, Radiocarbon Dating: An Archaeological Perspective, Academic Press, Orlando, FL.

Watson, P.J., "Prehistoric Miners of the Flint Mammoth Cave System", Proceeding of the 6th International Congress of Speleology, Vol. 6 (1977) pp. 147-149.

Watson, P.J., "Cave Archaeology in the Eastern Woodlands", Masterkey, Vol. 59 (1986) pp. 19-25.

Watson, P.J. (ed.), 1974, Archeology of the Mammoth Cave Area, Academic Press, New York.

Watson, P.J., et al., 1969, The Prehistory of Salts Cave, Kentucky, Reports of Investigations No. 16, Illinois State Museum: Springfield.

Watson, P.J., and Richard A. Yarnell, "Archaeological and Paleoethnobotanical Investigations in Salts Cave, Mammoth Cave National Park, Kentucky", American Antiquity, Vol. 31 (1966) pp. 842-849.

Young, Colonel Bennett H., 1910, The Prehistoric Men of Kentucky, Filson Club Publications No. 25, John P. Morton and Co.: Louisville.

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Three-Dimensional Mapping of the Bluff Greathouse Archaeological Site

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About AD 1000, a moderate size "greathouse" was constructed by the Chaco people near the present town of Bluff in southeastern Utah. A preliminary excavation of the site October of 1995 carried out by its principal investigators, Steve Lekson and Cathy Cameron of University of Colorado/Boulder, revealed a pueblo and two associated kivas. In spring 1996, I produced a three-dimensional map of the Bluff Greathouse archaeological site using detailed digital topographic maps and Surfer, a state of the art landscape reconstruction software program. I then manipulated the data to produce color contour and three-dimensional maps and completed an archaeological interpretation of the results. Through this research project, I identified subtle topographic features such as a ceremonial moat and midden area that were previously obscure. My conclusions were used by archaeological teams in the continued excavations of the site in the summer of 1996.

BACKGROUND

Beginning about AD 800, agricultural people moved into southern Utah along the San Juan River near the present town of Bluff (Figure 1). The first settlers lived in pithouses and farmed the nearby river valley soils. About AD 1000, the area came under the influence of a dominant Chaco culture, the center of which was to the southeast in New Mexico. A moderate size Chaco "Greathouse" was constructed on the northern terminus of a road leading to Chaco, beginning on the northern bank of the San Juan River.

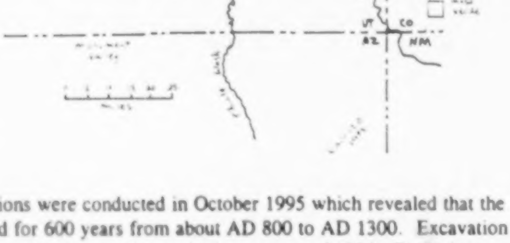

Figure 1: San Juan Region

Preliminary excavations were conducted in October 1995 which revealed that the site may have been occupied for 600 years from about AD 800 to AD 1300. Excavation of the greathouse and its surrounding features began in the summer of 1996. Preliminary analysis indicated that the site is part of the Chaco complex and is a likely Chacoan outlier. The greathouse appears to be a 12 to 15 room two-story pueblo with two associated kivas. The principal investigators of the site are Steve Lekson and Cathy Cameron from the University of Colorado.

Fifty meters southwest of the greathouse complex, is a probable great kiva, a major ceremonial feature lying at the terminus of the Chaco road system. Only a few great kivas have been excavated in the American Southwest. Portions of a ceremonial wall or embankment are visible on the surface surrounding the dominant architecture of the site.

Archaeological studies have been conducted in southeastern Utah since the 1910s, producing numerous information about greathouse sites. However, the Bluff area has not been studied until very recently. Chaco Canyon dominated the Pueblo Southwest during the Pueblo II period (AD 900-1150).

Massively built, multi-storied, greathouses along with great kivas, and small habitation clusters are visible across the Pueblo Southwest and are related to the "Chacoan community" pattern (Lekson 1991). The Bluff site fulfills the requirements of a Chacoan settlement pattern defined by the presence of a greathouse, a great kiva, and a prehistoric road through the center of the site (Cameron, Davis, and Lekson 1996). Other sites in the Northern San Juan Region also fit the requirements of the Chacoan settlement pattern (Adler and Varien 1993:90). A relationship between the Bluff greathouse and Chaco Canyon could also appear through economics, through trade, and stylistic architectural similarities.

Greathouses may have been reoccupied during the Pueblo III period (AD 1150-1250) after Chaco Canyon collapsed. Pueblo III reoccupation patterns are common in southwestern Colorado, but southeastern Utah has yet to establish such an occupation history of greathouses (Lekson and Cameron 1996).

A problematic relationship exists between Chaco Canyon and the Northern San Juan Region. Archaeologists share varying opinions about the relationship. Judd (1954) and Vivian (1990) suggest people from the Northern San Juan Region immigrated into Chaco Canyon at an early date. Vivian and Mathews (1965) favor a late immigration. Other archaeologists note a shift of interaction rather than a migration with trade from the Northern San Juan Region becoming more important towards the end of the Chacoan construction phase. Judge (1989) and Toll, Windes, and McKenna (1980) suggest the "center of gravity" shifts from Chaco Canyon to the San Juan Region.

Popular theories about Bluff include a Chacoan community established by people from Chaco trying to gain an economic advantage in the far region, or the Bluff site may have been established by local people copying the ways of Chaco Canyon in an attempt to gain power. Bluff is not a unique site, but part of a regional pattern where sites similar to the Bluff greathouse have been found in over 100 locations in the Southwest. High quality data is available at Bluff and combining it with available data from other sites will expand the body of knowledge of the Chacoan regional pattern and the relationship between Chaco Canyon and the Northern San Juan Region.

DIGITAL PHOTO INTERPRETATION

In the summer of 1995, an aerial photographic survey was conducted which produced a detailed (500m x 500m) digital photogrammetric topographic map of the site with resolution to 10 centimeters. These data were downloaded and used as the data base for this project. This project's focus was to customize the site area and enhance the site's features in order to reveal obscure or invisible features.. The computerized enhancement of the photogrammetric maps produced images that were able to be evaluated in theoretical frameworks.

COMPUTER METHODS

Digital data from the aerial photogrammetric map was entered into Surfer, a landscape reconstruction, contour, and three-dimensional surface mapping software package, in order to produce a three-dimensional topographic map of the site. The more pronounced features associated with the anthropogenic modifications then became immediately visible. Additional interpretation was then made to identify features not previously discovered during cursory surface surveys.

A topographic photogrammetric map was produced from aerial photography (Figure 2), which was the original base map. XYZ data points from the topographic map were digitized and exported as ASCII data files. Dr. Larry Conyers from the University of Denver, modified the XYZ data compiled from aerial photographs by taking out the coordinates of current land features including roads, transmission lines, and boundary markers. The modified data set consisted of 10,630 XYZ data points in ASCII format usable by the Surfer software.

The digitized data was imported into a worksheet where X = east, Y = north, and Z = elevation of ± 100 meters. The worksheet data was arranged in a row and column format, and a data file was then created from the worksheet. All further contouring and mapping using Surfer was generated from this data file.

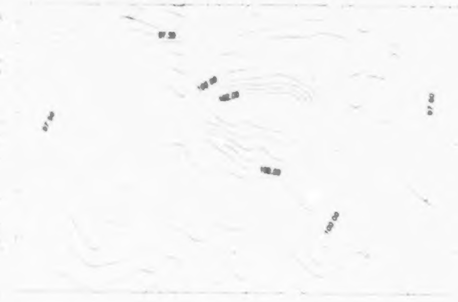

Figure 3: Contour Map

97.00
97.00
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Figure 2: Digitized Topographic Map

A grid file was then created from the XYZ data file. Grid density, gridding methods, and smoothing interpolators were modified to produce minimum curvature. Once this was accomplished, a digitized topographic contour map was created (Figure 2). Areas not directly associated with the archaeological excavation were included in the map.

A subset grid file used in all subsequent mapping was created by setting new map limits which eliminated the non-essential areas, concentrating on the area around the archaeological site. Rescaling expanded the size of the subset grid, and a new contour map showing the excavation area was generated (Figure 3).

Step 2 consisted of modification of the contour map. Contour levels were adjusted to .5 including an addition of new levels. Contour line labels were eliminated, contour line attributes were set to be consistent in color, style, and width, and additional smoothing of the curvature customized the map. Custom color fill between the contours was created to show differences in elevation, and a color scale was added to the map.

Step 3 was to produce a surface plot of the archaeological boundaries. Surface plots are three-dimensional representations of grid files. Modification of the surface plot used specific options of elevation angle of view. Hidden lines were removed to prevent a transparent appearance on the surface. The surface plot scale was exaggerated to show the land features and elevation more clearly (Figure 4).

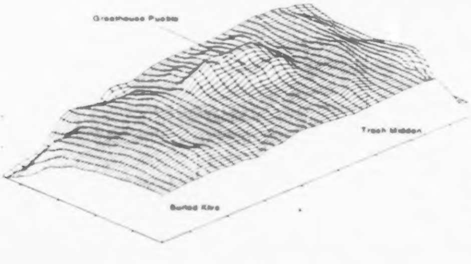

Figure 4: 3-Dimensional Digitized Surface Plot

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Step 4 created an overlay map using both the surface plot and the color filled contour map from above. Once this map was generated, the view orientation was manipulated by modifying the tilt, rotation, and perspective of the map. Rotation and perspective were changed to better illustrate important archaeological features.

In Step 5, both an image map and a shaded relief map were attempted. Shaded relief maps use different gray scales to indicate slope and light source position. However, high quality results were not obtained.

RESULTS OF DIGITAL MAPPING

By viewing the color contour map, archaeological surface features became visible. The pueblo, or greathouse, as well as the great kiva were both easily identified. A possible trash midden is also apparent to the southeast of the pueblo. Two small features behind the pueblo became discernible. They are the same elevation as the great kiva and although not round, show similar characteristics in size and shape and may be other unidentified kivas. An elevation contour of 99.5 completely surrounds the pueblo and trash midden, jutting out to the west encircling approximately one half of the great kiva. Because this topographic feature is so oddly shaped, further field investigation is suggested to determine if this could be part of the earthen berm discovered during reconnaissance. The prehistoric road segments do not appear on the contour map perhaps because it is either very subtle or buried by alluvium.

INTERPRETATION

Important spatial information was gained through the three-dimensional mapping of the Bluff Greathouse Site. Many otherwise obscure surface features became more visible after removing existing land features. A subset grid was created which concentrated on the area of interest--the greathouse, kiva, and midden. Contour intervals were adjusted to 10 cm in order to show the elevations and features more precisely. Adding color to the elevation levels allowed enhanced viewing and comparing of features with other elevations and possible features.

The size of the archaeological features was revealed in three-dimensional maps in proportion to other features. The trash midden is a prominent area in the color contour map and was not previously seen as a distinctive area in the original aerial photo generated topographic map. A possible ceremonial moat surrounding most of the great kiva was also brought to attention by this mapping project. It was recommended that a test excavation be used to further explore the moat and midden regions. Circular features are visible north of the trash midden. They are the same elevation as the great kiva. This area should be tested in the future.

This survey led to the identification of the trash midden and great kiva. Excavations were conducted during the summer of 1996 by the University of Colorado Archaeological Field School. Excavation units were conducted in the greathouse, earthen berm, and great kiva area. A large collection of artifacts were collected.

The earthen berm did indeed turn out to be a trash midden. Trash deposits were clearly represented by found items of charcoal, bone, ceramics, lithics, eggshell, and other related objects (Cameron and Lekson 1996). Two test units were conducted in the kiva area. Puzzling wall features were found suggesting two stages of construction. Further excavation is planned in the kiva next summer.

FUTURE WORK

Currently, computer technology is just beginning to be used in the field of archaeology, and most of the work being done is conducted by non-archaeological personnel. However, in recent years, several projects have been undertaken using computer graphic techniques to visualize complex data in archaeological investigations. This study adds to the growing body of knowledge. The impact of the research has provided the archaeological community at the University of Denver with computer technology and expertise that may have otherwise been under utilized.

New software programs are beginning to revolutionize the way archaeology is being structured, and the improved technology will enable cultural evolutionary theory to advance. Enhanced aerial photographic images and new software programs are enabling test excavations and archaeological field surveys to be customized, to be more efficient, more descriptive, and allow more productive information to be gathered (Larson and Ambos 1997:10).

Software programs are equipped with filters and enhancers that reveal exceptional detail of features that might otherwise be obscure or invisible on raw data. Subtle changes as well as exceptional detail in archaeological features can be obtained with filtering and smoothing capabilities. The new technology allows for the study area to be tested and evaluated in a specific theoretical framework, and can also be used in development planning without extensive excavation, thus preserving the site (Larson and Ambos 1997:12,30,39).

ACKNOWLEDGMENTS

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REFERENCES

Adler, Michael A. And Mark D. Varien

1993 "The Changing Face of the Community in the Mesa Verde Region A.D. 1000-1300. In *Anasazi Symposium 1991*, edited by Art Hutchinson and Jack E. Smith. Mesa Verde Museum Association, Mesa Verde.

Cameron, Catherine M.

1996 *Archaeological Testing at the Bluff Great House: Southeastern Utah October 1995.*

Cameron, Catherine M. And Stephen H. Lekson

1996 Preliminary Report on the 1996 Excavations on the Bluff Great House Site.

Cameron, Catherine M., William E. Davis, and Stephen H. Lekson

1996 *The Chacoan Era in the Northern Southwest: The Bluff Great House Project Research Design.*

Judd, Neil M.

1954 *The Material Culture of Pueblo Bonito.* Smithsonian Miscellaneous Collections, Volume 124, Smithsonian Institution, Washington D.C.

Judge, W. James

1989 "Chaco Canyon-San Juan Basin." In *Dynamics of Southwest Prehistory*, edited by Linda S. Cordell and George J. Gumerman. Smithsonian Institution Press, Washington.

Larson, Daniel O. And Elizabeth L. Ambos

1997 "New Developments in Geophysical Prospecting and Archaeological Research: An Example from the Navan Complex, County Armagh, Northern Ireland." In *Society for American Archaeology*, Vol 15, No 1.

Lekson, Stephen H.

1991 "Settlement Pattern and the Chacoan Region." In *Chaco and Hohokam*, edited by Patricia L. Crown and W. James Judge. School of American Research Press, Santa Fe.

Toll, H. Wolcott III, Thomas C. Windes, and Peter J. McKenna

1980 "Late Ceramic Patterns in Chaco Canyon: The Pragmatics of Modeling Ceramic Exchange." In *Models and Methods in Regional Exchange*, edited by Robert E. Fry. Society for American Archaeology Papers 1.

Vivian, Gordon and Tom W. Mathews

1964 *Kin Kletso*. Technical Series 6(1). Southwest Parks and Monuments Association, Globe.

Vivian, R. Gwinn

1990 *The Chacoan Prehistory of the San Juan Basin*. Academic Press, San Diego.

Scholarly Sightseeing in Rome, Ravenna, and North Africa: The Differences in Early Christian Centrally Planned Vaulted Structures

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Rome and Ravenna have always been in the center of focus for art historians. Rome has been a center of architectural development and innovation from its foundations to the modern day. Ravenna is a city almost frozen in time, offering some of the best preserved and grandest examples of fifth and sixth century Christian architecture. Indeed, these two cities, along with Constantinople, have always been at the focus of Early Christian and Byzantine architecture. For variations on the urban Early Christian architecture, art historians turned to the provinces. Far-flung places such as Syria, Asia Minor, Egypt, Illyria, and Gaul were found to have their own variations of Early Christian Architecture. One region, North Africa, was largely ignored in this perusal of the provinces. Roman North Africa's Christian architecture is worthy of study. While it would take a lifetime of work to rectify the scholarly negligence done to North African Christian architecture, some progress can be made. North African Christian architecture merits scholarly attention even when it is compared with the architecture of Rome and Ravenna. Focusing on centrally planned vaulted structures makes the differences between North African Early Christian architecture and Italian Early Christian architecture especially clear. Centrally planned vaulted structures are associated with two of Christianity's most sacred rites, baptisms and funerals; therefore, any differences between buildings used for these purposes is significant for art history as well as Church history.

In North Africa, a major part of the Roman Empire, the basic Christian centrally planned vaulted structure is either lacking or altered beyond recognition. In Italy and much of the Mediterranean after the reign of Constantine, baptisteries were virtually always round or polygonal, but in North Africa, very often, the centrally planned structure is not even implied; instead, vaulted squares, single-naved structures, and even concave squares are used. North African and Roman and Ravennate architectures were derived from many of the same sources, but North Africa makes a greater break with its Roman classical heritage and produces a more innovative Early Christian architecture. The different shapes—whether square, Greek-cross, rectangular, or concave-square—in North African ecclesiastical architecture call for even more attention when they compared with the nearby centers of Rome and Ravenna because the variations reflect a very strong native architectural tradition and differing liturgical practices.

Like Rome and Ravenna, North Africa had a rich classical architectural heritage from which it could derive new forms of architecture for the Christian church.[1] Yet, the basic type for a Christian centrally planned vaulted structure is virtually non-existent in North Africa; North Africa makes a cleaner break with its classical past and produces a truly original version of Early Christian architecture. While art historians such as Davies, in a single footnote, may declare North African Christian architecture to be unoriginal, North African Christian architecture employs many original shapes and plans (Krautheimer 167, Davies 102). While there are occasional examples of octagonal and hexagonal baptisteries— both are common elsewhere in the Mediterranean, especially in Italy—the Greek Cross[2] and square are much more common (Davies 102). Martyria of the central type, of which the Anastasis of Jerusalem was the greatest example, are non-existent in North Africa (Krautheimer 189).[3] There are even examples of baptisteries that have fonts that have several receptacles where more than one candidate could receive baptism simultaneously (Davies 102).[4] The baptistery at Bir Ftouha is the only Early Christian concave-square walled structure known. These shapes and forms are not present in Syria or Egypt, the supposed sources for North African Christian architecture.

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[1] There is still a lack of sources for North African ecclesiastical architecture. Presented here is a small sliver of the large amount of truly interesting and unique Early Christian architecture that exists in North Africa still today, if only in the most damaged remains.

[2] The Greek Cross will not be discussed here. It is a centrally planned structure, and its use as a baptistery is much more frequent in North Africa than elsewhere. The use of the Greek Cross as a baptistery lends further credence to the idea that North African architecture is unique in its uses, but the form of the Greek Cross is not unique. The Greek Cross is much more extensively used in Italy and particularly Constantinople, but in those regions it is more often used as a church rather than a baptistery.

[3] There may be one exception to this rule. A round, possibly vaulted structure has been found in Carthage, but its function is unknown. This example serves more than anything else to illustrate the general lack of attention North African Christian architecture has gotten; many of North Africa's Christian sights have yet to be satisfactorily studied (Krautheimer 187-188, 482-483).

Not only are the forms but also the arrangement and shapes of the ecclesiastical buildings of North Africa are unique. The attachment of baptisteries and martyria to the apse of the main longitudinal buildings is an arrangement peculiar to North Africa, and it is a startling contrast to the practice of Italy. In Italy the baptistery is directly in front of or at the side of the basilica. The baptistery is never attached to the rectangular basilica in Italy, although it is sometimes adjoined to the atrium (Lowrie 182). The Italian arrangement even has precedence in Classical Roman schemes of arrangement (Kostof 55-56). In contrast, baptisteries in North Africa are usually attached to the main basilica behind the apse (Davies 133).[5] Yet, North Africa seems to break with its classical past, and it produces new forms and arrangements for baptisteries.

The baptistery at the so-called cathedral of Carthage is a simple square, attached to the left of the entrance of the Church. On the rear wall of the baptistery is an attached chapel, which is an exact replica of the larger basilica, apse included. Directly behind the apse is what appears to be a large villa, traditionally called the bishop's palace. Immediately to the right of the basilica, across what would have been a street there is another Christian basilica. The shape of the baptistery differs significantly from any of the baptisteries in Italy.[6] While the square may be an earlier form for baptisteries in Italy, it is notable that the earlier form persists in North Africa, although the attached apsed chapel makes the baptistery more than a mere square. Its attachment is an even further deviation from any of the baptisteries of Italy. The simple square may be a conservative form for a baptistery, but the conservative form is modified and altered to fit the liturgical needs and regional variance of North Africa.[7]

However, the most unusual building in North African Christian architecture must be the baptistery at Bir Ftouha.[8] The baptistery at Bir Ftouha (mid-fifth century A.D. or later) is a building completely different from any known building in the Roman world.[9] It is a concave square, and it was most likely attached to the apse of a rectangular basilica.[10] The large number of vaulting tubes suggest the the structure was vaulted. (Stevens 33). There are also column foundations and architrave blocks, which are rare for North Africa (Krautheimer 191).[11] There is also evidence, such as packed surfaces for floors and wall foundations, for structures outside of the baptistery.[12] The baptistery may have been part of a much larger ecclesiastical complex. The baptistery at Bir Ftouha may have been a martyrium that was converted into a baptistery; a reliquary box and several tombs were found. In the West, martyria were usually not converted into baptisteries, although the practice occurred not infrequently in North Africa (Kostof 55-56). The placement of the baptistery at Bir Ftouha—onto the apse of a greater, rectangular basilica—is most unusual for Early Christian architecture. Yet, this placement is not uncommon for Early Christian architecture in North Africa; the baptistery of the church at Leptis Minor has the same placement in relation to its basilica. Still, the shape of the baptistery at Bir Ftouha is very unusual for any area of the Roman world.

The reasons for North African Early Christian architecture's variance from that of the rest of the Early Christian Roman world are unknown. No conclusive study has been done. While conditions and circumstances, such as stone types and the lack of wood may have influenced certain aspects of North African architecture, ultimately the differences must be attributed to

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[4] Davies apparently knew of some of the innovations of North African Christian architecture, but he still refused to give North African Christian architecture the attention or credit it deserves.

[5] Sometimes the baptistery is attached directly to the apse; sometimes there is a space, not necessarily an ambulatory, between the apse and baptistery.

[6] The early baptisteries in Italy are squares. Generally, the square is considered to be the primitive form for baptisteries, but its persistence in North African Early Christian architecture, even when it is obvious that the technical skill for domed octagons was available in North Africa, is another aspect of the uniqueness of North African Early Christian architecture. This conservatism is hard to explain; perhaps it reflects the conservative nature of the North African Church. Vaulting tubes and many of the structures described below, especially the baptistery at Bir Ftouha, prove that North Africans certainly had the technical skill to build any form of baptistery that they liked.

[7] It has been suggested that the attached chapel may have played a part in the baptism ritual of the North African Church. Still, too little is known about the liturgical practices of North Africa to make any definite conclusions.

[8] Bir Ftouha is an archaeological dig in progress, so much information concerning the building is incomplete.

[9] The baptistery/martyrium at Bir Ftouha has been described as "Hadrianic." The shape does have precedence at Hadrian's Villa at Tivoli. How such architectural ideas and methods could have been transferred from Italy to North Africa over such a period of time is impossible to say. The most plausible explanation is that the idea for a concave square was not transferred, but rather, the idea was developed independently in Christian North Africa. Why the baptistery at Bir Ftouha is shaped as it is another question all together.

[10] The baptistery is most probably attached to a basilica, but the existence of a basilica relies on earlier, scantly published excavations. I is yet to be proved conclusively that the baptistery at Bir Ftouha is attached to a basilica.

[11] North African architects overwhelmingly preferred the archivolt to the achitrave.

[12] The actual foundations have been robbed. Bir Ftouha is a perfect illustration of the poor state of most of the Early Christian ruins in Carthage; it is sobering to know that Bir Ftouha is actually well preserved for Early Christian Carthage remains.

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something greater. There are not obvious architectural centers. nor do the political and religious controversies like the frequent border raids and Donatist controversy. and other changes that took place in North Africa seem to have had a strong influence upon the Christian architecture of the region (Krautheimer 187). The most probable explanation is that North Africa had significantly different liturgical practices (Krautheimer 482-483). The North African Church had many peculiar and independent features like liturgical practices. the Donatist schism. and significant martyrs' cults. Still, as mentioned above. the degree of influence such controversies had upon the architecture is questionable. If Kostof is right in attributing great theological significance and symbolism to the placement and shape of Italian baptisteries (56). then there must be some reason for the shape and placement of North African baptisteries.

The true uniqueness of North African Early Christian architecture is more fully understood when it is compared with the nearby centers of Rome and Ravenna. Rome was the capitol of the Empire. Rome, unlike North Africa. had always been a political and architectural center. From the earliest days of Christianity. Rome was an important center in the Christian church. When the Roman Emperor Constantine promulgated his Edict of Milan in 311 A.D. the new era of toleration allowed the Christian church to begin building grand. public structures. Christian architecture came into an even greater blossoming after Constantine had his vision at the Battle of Milvan bridge (A.D. 312). While the nature and extent of Constantine's conversion may be debatable. it is clear that after A.D. 312 and the consolidation of his power. he began to favor and promote the Christian religion (Boak 414-415. 513). The ascension of Constantine to the throne and his patronage of the Christian Church had a direct influence on Christian architecture.

To see the earlier Roman roots of the Early Christian architecture of Rome. one must first examine the Pantheon (A.D. 125-128). the quintessential centrally planned vaulted structure of Classical Rome. From the zenith of Roman centrally planned vaulted structures. the Pantheon. early Christian centrally planned buildings are derived. including the buildings examined here. The Pantheon would have been the perfect model for Early Christian architects. The Pantheon certainly is monumental. Its memorial symbolism would make its shape perfect as a martyrium or as a baptistery in which to celebrate one of the Church's most monumental rites. There is a connection between the use of the Pantheon and the uses of the Christian buildings derived from it. For example. note the connection between the uses of the Pantheon and Christian buildings like Santa Costanza. The Pantheon is a memorial structure and so is Santa Costanza. Santa Costanza is a mausoleum for Constantine's sister; her tomb is round. just as the tombs of many of the emperors were round. While all elements of the Pantheon are not present in Early Christian edifices. the pattern of evolution from the Pantheon to a structure like Santa Costanza is pretty clear. The Pantheon is a round building with a great dome. Its walls are immensely thick—six meters. In the interior the walls are pierced by seven great niches (Macadam 120). Interior niches are used over and over again in many similar structures (Davies 59).

Of course. the centrally planned vaulted structure goes through some phases of development before it is adopted by Christian architects for Christian purposes. The nymphaeum in the Licinian Gardens. called the temple of Minerva Medica. represents the next stage after the Pantheon. In The Temple of Minerva Medica (A.D. 263-268) ten niches pierce through the inner wall and become arches—or a colonnade in other structures—that opens into the surrounding ambulatory (Davies 61). The Temple of Minerva Medica is the bridge between the Pantheon and Early Christian structures like the Lateran Baptistery and San Vitale because rather than circular walls. the Temple of Minerva Medica has ten-sided walls. These are easier to construct than circular walls. but the near-circular shape of the walls makes surmounting the walls with a dome easier than with a hexagon or square (Macadam 219). The Temple of Minerva Medica was a model for many classical buildings. but its basic plan. a polygon surmounted by a dome. became a model for many Christian buildings.

This form of an inner wall pierced with arches became a common feature of Roman construction. clearly derived from the Pantheon where the niches are embedded in the thick walls (Davies 59). As the dome and the walls become thinner and lighter. the niches eventually became arches. as in the Temple of Minerva Medica. To the central dome. supported by a wall. either octagonal or round and completely pierced with niches. is added an ambulatory. The inner wall. instead of a wall with arches as openings. eventually becomes a colonnade with an architrave or. more commonly. an archivolt (Lowrie 135-136). For example. the interior colonnades of such structures as San Stephano Rotundo. Santa Costanza. and San Vitale are ultimately derived from interior niches: the piers of the niches became columns and an ambulatory was added. Occasionally. the niches are replaced by apses. as at the Orthodox Baptistery of Ravenna (Lowrie 137). This plan develops into the typical plan for baptisteries in the Latin West: an octagonal or circular plan with an inner octagon of eight columns which support a dome. The Lateran Baptistery. Santa Costanza. and the Orthodox and Arian

Baptisteries of Ravenna all follow this basic plan (Davies 101-102).

The wide range and development of the central type should not be underestimated or down-played. Centrally planned Christian structures are innovative and original, but they are also clearly derivations from earlier Classical buildings such as the Pantheon and the Temple of Minerva Medica. Centrally planned vaulted structures became the structures for Christianity's most sacred sights. Some of the earliest and most famous churches were the central type like Constantine's church at Antioch (Lowrie 139-140) or the Anastasis in Jerusalem. These churches are clearly based on the classical models (Krautheimer 74). While these churches were the grandest of their type, they still would become models for centrally planned Christian structures. These churches were models for churches from Rome to Constantinople, but the model derived from the Pantheon never seems to have been used in North Africa. North Africa makes a clear break with the classical past and abandons the model derived from the Pantheon in favor of fresh, new, inventive forms. Rome remains true to its traditions.

Christian Roman centrally planned structures have a clear derivation from earlier structures whether the structure is used as a baptistery, mausoleum, or a church. The standard type for Roman baptisteries was established early, and as soon as the Church was free to build as its own public edifices without harassment from the Imperial government, baptisteries became free standing structures (Kostof 55). The earliest surviving baptistery built in the West is the Lateran Baptistery in Rome, also known as San Giovanni in Fonte. It was originally built by Constantine (c. A.D. 315-324) in an octagonal form which apparently was already becoming the form typical for baptisteries on the Italian peninsula. The Lateran Baptistery was copied many times over in Italy and Gaul (Macadam 215). It was later remodeled by Sixtus III. A clerestory and ambulatory were added. The Lateran Baptistery essentially became a smaller version of Santa Costanza (Krautheimer 90). In Rome, it is clear that a standard type, the polygon, for baptisteries becomes established very early; in North Africa, however, innovation with a variety of types continues until the Arab conquest shortly after A.D. 622.

Santa Costanza (A.D. 324-6) was built in Rome by Constantine, and it is typical of buildings of its type built during Constantine's reign (Krautheimer 67). Although it was built as a mausoleum, it follows the typical plan for baptisteries and it was used a a baptistery for the adjacent basilica of St Agnese (Davies 102). The windows around the drum beneath the dome are for light and correspond to a clerestory in a rectangular basilica. Still, St. Costanza is like the Lateran Baptistery and San Stephano Rotundo: it is the same simple form derived from Classical models like the Pantheon and the Temple of Minerva Medica. These buildings are new styles, but their derivation form earlier predecessors is obvious. The baptisteries and martyria of North Africa make a much more daring break with the past.

It is clear that the Early Christian architecture of Rome is based on basic forms derived from Classical Roman models like the Pantheon. These three buildings are all essentially the same building with only size and minor details differentiating their plans. The type of these three buildings shows a very clear derivation from the Pantheon. This type, common throughout so much of the Roman world, barely appears in North Africa. While Roman Early Christian architecture almost becomes static in its commitment to a fixed type, North African Christian architecture increases in experimentation and innovation, and develops a further break with the Classical past. Rome, after developing Early Christian architecture, was turning to its Classical heritage, looking to early classical models in an attempt to recreate some of the grand pagan architecture in a Christian setting. Rome became static in its architectural styles while North Africa became more and more inventive.

Unlike Rome and even cities in North Africa such as Carthage, Ravenna was a backwater until it enjoyed sudden imperial patronage as the capitol of the Empire. In A.D. 293 the capitol of the Empire was moved from Rome to Milan. In 402 the capitol was transferred from Milan to Ravenna. After Italy fell to the Ostrogoths in 476, Odovacer became king of Italy. In 488, the very much romanized Theodoric (495-526), who had close contact with the Eastern Roman Empire, defeated Odovacer and set up a kingdom and ruled from Ravenna. However, Theodoric never severed ties with the Eastern Roman Empire, and, like most of the Western barbarian kings, he considered himself a virtual vassal of the Eastern emperor (Krautheimer 93, 181). Hence, even under Gothic rule, Ravenna was importing architectural styles and ideas from Constantinople. Ravenna, like Rome, would employ fixed, derived styles imported from Rome and Constantinople. Ravenna would not invent its own styles and forms like North Africa. The main examples of Early Christian centrally planned vaulted structures in Ravenna are the Orthodox Baptistery, the Arian Baptistery, San Vitale, and the Tomb of Theodoric.

The most magnificient Early Christian building of Ravenna only goes further to prove the unoriginality of Ravennate architecture. San Vitale was built in 546-548. It is of the same style as San Costanza: an octagonal or circular structure surmounted by a dome and surrounded by an ambulatory. San Vitale, however, has Eastern features such as a gallery (Lowrie 112-113). It has an inner wall pierced by niches and surrounded by an outer wall. It does not have an exact counter part in Rome. San Vitale is an Eastern import, commissioned and built by Justinian, who was reconquering the West. San Vitale is an very good example of how the architects of Constantinople developed the centrally planned church. It is a very innovative building, but it is Eastern, not Ravennate. The centrally planned church was overwhelmingly favored in the East (Edgell 163-164). It bears a strong resemblance to Ss. Sergius and Bacchus in Constantinople, which was modeled after Constantine's church at Antioch (Davies 62. Lowrie 139-140, 146). It is very likely that San Vitale was copied from Ss. Sergius and Bacchus; after all, Justinian commissioned both structures and may have used the same architect. Its plain exterior and polygonal shape are also imports from Constantinople (de La Croix 272). San Vitale has all the magnificence and innovation that the Byzantines could apply to centrally planned architecture. It is San Vitale's magnificence that proves the point: San Vitale is of an imported style, not a style original to Ravenna.

By 380 the architectural types of Christian architecture had been standardized; the search for new types of Imperial Christian architecture was over. This standardization was especially evident in Rome, but it was evident in all the main centers of the Empire, including Constantinople. Even baptisteries had become standardized, and the octagonal form was the standard (Krautheimer 93-94). In North Africa however, these standards never became accepted; baptisteries in North Africa kept the conservative square form or they embraced radical new forms such as the concave square. North Africa forged its own brand of Christian architecture, even the Byzantine reconquest did not lead to a significant imposition of Byzantine styles on North Africa. On the other hand, Rome shows a clear line of development from its earlier Roman sources while Ravennate architecture is imported from Rome and Constantinople. Yes, North African Early Christian architecture shows a clear line of diversion from its Roman sources. North Africa remained unique, in its very structures, and even in their placement. North Africa develops its own version of Early Christian architecture.

WORKS CITED

Davies, J. G. *The Origin and Development of Early Chistian Church Architecture* London: SLM Press. 1952

de La Croix, Hurst and Richard G. Tansey. *Gardner's Art Through the Ages* 8th edition. San Diego: Harcourt Brace Jovanovich, 1986.

Edgell, George Harold, and Fiske Kimball. *A History of Architecture* Westport: Greenwood Press. 1946.

Humphrey, John H. "A New Museum at Carthage." *Archaeology* March/April (1985): 1985.

——, ed. *Excavations at Carthage*, 1976. vol III. Ann Arbor: University of Michigan Press. 1977.

——. and Pedley, John Griffiths. "Roman Carthage." *Scientific American* Jan.-Feb. (1978): 111-121.

Khader, Aicha Ben Abed Ben, Hedi Slim, and David Soren. *Carhage Uncovering the Mysteries and Splendors of Ancient Tunisia* New York: Simon and Schuster, 1990.

Kostof, Spiro K. *The Orthodox Baptistry of Ravenna* New Haven: Yale University Press, 1965.

Krautheimer, Richard. *Early Christian and Byzantine Architecture* New Haven: Yale University Press.1986.

Lowrie, Walker. *Monuments of the Early Church* New York: The MacMillan Company, 1923.

MacAdam, Alta. *Blue Guide Rome and Environs* London: A & C Black, 1994.

MacDonald, William L. *The Architecture of the Roman Empire An Inroductory Study* New Haven: Yale University Press, 1982

——. *The Architecture of the Roman Empire Volume II, An Urban Apraisal* Vol II New Haven: Yale University Press, 1986.

Nelson, Harold D., ed. *Tunisia A Country Study* Washington: The American University Foreign Area Studies, 1988.

Richerson, Jim; and Stevens, Susan T. "Between Caeser and Mohammed: Uncovering Christian Carthage." *Minerva* Jan.-Feb. (1994): 31-33.

Stevens, Susan T. "Excavations of the Suburban Cemetery Church Complex at Bir Ftouha (Carhage): Preliminary Report of the Goals and Findings of the 1994 Season." *Archaeological News* 19 (1994): 31-34.

Yacoub, Mahamed. *La Musee Du Bardo* Tunis: Editions de l'Agence Nationale du Patrimoine, 1993.

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Self-Perceptions and Representations
# of Hawaiian Identity,
Ke Kanaka and *Ke Kane Ikaika*

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To follow are excerpts and arguments of a research paper completed for the Honors Department at Brooklyn College. The paper focuses on images of Hawaiian identity from the 19th through the 20thC and argues against a dichotomous approach to culture which limits understanding to a "native" (subjectivist) perspective or a "foreign" (objectivist) perspective.

INTRODUCTION

In November of 1995 Clifford Geertz the highly acclaimed guru of anthropology reviewed two then recently released books, one by Gananath Obeyesekere entitled The Apotheosis of Captain Cook: European Mythmaking in the Pacific, the other by Marshall Sahlins, How 'Natives' Think, About Captain Cook, for Example. His review, "Culture War," printed in the New York Review of Books, encapsulated the ongoing academic debate between a *subjective*-- "psychological," "moral," "holistic," or "universal"-- perspective and an *objective*-- "sociological," "empirical," or "diverse"--perspective that stands at the heart of both authors' contrasting viewpoints. Obeysekere, fighting to claim Hawaiians as "rationale" (in otherwords like the Professor who is culturally translating them), becomes representative of subjectivist or "native" thought, while Sahlins portraying Hawaiians as existing within their own cultural schema becomes here Geertz's leading advocate for an objectivist approach (4-5). Despite Geertz's self-professed preference for Sahlin's structuralist arguments, an approach he labels as more "persuasive," "penetrating," "less prey to the confusing noises of the confused" (6), he ends his article with academia's necessary mantra to "keep the conversation going," maintaining that only by continuing opposition will "the level of anthropological disputation . [be] raised," that only through divisiveness will there be progress(6). Yet two years after the publication of Geertz's review, and countless years past Academia's ongoing conversation about "difference," the debate between a subjective and objective perspective still finds itself caught in a binary tug-of-war, with more and more scholars rushing to catch hold of either side of the rope. The once touted linear road to progress finds itself held by its oppositions which rather than enticing movement serves only to promote further stasis.

[Comparing a report I completed two years ago which argued for a diverse reading of Hawaiian culture (Hawaiians as "other") to the position of Haunani-Kay Trask, Dean of the Hawaiian Studies Department at the University of Hawai'i and a leader in *Ka Lahui Hawai'i*, a pro-sovereignty political organization, who argues for a holistic reading of Hawaiian culture (Hawaiians as possessive of a hegemonic culture), I closed my introduction with this paragraph:] Yet Trask's argument of 'sameness' and my own argument of 'difference' really argue one and the same point. They are both two faces of the same coin; for both uphold the same 'foreign' and 'native' dichotomy, read here as dominant and residual: the argument of sameness for operating under the same standard of dominance and the argument of difference by reinforcing the ideology of dominance through its opposition. The definition of culture produced here is inevitably static with both approaches serving to limit and control the understanding of culture by its refusal to upset the established hierarchy. For both Trask and myself, what is deemed "humorous" (Hawaiian *kanaka*) and "sexual" (Hawaiian *i'ini*) is opposed to what constitutes Hawaiians as "authoritative" and "autonomous." Continuing along the same dichotomous *progression*, we both seek to perpetuate images of Hawaiian culture which portray Hawaiians only as moral, modest, well-educated, politically strong and potentially prosperous-- in other words, as perfect embodiments of America's middle-class ideals. Yet I think we both forget that there was a time when humor and sexuality was very much a part of Hawaiian ideology, part of its authorial make-up, when culture was more than just a measure of strength, aptitude and wealth. Simultaneously, we should remember that if we are to talk about "Hawaiian Culture," if we are to describe it, reclaim it, construct it, these attempts include accepting a 200-year history of domination; it includes accepting the image of the *kanaka* and the *i'ini* as reflections of who Hawai'i is: what we have been re-written to be. We should remember that it is not so easy to isolate, despite the prophecies of Clifford Geertz, opposing interpretations of culture. That we by continuing to perceive culture through static oppositions of subjective/objective, dominant/residual, strength/sex, laughter/authority, neglect to consider that definitions alter, interpretations evolve and that images of "tradition," whether we like it or not, inevitably change.

BODY (segmented into four parts)

1. Legends, Myths, Dance and Song: Kalakaua, the Merry Monarch.

This section looks at representations of Hawaiian identity from the early 19thC, focusing on the effects of the 1820 arrival of New England missionaries in legend and song and the subsequent reassignment or splitting of Hawaiian culture into categories of official (serious) and non-official (funny or sexy).

2. The Trickster and The Dancer.

This section looks at the incorporation and isolation of "sex" and "humor" (as opposed to notions of "authority" and "strength") in the re-interpretation of the *Makahiki* (festival of harvest) by Kalakaua, the new lyrics of 19thC *meles* (song) and the replacement of chants (*mo'olelo*) which were re-defined as "too serious" with song. It also focuses on the 1959 switch of Hawai'i's economy from agricultural to commercial (i.e. tourism and land development), the influence this change of economy had on school curriculum and, lastly, the generated iconography of Hawaiian culture this new commercial economy produced: advertisements.

3. From Brothers to Blallahs: Hawai'i's *Kupakahi* ("mixed up") World.

This section introduces Hawaiian Creole: the language of diversity possessed by the multi-ethnic community of Hawai'i and the ever-expanding role of the *kanaka* now an icon of nativism. The rise of pro-Hawaiian political movements and the social divisiveness which ensued in the eighties as more and more political organizations emerged, each claiming to speak "for the people," is presented as threatening to this multi-cultural fabric of Hawai'i for perpetrating once again the same categories of official (serious) and non-official (funny or sexy).

4. *'Aka 'Aka*: The Sound of Laughter.

The role of the *kanaka* as "a social indicator of historical developments and social changes" is focused on in this section. In contrast to the political organizations of the seventies and eighties, the *kanaka* image, as represented by Hawaiian comedians of the 1970s-90s is not seen as limiting or selective: the affable and humorous image introduced in the 19thC begins to, in the 20thC, incorporate the attributes of strength and authority. By the 90s there is no longer a separation between the *kanaka* image (the comedic persona) and the man (the comedian) with the introduction of Bu la'ia, a comedian who ran for governor of Hawai'i and received over 5,000 write-in votes.

CONCLUSION

Perhaps the acceptance of Bu as a potential governor is due to the development of the American Entertainment State and the now historical precedent set by such entertainers-turned-politicians as Ronald Reagan, Clint Eastwood, Sonny Bono and Fred Grandy (Gopher from *Love Boat*). In their roles, these entertainers embodied an ideal people identified with, be it the affability of Reagan or the raw courage and personal honesty of Eastwood. If John Wayne were alive today, chances are he would be President. However, by all accounts Bumatai's Jr. Boy, Delima's Blallah, and Kaui Hill's Bu La'ia are not ideal: they appear questionable heroes at best, with their enlarged hair, blackened teeth and broken speech patterns. Their affability, should the characteristics they promote be understood as self-debasing, is found bordering on sarcasm. And instead of exemplifying a model for Hawaiian youths to aspire to, it could be argued that they promote all which is wrong in Hawaiian society. However, the image of the *kanaka* is the image of Hawaiian society, an image come to life in the hotels, schools, and the tented state-park homes: this has become the new tradition of Hawai'i. To appreciate the humor, there needs to be an understanding that the *kanaka* image is an emergence of two cultures meeting together, a meeting of representations and self-perceptions: one image which is neither "foreign" *or* "native," "dominant" *or* "residual" (a division prioritizing one over the other): it is necessarily and simultaneously both. Rather than deny this heritage, these *blallahs* and *bu la'ias* remain the only ones to speak from it. They are the only ones who remain truly "Hawaiian" for they do not seek to view their world divisively. Even failure is simultaneously understood as victory as Bu's parting words to the winner of the 1995 gubernatorial election, Ben Cayetano, reflects: "You bettah take care da Washington Place [the governor's mansion]," he warns, "cuz I goin be dere pretty soon-- so no wreck da place eh!" With the next gubernatorial election scheduled for 1998, the question remains, will the majority of Hawai'i's voters decide to take this comic seriously?

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Mexican Catholicism:
The Syncretic Result of the Spanish and Indigenous Religions in Contemporary Mexico

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INTRODUCTION

Since the arrival of the Spaniards and the conquest of the great Tenochtitlan, the Roman Catholic Church has played a key role in the life of New Spain and independent Mexico. Shortly after arriving in the New World, the conquistadores and friars began spreading Catholicism among the indigenous populations. The Indians were engaged in learning the new religion, but adopting it did not happen overnight, much less peacefully. However, little by little, Catholicism infiltrated the New World's folk religion. By 1810, Catholicism had permeated New Spain's society so deeply, that Father Miguel Hidalgo led the fight for independence with a standard of the Virgin of Guadalupe as the national symbol. The Catholic faith came to dominate the life of the New World.

Distanced by almost five centuries, Mexico has developed its own Catholicism characterized as a mixture of Spanish and Indian religions, in which remnants of both can still be seen today and traced to their origins. Nevertheless, even when the origins have been found, the contemporary results of the initial syncretism cannot be separated into its original components. The mixture has become an intrinsic part of twentieth-century Mexico, where religious syncretism still plays a very important role not only in religious holidays, but in day-to-day life as well.

The purpose of this paper is to show how Catholicism, being the predominant religion in Mexico, exists in a heterogeneous form. This is the syncretic result of Spanish Catholicism mingling with indigenous beliefs and rituals from the time of the conquest through the colonial period and up to contemporary Mexico. Because of the breadth of the topic, Holy Week festivities are the focus of this work. Holy Week lends itself as a case study because it encompasses the climax of Christ's life on earth and forms the substantive basis for Catholicism.

HOLY WEEK

In order to talk about Holy Week, it is necessary to establish a common understanding of the Major or Greater Week for the Catholics and its meaning. Holy Week is, "[t]he week immediately preceding Easter Sunday in which is recalled the memory of our Lord's last days and passion before the resurrection. The liturgical prayers and ceremonies of the week . . . show Jesus Christ as the triumphant Messiah and the suffering Redeemer . . . "(Attwater, 235). Holy Week begins with Palm Sunday. This day commemorates Jesus' entrance into Jerusalem. Its name came about because the people who gathered to receive Jesus (after fasting for 40 days -- Lent -- on Mount Olivet) greeted him with palm leaves. Monday, Tuesday and Wednesday are days of mourning, for Jesus' crucifixion is coming. Maundy or Holy Thursday is the commemoration of the Holy Eucharist, or the famous Last Supper. Also, the betrayal of Jesus by one of His apostles --

Judas Iscariot, who turned him in to the Roman authorities -- happened on this day. Good Friday is a mournful and sad commemoration of the crucifixion. Holy Saturday remembers Christ's burial and Mary's mourning for her Son. Easter Sunday is a day of joy which celebrates Jesus' resurrection and ascension into heaven according to the Bible.

EVANGELIZATION IN THE NEW WORLD

When the American continent was discovered, Catholicism was transported to the new territories. The Spaniards not only brought a new religion, but with it came a new way of life established by Christianity. In Catholicism, great importance is placed on propagating the faith to obtain forgiveness of sins in order to save one's soul from burning in the flames of hell. And this, precisely, was the idea that the Spaniards brought with them.

The discovery of the New World gave Spain an opportunity to expand not only its dominion but its faith. It provided Spain with an ideal way of preserving and spreading Christendom as a hedge against Protestant success in Europe. The chance of spreading the Gospel in the newly discovered worlds made her feel as the chosen nation, predestined to be the redeemer of the Indian non-Christian (thus sinful) souls.

Isabella (1492-1504) and Ferdinand (1506-1516), were the founders of Catholicism in the Indies. Even though the Church in the New World was a copy of its counterpart in Spain, there were not as many members in the former as in the latter. Actually, a very reduced number of friars would venture to New Spain and therefore, evangelization problems arose. An important problem was language. Most of the time the indigenous languages did not have words for the same concepts the Spaniards were trying to transmit.

The missionaries could not sit down one-on-one to teach the appropriate meaning and concept to the Indians, but even if the friars had time for catechism, there was an imminent need to save the Indian souls as fast as possible: the indigenous population was dying quickly with the illnesses brought by the Spaniards. In order to save the natives' souls, the friars conducted mass baptisms even if the Indians had little or no knowledge of what their christening meant. A friar would baptize four to six thousand Indians in a day.

Once the urgent character of learning the main prayers and erasing the original sin through baptism had passed, an important remaining part of the evangelization was teaching the Bible to the Indians. By studying the Indian customs, the friars discovered a deep interest for music, dancing and painting. The friars devised the idea of preaching the Gospel through theater; after all, it involved those three skills in which the Indians delighted so much.

Representations in the Gospel theater usually corresponded to the major Catholic celebrations such as Christmas, Epiphany, Holy Week, Corpus Christi and Pentecost. The missionaries were in charge of writing the libretti, which were usually in the natives' tongue. The actors and spectators were all Indian. The performances could take place inside a church, but were usually held outdoors, primarily in what are called capillas abiertas or open chapels. These chapels were specifically created for the Indian masses allowing, certainly, a far greater number of spectators (thousands) than those who could fit inside a church. The open chapels were usually located in the church's atrium in a chosen place where they could be seen by the crowd from a distance. The actors were also in great numbers; some written records talk about eight hundred, twelve thousand, etc., participants (Iglesia, Religión, 142).

According to the Spanish chronicles, the scenery for such theatrical representations was not only quite impressive because of its colorfulness but also because it had live animals as well as natural and artificial plants. Music was also an important part of the opening and closing of the Gospel theater. Fray Toribio de Benavente "Motolinía", in his Historia de los indios de Nueva España, refers to the staging in 1538 of Adam and Eve's fall from paradise:

> Adam and Eve's lodging was so ornamented that it seemed like paradise on earth, with various trees with fruits and flowers, some of them fresh and some of them made of feathers and gold; the trees had a diversity of birds, from the owl and other birds of prey to small birds and above all they had many parrots, and it was so much talking and yelling they had that some times they interfered with the action on stage ... There were also some birds that were made of gold and feather really worth seeing. The rabbits and hares were so many, that everything was full of them, and many other funny animals that not until then had I seen (Iglesia, Religión, 142).

The result of these processes was the superficial evangelization of the Indians. Furthermore, some of the Catholic deities were equated to the native ones either purposefully by the friars for easier assimilation or accidentally in the Indians' mind. To mention the most important ones, Tonantzin or Mother Earth became the same as the Virgin Mary, the Mother of Jesus; and Huitzilopochtli, the god of war, became the same as the Archangel Michael, always represented destroying the devil. Some Indians were reverting to their religious practices as a result of not being truly converted. There were rebellions with the purpose of restoring the old -- native Indian -- world order, but the Spaniards suffocated them. On the other hand, some natives began to combine their religious images with the new Catholic ones. Syncretism started here. Even though Catholicism was the predominant religion, the indigenous elements were always present: in 1769 Archbishop Francisco Antonio de Lorenzana forbade "stage representations of the Passion of Christ ... and other dances, because he considered them 'superstitious' and 'irreverent' ... because they stimulated the use of prehispanic languages ... [and] also due to other reasons such as 'drunkenness, paganism, dissipation, idolatry'" (Florescano, 47).

SYNCRETISM IN CONTEMPORARY MEXICO

Two accounts demonstrate the syncretic result of the Spanish evangelization efforts. I do not try to suggest that the Spanish-Indian syncretism can be "peeled," divided into sections and put back together into its original forms. On the contrary, the mixture of innumerable elements of both religions gave birth to a new form of Catholicism, a heterogeneous one, a Mexican Catholicism.

Rarámuri Holy Week

The Tarahumaras, or the Rarámuri as they call themselves, are a population of about sixty thousand natives of Barranca del Cobre (Copper Canyon) in Chihuahua. The Indians call Holy Week "norirawachi." It literally means "when we walk around in a circle" (Triedo, 62), because most of the celebrations are about circling a Catholic church in a continuing and devoted procession. During the Rarámuri Holy Week there is no public: all Tarahumaras are faithful participants in the ceremonies.

The main Holy Week celebration is the conflict between god and the devil. The Rarámuris participate in this conflict by dividing themselves into two groups: the Pharisees who are helpers and allies of the devil; and the Captains and Soldiers whose role is to defend god. Why can't god defend himself? The devil has forced god to drink great quantities of tesgüino (maize liquor) and he has not recuperated yet. The Tarahumara god is drunk, thus weak and vulnerable. It is now the Rarámuri responsibility to protect god and his wife (who is drunk as well) until they are in good health again. Otherwise, the devil will take advantage of the opportunity and destroy the Tarahumaras.

The Rarámuri dance and sing to their music all day long. On Easter Sunday fights between Pharisees and captains and soldiers are re-enacted, the purpose of which goes beyond defeating the devil and honoring God now that he is in good health. The mock fights symbolize the battle between right and wrong. The festivities end and god is satisfied. He will protect the Rarámuri, his children, until he needs their protection again, the following year.

Holy Week in Iztapalapa

Iztapalapa is a borough of Mexico City. Holy Week in Iztapalapa is a re-enactment of the life of Jesus on Palm Sunday, Holy Thursday and Good Friday. On those three days, there is a procession through the streets of Iztapalapa in which thousands of people participate and millions watch.

Bernal Díaz del Castillo describes "Estapalapa" (sic) with great admiration. In Iztapalapa, the Cerro de la Estrella (Hill of the Star) was a sacred place in which the Indians had a temple to the god Tezcatlipoca. With the Spanish arrival, the friars imposed a deity -- El Señor de la Cuevita (The Lord of the Little Cave) -- atop the temple to Tezcatlipoca. The Spaniards used the Gospel theater to teach the Bible to Iztapalapa's inhabitants.

In 1843 there was an epidemic of cholera morbus in Mexico City. Iztapalapa's population was decimated but suddenly the illness ceased. The miracle was attributed to the Señor de la Cuevita. In order to thank him, the staging and processions of Christ's Passion began. Today, the festivities take place in three main areas: the main square, the streets and the Cerro de la Estrella.

During Passion Sunday the houses and streets are adorned with pink and white flowers. The procession parades through the streets while the actors carry palm leaves tied around aromatic herbs -- chamomile, rosemary and bay. The procession's last stop is the church of San Lucas (St. Luke) where a priest will say mass and bless the palms and herbs. Once blessed, the bouquets acquire a certain magic; Iztapalapa people keep them throughout the whole year to cure the sick.

On Holy Thursday the streets are decorated with purple and white bows. The ceremonies begin with a mass said in the sanctuary of the Señor de la Cuevita, followed by a procession visiting each of the eight churches of Iztapalapa. The actors finally reach the main square where the staging of the Last Supper takes place, after the washing of the Apostles' feet. Jesus praying in the grove takes place afterwards "on location" at the Cerro de la Estrella. Watermelons, cantaloupes and mameyes are the decorations for the grove: a tropical conception.

White and yellow flowers decorate the streets of Iztapalapa on Good Friday. The actors playing the role of the Nazarenes carry heavy crosses; there are about two thousand of them. Jesus is imprisoned, later he will be tied to a column and whipped. Pontius Pilate comes on stage and gives the verdict for Christ: he will be crucified. The Via Crucis begins. Jesus crowned with thorns carries his heavy cross, falls three times and the stations of the cross culminate on the Cerro de la Estrella where Christ is crucified. On the cross, Jesus pronounces the last of His seven words "All is consummated." There is a collective ecstasy flowing in the air.

To meditate the sacrifice that Jesus Christ just made for the human race, His crucifixion is followed by a silent procession down the Cerro de la Estrella through Iztapalapa. Hooded youths carry a statue of the Señor de la Cuevita. Devoted and faithful Iztapalapa pays homage to the saint, thanking him once more, for having relieved them from the terrible cholera morbus.

The accounts described above portray Holy Week celebrations in both very similar, and very different ways. The similarities are found in the Catholic core belief of Jesus Christ and His Passion, and the need to celebrate and re-enact this event year after year; the differences vary. The Rarámuri, believe in Jesus Christ, but He is also the Sun and there is not a Holy Trinity as in the Father, the Son and the Holy Spirit. The Lord of the Little Cave in Iztapalapa, superimposed on Tezcatlipoca, is someone who needs a yearly sacrifice consisting of the representation of Christ's Passion. The idea of keeping the deity happy to avoid bad times (in this case the return of cholera) still persists from ancient times. Syncretism is a continuum, a dynamic religious culture in Mexico that is constantly evolving and changing.

CONCLUSION

It is practically impossible to erase completely the religious habits, beliefs and symbols of a given culture and impose new customs. After five centuries of history, the visible religious remnant of the Spanish conquest is not a superficial Catholicism imposed upon native beliefs, but a deeply imbedded new faith, Mexican Catholicism.

By the ever changing nature of culture, a religious stasis is not encountered in Mexico. On the contrary, a process of constant accommodation and modification of new cultural elements is always happening. Despite some new additions, many of the Holy Week's celebrations in Mexico today are lively remnants of the evangelization process; some other remnants are a part of the native religious celebrations. Whatever the case, those celebrations have become an intrinsic part of the Mexican religious culture with a very special flavor due to its dual heritage.

REFERENCES

Attwater, Donald, ed. A Catholic Dictionary (The Catholic Encyclopaedic Dictionary). New York: The Macmillan Company, 1949.

Florescano, Enrique. El Ocaso de la Nueva España. Coleccion La Antorcha Encendida. Mexico: Editorial Clio, 1996.

Iglesia, Religión y Sociedad en la Historia Latinoamericana (1492-1945): Congreso VIII de la Asociacion de Historiadores Latinoamericanistas de Europa, 1987. Hungary: Jate Kiado, 1989.

Rodriguez Mariangela. Hacia la estrella con la pasion y la cruz a cuestas: Semana Santa en Iztapalapa. Mexico: Ediciones de la Casa Chata no. 35, CIESAS, 1991.

Triedo, Nicolas. "Los Guardianes del bien y del mal. Tewerichic: Semana Santa Raramuri," Mexico Desconocido. Año XX, Numero 230. Mexico: Editorial Jilguero, Abril 1996, pp. 58-65.

Rocky Road: The Long Journey to Educational Freedom in Prince Edward County

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EDUCATION IN FREE SCHOOLS WAS NOT ALWAYS LAW

Blacks in the South have experienced many hardships, especially in the school systems. Public education in Prince Edward County, in southside Virginia, did not begin until 1870 after the Underwood Constitution of 1867-68 took effect. The schools were segregated, and the black schools were always at a disadvantage. Unlike white children, black children did not have proper materials or even adequate school buildings. Although there were more black children than white children who attended school in Prince Edward, the white children got a better education.

Education for whites was developing at a moderate pace and even more slowly for blacks when the Civil War broke out. The Literary Fund, intended as support for education, was then used to provide additional money for military defense, as directed in the state convention on June 26, 1861 (Maddox 170). Once the Civil War was over, the negative attitude of white people towards free schools became stronger than before. Blacks and a few white radicals proposed that the system be completely democratized by letting blacks attend school along with whites of all classes, so they would be seen as equal individuals (Maddox 170). Blacks believed that only by having the schools mixed could equality be guaranteed. If both blacks and whites were taught in the same classroom, then each student would get the same information, and neither race would miss out. Blacks realized that education was the key to a better future for the black community. Although blacks had support from some white people, that support was not enough, and the idea of mixed schools was rejected. In Prince Edward County, as well as in other counties, public schooling was not a popular idea.

New and recurring factors started to play important roles in the development of a public school system: for example, the belief in a real need for education in order to make the republican government advance into the future; evidence that school funds, societies of public schools, and others could not afford the distribution support (Monroe 232). The Underwood Constitution of 1867-1868 was accepted at a convention that established public school systems by 1870, and the Constitution spoke clearly on the subject of public education (Maddox 171). The Virginia School Report of 1871 reported that on February 10, 1870, the General Assembly met and listed what was required: school houses, school furniture (a bucket and ladle, broom and brushes, blackboards, wall maps, etc.), school expenses (fuel to make fires), school books for poor children, record books and stationery for the Board of Trustees, pay for district clerks, and expenses for special elections (Annual Report of the Superintendent of Public Instruction 2). On July 11, 1870, an act to establish and maintain a system of public free schools was approved by the United States.

PRINCE EDWARD COUNTY'S SCHOOL SESSIONS

For the 1870-1871 session at Prince Edward, twenty-two schools (eleven for white students and eleven for black students) were dispersed throughout five electoral districts: Buffalo, Hampden, Farmville, Lockett, and Leigh. There were 849 students enrolled (371 [27.4%] whites and 478 [20.5%] blacks) of a school age population of 1,353 white children (659 males and 694 females) and 2,330 black children (1,364 males and 966 females), giving a total of 4,110 (Virginia School Report 184). The cost of tuition per month for each student who was enrolled was $1.29 and the cost of tuition was $1.75 per month per student. Twenty-seven teachers (eighteen white men, eight white women, and one black woman) taught the children in the five districts. Black teachers had a hard time finding jobs as teachers because the white people saw blacks as inferior and because training was expensive and not possible for most blacks. The monthly salary for male teachers, $43.22, was higher than that for female teachers, $33.08.

For the session 1871-1872 in Prince Edward, thirty-five schools opened with thirty-seven teachers and 1,296 students enrolled (638 white and 658 black). During this period the idea of creating graded schools had been spreading in other counties, but it did not reach Prince Edward until the session of 1872-1873. The Farmville Colored school, whose principal was Richard V. Watkins, a white man, was the first graded school in Prince Edward County. The school had three grades along with three teachers and ninety-six students. The average attendance was seventy and the school was taught in a five-month session. The cost of tuition at the colored graded school that was paid by the parents was $0.83 per month per student. The graded schools grouped the students in grades according to how much education they had, instead of grouping all the students together. The graded school let the black students be placed in classes that were set according to the students' levels of education (Bradshaw 491). The accomplishment of getting a graded school showed that the black community had pushed hard to get better conditions for black students. The number of teachers in the schools generally was regulated by the number of grades in the schools (Virginia School Report 188).

In every succeeding school session there was a significant increase in the number of students who enrolled in Prince Edward's schools. In 1874-1875 the school age population between five and twenty-one years for whites was 1,472 and for blacks 3,083, giving a total of 4,555 students; however, 667 (45.3%) white students and 834 (27.1%) black students were enrolled in Prince Edward. Although black students outnumbered white students, black students had fewer schools and fewer facilities. There were thirty-seven schools (twenty-one white and sixteen black) opened in Prince Edward, which ran an average session of six months with thirty-seven teachers (thirty-two white and five black). Although the black students had more students enrolled in Prince Edward schools than whites, blacks still had fewer school buildings. The black students were in crowded conditions because black education was not seen as an important matter for the all-white board. The white school did not have an overcrowding problem or a crucial need for better facilities. There were forty-seven teachers, but only five of them were black (two men and three women). In 1882, five people of the Farmville Colored school signed a petition asking for a black teacher who was as qualified as the white teachers to be employed, but the trustees told them that no qualified black teacher had applied (Bradshaw 491). The employment of black teachers was not a major concern in the county. Since most white people thought education for blacks was not important, whites did not see a need to employ black teachers for black students.

Despite the resistance of whites; by 1890-1891, the number of black teachers had increased dramatically. There were thirty-one black teachers (twelve men and nineteen women) and thirty white teachers (eight men and twenty-two women). The increase in black teachers may have resulted from the fact that more black teachers were being certified by black schools such as Virginia State Normal school. There were a greater number of blacks who applied for positions. There were 2,895 (866 whites and 2,029 blacks) students in sixty-one schools, of which thirty-one were black schools and thirty were white schools (Virginia Reports 1890-91 p.10).

ESTABLISHMENT OF HIGH SCHOOLS

In Virginia the legislature had authorized the establishment of high schools as early as 1875. The first serious attempt to establish high schools was made in 1906, but these schools were mostly for whites (Ryan 21). The Virginia legislature appropriated $50,000 in 1906 to be used in the development of public high schools. In 1906, J.D. Eggleston of Prince Edward was appointed State Superintendent of Public Instruction. Eggleston devised a plan in 1906 to have the state appropriate money for district high schools and to have the localities provide buildings and matching funds to support the new high schools (Bradshaw 494). The school building would contain three classrooms on the first floor and a town hall on the second floor (Bradshaw 494). The principal's salary of $250 would be provided by the Southern Education Board (SEB). On May 1, 1906, a meeting in Rice established a district high school. The people had plans to raise $1000 for the building and $300 each year for the next five years in order to support the high school. By the fall of 1907, all districts in Prince Edward had a high school except for Buffalo.

Whites disliked high schools for blacks because secondary education meant more education than just knowing how to read and write. By 1920, all but three counties in Virginia had high schools. However, there were only sixteen black high schools with a total of 297 black students enrolled. The white students enrolled in high schools totaled 22,061 in 1920 (Link 189). Most black students did not have an opportunity to get a secondary education. Therefore, black students did not get an education equal to white students' education. Most whites believed that blacks did not need further education than what was taught in the elementary school. Whites thought that the blacks should not spend so much time in schools but more time in the fields.

THE BLACK COMMUNITY WANTED SCHOOL FACILITIES IMPROVED

The county school board was established in 1922 when the district school boards were done away with. Within the same year, all the white schools in the Lockett District were consolidated with those in the Rice District. In the next five years, all small white schools in the county were eliminated through consolidation, and six district high schools were built-- Darlington Heights, Farmville, Green Bay, Prospect, Rice, and Worsham (Bradshaw 497). At this point, there were still no black high schools in Prince Edward. Again, blacks were not permitted by whites to go to a high school in order to acquire a higher level of learning, as white students did.

Between the years of 1923 and 1927, all white school children in Prince Edward were

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put in brick buildings with heat and proper ventilation. They also had a safe water supply and transportation by twenty-two school buses if they were not within walking distance. Blacks, on the other hand, had small buildings that allowed cold winds to come through in the winter. Blacks did not have any transportation to carry them to school. Black students had to walk miles in the snow and ice just to get to school during the winter (Allen).

During this period blacks in Prince Edward County were always trying to improve the education system for their children and to push for adequate materials, education, and funds such as the whites had for their schools. On February 5, 1924, at a school board meeting, a committee of three black men from the Farmville area asked for the establishment of an eighth grade in Farmville Colored School and for other improvements, such as remodeling the school building so it would be suitable and sanitary (School Minutes Feb. 5, 1924). The eighth grade was finally approved after many visits from the committee, but not much was said about remodeling except for repairing the roofs of the colored school in the Farmville District. Then on February 3, 1925, a petition asking for a new school building was presented to the board by patrons of the Farmville Colored School. The patrons also asked how much they would be responsible for raising in order for the building to be constructed. An answer was not to be given until a later date (School Minutes Feb. 3, 1925). During this waiting period, on June 11, 1925, a motion was made and carried to adopt a salary scale for black teachers. Those teachers with elementary certificates were paid an additional $50 per month with an increase of $2.50 per month every year for four years. Those teachers' salaries were still well below what white teachers received, a salary of an extra $600 and up (School Minutes June 11,1925). The black committee was constantly trying to improve the black children's educational system because the committee saw how important education was and how many opportunities there were when a person had an education. On June 30, 1925, the vote for a bond issue of $60,000 held in the Farmville District was rejected by eighteen votes (School Minutes July 7, 1925). Some patrons of Farmville Colored School came to the school board on August 5, 1925, to request repairs for the old building so that it could be used the next session. They asked for a room to be used to grade students' work and for larger pipes so that water pressure would be better (School Minutes Aug. 5, 1925).

On April 6, 1926, the school board finally declared the Farmville Colored School totally inadequate--poorly lighted and unsanitary. This was the start of planning for a new black school. The contract to build the Farmville Colored School was given on August 6, 1926, to the Motley Construction Company for $27,743.79 and to W.J. Bloomfield of Blackstone, Virginia, for $2,525 to equip the building with heat. Motley Construction Company asked for eight months to complete the building, but the company said that construction would be complete in six months if possible (School Minutes Apr. 6, 1926). The patrons of the Farmville Colored School had to raise $5,000 toward the new building. At this same time, the Farmville High School for whites was building an auditorium, gymnasium, and office that cost approximately $35,000. The whites did not have to raise any money for their additions to the Farmville High School. The school board spent more money on the white school than on the black school.

The new Farmville Colored school, the building presently known as the Farmville Recreation Center on South Main Street, had a capacity of 400 students and was made out of brick and contained eleven rooms, an auditorium, and a gymnasium (Today & Yesterday... 79). The new Farmville Colored school opened in the fall of 1926. It had 152 black students in the high school, which had only the eighth grade and was on the second floor, and 280 black students in elementary grades on the first floor during the first year. The students who attended the eighth grade came from the surrounding counties, but those in elementary school came only from Farmville. When it opened, the colored school had already exceeded its capacity. In the construction of the Farmville Colored school, the school board once again did not pay close attention to the needs of the black community. Mr. Joseph B. Pervall was principal, along with ten trained teachers who were all college graduates. The school was recognized by the Southern Education Board (SEB) as an institution that maintained the standards for its graduates to proceed in higher education. This school was named R.R. Moton, in honor of Robert Russa Moton.

The construction of a new Farmville Colored school was a great accomplishment, but the black community continued to push the school board for better conditions. For example, on April 12, 1927, three people from the Council of Colored Women (Martha E. Forrester Council of Women), which was established in 1920, requested three things from the school board: 1-they wanted a say in the choice of teachers who would teach in the Farmville Colored school; 2-they wanted to have local people appointed as teachers; and 3-they wanted to have the compulsory attendance law enforced (School Minutes Apr. 12, 1927). Also a committee of blacks from Farmville came to the school board on August 8, 1928, and asked for ninth and tenth grade in the Farmville Colored school for the upcoming session. John Allen, Nathan Miller, and others said that nineteen students were ready for the tenth grade. The school board responded by telling the blacks that there was not enough money available to hire an extra teacher for that year--a cost of around $800 or more. The school board said that if the patrons of the Farmville Colored School could raise the money and place the necessary amount of cash or negotiable paper in the hands of the board by opening day of school, the school board would be happy to employ a teacher in the school and provide a ninth and tenth grade (School Minutes

Aug. 8, 1928). The patrons of the Farmville Colored school as well as the Council of Women did raise the money for the two new grades. This requirement was an example of the injustice at work because the black community not only paid county taxes for education, but also had to pay for these additional grades in the colored school. The white citizens never had to raise money to add grades to the white school.

During this period, black students walked to school--children as young as five years old walked to school while the white children rode on school buses. On February 5, 1935, a delegation from the R.R. Moton School came to the school board asking for transportation and for additional rooms to be added to the already overcrowded school building. The school board told them that the school bus situation would be taken into consideration. On April 2, 1935, a motion was made on the matter of transportation of the black students to the R.R. Moton School, but a decision was delayed until a later date (School Minutes Apr. 2, 1935). Committees from different districts that attended R.R. Moton High School came to the school board many times from 1935 to 1941 and beyond to ask for transportation to the school. Finally on August 6, 1941, the Board agreed to provide second-hand buses to transport students, provided that each pupil pay ten cents per day. It was not until February 24, 1937, however, that the school board actually gave a reason for not starting to prepare for a new R.R. Moton High School. The school board said that there was an emergency at the white Farmville High School. During that same year, on September 1, some blacks from the community appeared before the school board asking about plans to enlarge R.R. Moton School in order to end the overcrowding, but again, "no definite action was taken" (School Minutes Sept. 1, 1937). Then on October 6, 1937, the school board finally attempted to resolve the problem by renting a room for $2.50 per month near the R.R. Moton School so that it could be used as a classroom (School Minutes Oct. 6, 1937).

THE OVERCROWDING SITUATION

The school board began to think more seriously about the overcrowding at R.R. Moton when the motion was made and carried and filed with the State Board of Education in order to get a loan from the Literary Fund for $49,500 to meet the Public Works Administration (P.W.A.) grant of $40,500. The Anna T. Jeanes Fund application was soon made by the school board so the board could get an appropriation of $4,000 toward the construction of the colored high school (School Minutes Aug. 12, 1938). By this time, the school board paid more attention to the construction of a new high school. On September 8, 1938, the school board authorized the purchase of additional land for the R.R. Moton high school. And within the same month, the school board hired the Farmville Manufacturing Company to construct the new building for $36,952 (School Minutes Sept. 8, 1938).

Moton High School was built in 1939 at the intersection of South Main Street and Griffin Boulevard in Farmville. The school had ten rooms and a 180 student capacity. One hundred and sixty-seven students were ready to attend the school when it first opened. The Moton High School was the first separate school for black high school students in Prince Edward County. As the years went by, especially in the 1940's, enrollment in black high schools grew very rapidly; in 1940, in Prince Edward there were 219 black high school students; by 1950 there were 477, all of whom still attended the 180-student-capacity Moton High School. This growth was a major concern for the black community because to the blacks, it seemed that the county did not plan for adequate education for black students. In the early 1940s, parents of the Moton students formed a Parent-Teachers Association in order to stop the overcrowding. On June 28, 1945, Superintendent T.J. McIlwaine reported to the school board that the R.R. Moton combined Elementary and High School building (presently the Recreation Center) was "inadequate to accommodate" students; he suggested that four rooms be added to the high school (School Minutes June 28, 1945). After many ideas had been discussed, finally in May of 1947, the school board got a $50,000 appropriation from the State Board of Education to build yet another new R.R. Moton High School.

On June 3, 1948, a plan to construct temporary buildings to stop the overcrowding in Moton was created by T.J. McIlwaine, Superintendent of Schools. Maurice Large then asked the Board of Supervisors about the idea, and the Board of Supervisors told the school board not to spend more than $25,000 in relieving the congestion. This amount was just enough money to build three tar paper shacks in 1948-1949 which helped with the overcrowding problem, but not with the black children's or black community's self-esteem. A three-man committee was appointed to find a place to put a new Moton High School (Smith 18).

The Moton PTA saw that the three-man committee was going to get little done, so the black community asked the school board if black people could help look for a site for the new Moton High School. The school board accepted the Moton PTA's offer. Soon the committee told the school board about fifteen acres of land about three miles south of Farmville on Route 15 which could be bought for $8,000. The school board was astonished by the quick report on the site from the PTA. The board was also amazed that the PTA was willing to have a school away from town, but the PTA and the black community desperately wanted a new Moton High School (Smith 22).

The construction of the new Moton High School would cost $800,000. The local bond issue would have to be about three-quarters of a million dollars (Smith 25). One reason for spending so much money on the black school may have been that the school board of Prince Edward County was trying to inhibit the possibility of a future lawsuit by the blacks about unequal facilities. During this period, other public school lawsuits elsewhere in Virginia were about to begin. The NAACP was ready to file suit to desegregate Pulaski County High School and others.

The conditions at the Moton High School were getting even worse as the planning for a new school progressed. A sixteen- year-old girl, Barbara Johns, was one of the Moton students who grew tired of having to learn in the grim conditions of the school, so she decided to do something about the conditions. Barbara Johns and some other students began to meet about the condition of the school and to discuss what they could do to make people listen. Barbara Johns knew that the only way people would listen to them was if they took action, and quickly.

In April of 1951, the students of Moton High School walked out of the school and did not return for two weeks. They were led by Barbara Johns. The NAACP attorneys, Oliver W. Hill and Spotswood Robinson III, were asked to represent the students in court about the conditions and desegregation of the school. The NAACP took the case to the Supreme Court where it became one of the five court cases to make up *Brown v. Board of Education of Topeka.* During this time, the new R.R. Moton High school was built and occupied on September 8, 1953.

On May 17, 1954, the Supreme Court decided that segregation in the public schools was unconstitutional and that the schools should be desegregated. After the decree, the black community rejoiced, but the white community was very upset with the idea that their children would have to be educated with black children. So a private school group appealed the Court's decision and on July 18, 1955, the three-judge federal court ruled that Prince Edward County did not have to desegregate its schools for the 1955-1956 school year but must desegregate at a future date (Smith 125). In return, NAACP lawyers filed motion for the schools to be desegregated right away. After the back-and-forth battle, on June 2, 1959, the U.S. Fourth Circuit Court of Appeals ordered that Prince Edward schools be immediately desegregated (Smith 151). At this point the Prince Edward school board announced on June 3 that the supervisors would not let the school board appropriate any money for the public schools, a decision which meant that the public schools would close. This announcement also meant the black children would have no school to go back to. For the white children, a private school was going to open. On September 14, 1959, Prince Edward Academy opened for white students. Black students had no school to attend in Prince Edward.Black children were without schooling for five years in Prince Edward County. Some black children left to live with family in the North in order to get an education, while others stayed in Prince Edward and just got jobs. In September 1961, the NAACP asked the State Supreme Court of Appeals to force the Board of Supervisors to appropriate money for the schools. It was not until the year 1964 when the Supreme court ruled that Prince Edward must reopen its schools, after nearly 1,600 Negro students had been denied education since 1959.

WORKS CITED

Allen, Vera. Personal Interview. 30 May 1996 & 16 August 1996.

Bradshaw, Herbert. History of Prince Edward County, Virginia. The Dietz Press, Incorporated, 1955.

Brawley, Benjamin. Dr. Dillard of the Jeanes Fund. Fleming H. Revell Company, NY,1930: 54-66.

Maddox, William. The Free School Idea in Virginia Before the Civil War. Teachers College, Columbia University, New York City, 1918.

Prince Edward County School Minutes. Prince Edward County, VA. 11 Jan. 1871- 30 Aug. 1963.

Rochelle, Belinda. Witnesses To Freedom. Lodestar Books, NY, 1993: 1-9,17.

Ryan, W. Carson. Secondary Education in the South. The University of North Carolina Press, 1986.

Smith, Bob. They Closed Their Schools. The University of North Carolina Press, Chapel Hill, 1965.

Today and Yesterday in the Heart of Virginia. The Farmville Herald, Farmville, Virginia, 1935.

Virginia School Report 1871-1st Annual Report of the Superintendent of Public Instruction . Richmond: C.A. Schaffter, Superintendent at Public Printing, 1871.

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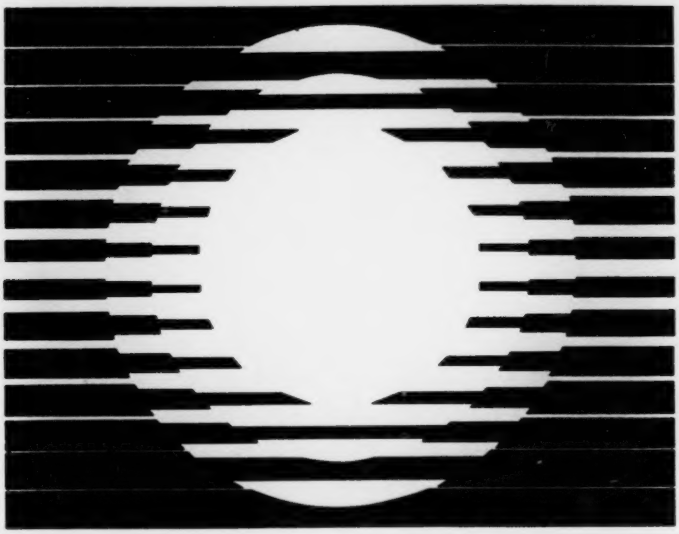

PROCEEDINGS

ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

Robert D. Yearout
Editor

Volume II

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THE UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE

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PROCEEDINGS
ELEVENTH
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VOLUME II

THE UNIVERSITY OF NORTH CAROLINA at ASHEVILLE
JULY, 1997

Foreword for the
Proceedings of the Eleventh National Conference on Undergraduate Research

University of North Carolina at Asheville
April 24-26, 1997

The University of Texas at Austin was pleased to host the 1997 National Conference on Undergraduate Research, affirming its commitment to excellence in undergraduate education and to the research experience in particular. Over 2100 students and faculty attended some 1500+ oral, poster and performing or visual arts presentations scheduled over April 24-26. A special feature of NCUR '97 was a series of more than 30 presentations by faculty members from all disciplines demonstrating the integration of research and teaching with the new technologies. These presentations were capped by a performance on Saturday night of "Ears and Feet," a concert of new interdisciplinary work by student and faculty composers, choreographers, dancers and performers from the UT College of Fine Arts. Electro-acoustic music and modern dance explored interactivity of disciplines and technologies by allowing dancers' movements to control electronic music and robotic lighting by way of a touch-sensitive computer dance floor.

President Robert M. Berdahl opened the conference quoting a Chinese proverb: "I hear and I forget. I see and I remember. I do and I understand." Berdahl praised the research experience as the most practical and potent method to provide students the perspective of inquiry, innovation and exploration as they prepare "for a future that is not so much known to be uncertain, but instead, certainly unknown." That facts and methodologies become obsolete in a world in which developments and advances occur with dizzying rapidity points to the importance of incorporating research activity into the undergraduate experience.

Dr. Berdahl also praised the student-faculty relationships that are fostered by the research process, congratulating the faculty mentor for serving the educational needs of the talented and motivated students by participating in the adventure of exploration and discovery, of cooperation and collaboration which characterize academic life.

Five distinguished plenary speakers addressed conference participants throughout the three days. Dr. Steven Weinberg, Nobel laureate in physics and professor at the University of Texas at Austin, challenged listeners to consider the future of science by posing the questions "The End of Science?". Dr. Robert Williams, Director of the Space Telescope Science Institute, dazzled the audience with the most recent images from the Hubble Space Telescope. From the vastness of space to the minute complexity of genetic research, Dr. Steven McKnight of the UT Southwestern Medical Center at Dallas introduced conference participants to the fascinating work being done in gene regulation and cell differentiation. Friday night's fete "Texas Culture Swing" featured, in addition to an outstanding sampler of culinary and musical styles of the Lone Star state, a mini-plenary address on the multifaceted aspect of Texas border cultures by Dr. Rolando Hinojosa-Smith, distinguished author and professor of Creative Writing. NCUR 97 closed with a resounding standing ovation upon conclusion of "The Challenge of Leadership" by Sarah Weddington, J.D., former Texas legislator and White House assistant, now author, lecturer and adjunct professor.

The University of Texas at Austin is proud of the privilege to share our campus for these few days with the distinguished group of students and faculty whose work is presented here in published form. We congratulate you for your accomplishments and encourage you to continue to participate in the challenge of research.

Susan Wells Howard, Chair, NCUR '97

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PREFACE

The 407 papers published in these five volumes are representative of the approximately 1825 papers and posters presented at the celebration of undergraduate research that was NCUR '97'. The faculty, staff and students of the University of Texas at Austin are to be commended for making NCUR '97' such an enriching experience. The student authors deserve recognition for their hard work and for their persistence in seeing their research through to its final publication.

Special thanks are extended to Dr. Susan Howard, Ms. Kelly Johnson and other members of the NCUR '97' staff. Their help during the days of the Conference was invaluable. Many thanks also to the members of the National Board, who reviewed a large number of papers submitted to the Proceedings under time constraints. Their continued efforts to standardize has raised the Proceedings quality. This project would have not been successful without their assistance.

I would also like to thank the UNCA Editorial Board, who put in many long hours reviewing, checking and organizing papers, and Tracy Walker, and Adam Bradley, who did all the cutting and pasting necessary for these volumes. I owe a special debt of gratitude to Katherine Whatley, Tracy Walker and Mila Cleverdon for their support, encouragement, and mentorship during the entire process of organizing the Proceedings.

To all the students who submitted papers to the Proceedings go thanks for their participation and congratulations for their achievements. Your enthusiasm and achievement will serve as role models for the next group of student researchers - whom we look forward to meeting at the Twelfth National Conference on Undergraduate Research at Salisbury State University, Salisbury Maryland.

Robert D. Yearout
UNC at Asheville
1 July, 1997

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PROCEEDINGS OF THE ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

CONTENTS

VOLUME I

FOREWORD iii

PREFACE iv

ARTS AND HUMANITIES

Collaborative Art: A Movement in the Twentieth Century 1
Kristen Jo Kerr (Jane-Allen Mckinney)

Nature and the Natural in the Paintings and Prints of Helen Frankenthaler 6
Danielle G. MacCartney (Debora Rindge)

A Comparison of Frank Lloyd Wright and Michael Graves: Furniture Influenced by Architecture 9
Nieya C. Wallace (Jane-Allen McKinney)

Art Education: Art is Underrated as an Instrument for Teaching Essential Learning and Cognition Skills 14
Jennimarie L. Ward (Jane-Allen McKinney)

Toontown: The Disney Tradition Continues 18
Jennifer Lugg (Dianne S. Macleod)

Political Ideologies of Harlaxton Gardens, Harlaxton, Lincolnshire, England 23
Nicole L. Stutzman (Shirley Schwarz)

Reminders of Death and Lessons for Life: Vanitas and Memento Mori Paintings of the Spanish Golden Age (1556-1700) 27
Wendy Singer (Susan V. Webster)

Visualizing the Human Form: Art and Anatomy in Eighteenth-Century England 31
Erin M. Loos (Philip Wilson)

The American Canon: Great Male Playwrights and Their Female Characters 34
Michelle McGovern (Mark Pizzato)

Henry Purcell's Dido and Aeneas: A 1689 Composition Endures Controversy 39
Stacy M. Dieckman (Patricia Kazarow)

Determining the Authorship of the Toccata and Fugue in D Minor, BWV 565 44
Aaron Juhl (Patricia Kazarow)

Plains Attire: The Individual Expression of Culture, the Cultural Expression of Identity 48
Sherri A. Mainord (Anne Guernsey Allen)

Victim vs. Participant: A Comparison of Dmitri Shostakovich's Lady MacBeth of Mtsensk and Katerina Ismailova 53
Heather Miller (Charles McKnight)

New Possibilities in Composition Through Computer Technology 56
Christopher Watts (Daniel Koppelman)

The Conception of "Poet" in the Work of Bei Dao 61
Jennifer L. Berry (Martin Backstrom)

Bei Dao's Poet 66
Jennifer L. Berry (Martin Backstrom)

"There Is No Loneliness Like Theirs": James Wright's "A Blessing" and C.K. Williams' "On Learning of a Friend's Illness" Examined 71
Kirsten C. Bender (William Aarnes)

Embrace of Dionysus The Presence of African Art In D.H. Lawrence's Women in Love 76
Kristin A. Frey (Eric Chandler)

A Poststructural Analysis of Richard Wright's "Big Black Good Man" 80
James S. Guignard Jr. (Jill Sessoms)

William Shakespeare's Othello: The Moor of Venice A Case Study in the Thermodynamics of Evil 85
Roger A. Harris (Linda K. Barlow)

Wilde's Christ: Exemplifying Aesthetic Morality 89
Elizabeth M. Hendershot (Daniel Born)

Pearl's Scarlet Soul: The Influence of Spenser's Una on Hawthorne's Ideal Vision of Daughters 93
Tracy Ann Kennedy (John C. Bean)

Agrarianism in the American South: From the Vanderbilt Agrarians to Wendell Berry, A Shift from Regional Myth to Practicable Ideal 98
Robin Kidd (John Cawelti and David Hamilton)

Margaret Fuller's Women in the Nineteenth Century: An Appeal for the Inclusive Self 103
Jeanne Kolker (Sara McAplin)

The Paradox of the Crucifixion Allegory in Ben Franklin's "The Kite Experiment" 107
Sandra Argroves Watson (Steven L. Hamelman)

The Doorway to Wildness: Four Poems by Muriel Rukeyser and Adrienne Rich 112
Trace V. Wilson (Richard Chess, Michael Gillum, and Jeff Rackham)

The Relationship Between Cognitive Growth, Journal Writing, and the Development of Critical Thinking 117
Lynn Herink and Anna Long (Larry Nichols)

Images of Health in Health Magazines 122
Travis Bebout (Sarina Chen)

Blissfully Rude: The Diatribe of ACT-UP 127
Mark S. Buchanan (Suzanne E. Lindsey)

Eyewitness vs. Pseudo Reality: A Comparative Analysis of Student's Accounts and the Media Reports of a University Disturbance 132
Ben L. Daniels (Sarina Chen)

Light in the Crevice Never Seen: The Indigenous Voice and the Rhetoric of Resistance Literature 137
Blayne M. Higa (Catherine A. Collins)

Marketer's Use of Semiotics and Symbolic Representation of Children's Packaging 142
Reagan Turok and Heidi Redeker (Lois Smith)

Same-Sex Marriage Politics: The Politicizing of Sexual Orientation 147
Kari Wagener (Phillip Voight)

"Do As Little As Possible" The Transformation of Film Noir's Myths in Chinatown 151
Karen Demski (Chris Hassold)

BEST COPY AVAILABLE

Outside Looking In: Sacred Space of Taos Pueblo 157
Brenda L. Hanson (Anne E. Allen)

Directed By and Starring Cindy: Sherman's Performance Photography 161
Jennifer Lemmer (Cris Hassold)

Reinterpreting Roman Morality 166
Ryan Pesch (Marleen Flory)

Edna St. Vincent Millay: A Feminine Perception of Love 170
Mandy C. Carlson (Lysbeth Em Benkert and Jay Ruud)

The Romantic Paganism of Niccolo Ugo Foscolo: Infancy, Greece, Venus, Exile, Pain, and Death in the Foscolian Artistic Sensibility 174
Mark Anthony Espinosa (Andrea Baldi)

Subject Pronoun Usage in Mexican Spanish in South Texas 179
Javier M. Morin and Carla Chapa (Sandra Baumel-Schreffler)

I, Tituba, Symbol of the Antilles 183
Debbie Officer (Margarite Fernandez-Olmos)

A Profound Cultural Exchange: The Mexican Muralist Movement and the Harlem Renaissance and its Modernist Descendants 187
Alice Psirakis (Raysa Amador)

The Issue of Status in Puerto Rico: Internal Strife in the Search for Status 192
Mandy Robinson (Paul Simon and Maria Dolores Goddard)

Multinational vs. Global Organizations: A Case Study of the Corporate Culture of IKEA 197
Katherine J. Ross and Saturnia Alcala (Peter Hackbert)

The Creation of Christianity: Exploring the Role of Women in the Development of the Ancient Church 202
Jennifer L. Borden and Kevin S. Minoli (John R. Lanci)

For Better or For Worse: The Case For Gay Marriage 205
Kathrine Ehrlich (Laura Purdy)

The Mother-Daughter Relationship of Harriet Taylor Mill and Helen Taylor 210
Amy M. Kuhl (Jo Ellen Jacobs)

Pragmatic Faith in John Dewey and Fyodor Dostoevsky 215
William D. McCracken (Stuart E. Rosenbaum)

Epistemological Conditions: How Plato Anticipates Gettier 220
Andrew T. Cronan (A.M. Weisberger)

Adversity and Sacrifices: The Examination of Two Lives 224
Patience Adibe (Harriette Pipes McAdoo)

The Acquisition of Knowledge According to the Theory of Jean Piaget 229
Donna M. Cain (Ralph Carlson, Dalinda Rodriguez, Raymond Welch, and Keith Turner)

A Descriptive Survey of the Three Contemporary Approaches to Fluency Disorders 234
Peter Golleck (Raymond Welch, Barbara Johnson , Teri Mata-Pistokache, Timothy Meline, and Keri Parchman-Gonzalex)

Cosmos and Chaos: An Analysis of Themes and Issues in Doris Lessing's The Fifth Child 238
Anna C. Long (Hamida Bosmajian)

Toni Morrison's Sula: The Pharmakos of Her Community 243
Joseph Van Mieghem (Hamida Bosmajian)

The Search for Innocence in the Art of Jean Cocteau 249
Erin Nicole Parisi (Alexandra Wettlaufer and Jonathan Bober)

Preferences of Positive Reinforcers Among Elementary Students 253
Kelly Schutte (Lian-Hwang Chiu)

Implementation of Civil Rights Policy in Education 257
Autumn Stewart (Carter A. Wilson)

Jewish Resistance to the Nazi Occupation of Lithuania and Belarus during World War II 260
Phillip C. Alloy (L. Wilcox)

Peddling Public Assistance: The Children's Bureau and the Aid to Dependent Children Program in the Social Security Act of 1935 263
Katherine E. Anselmo (Helen Wheatley)

A Case Study of the Tax Reform Initiative by Marylanders 268
Juanita Maria Banks (Abdul Karim Bangura)

Famous and Forgotten: The Life and Death of the Dubuque Dial, 1934-1935. 272
Katherine Dietrich (Michael Anderson)

The Stonor Letters and the Wars of the Roses: Violence and Politics in Fifteenth-Century England 276
Michelle Dowd (Richard Kaeuper)

Thomas Becket and King Henry II A Medieval Drama with a Contemporary Application 281
Lorie Fratz (George Sochan)

The Mushroom of Feeling: American Public Reaction to the Atomic Bomb, 1945. 285
Jason C. Gaskill (Larry Lipin)

Henry Laurens: The Making of a Revolutionary 289
James Hutchinson (Bruce Greenawalt)

Beyond the Imperialist V Anti-Imperialist Dichotomy: American Intellectuals and Fin De Siecle Expansionism 294
Robert James Kijewski, Jr. (David Worbel)

"Being Madame is a Miserable Job" The Letters of Liselotte von der Pfalz, 1672-1722 299
Christie King (Caroline Castiglione)

Fencing out the Foreigner: Influences on the Eighteenth Legislature of Wyoming and its Exclusion of Foreign Physicians 304
Susan Macki (Eric Kolher)

A Woman's Place: Female Tavern and Inn Keepers in Early Pennsylvania 310
Sarah E. Morgan (Larry Eldridge)

The Debates and Arguments Leading to the Passage of the Seventeenth Amendment 314
Tara M.E. Yencha (Deborah A. Rosen)

Jane Addams: Women-Based Political Actor as Role Model 320
Oona Besman (Susan Harrison)

Lesbian Perspectives on Love, Sex and Relationships: Adult vs. Youth 325
Angelica Victoria Hernandez (Mary L. Alpaugh)

Women's Body Image: Effects of Media Imagery and Anorexia Nervosa 330
Grace Lager (Susan Harrison)

Testing the Effects of Sample Composition and Context on Radiocarbon Dating from Mammoth Cave, Kentucky 335
Sarah McCloskey (Kenneth B. Tankersley)

BEST COPY AVAILABLE

Three-Dimensional Mapping of the Bluff Greathouse Archaeological Site 339
Natasha Psenicka (Lawrence B. Conyers)

Scholarly Sightseeing in Rome, Ravenna, and North Africa: The Differences in Early Christian Centrally Planned Vaulted Structures 344
Benjamin D. deLee (Christine Colley)

Self-Perceptions and Representations of Hawaiian Identity, Ke Kanaka and Ke Kane Ikaika 349
Cheryl Nohealani Olivieri (Margarite Fernandez-Olmos)

Mexican Catholicism: The Syncretic Result of the Spanish and Indigenous Religions in Contemporary Mexico 352
Helena E. Colyandro (Susan Deans-Smith)

Rocky Road: The Long Journey to Educational Freedom in Prince Edward County 357
Randy A. Jones (George Bagby and Lowell Frye)

VOLUME II

SOCIAL SCIENCES

Preclassic Maya Pottery From Colha, Belize 362
Sharon Hankins (Fred Valdez, Jr.)

Deciphering the Secrets of Skeletal Remains from Hellenistic Abdera, Greece 367
Thomas P. Bolioli and Tara M. Kirkpatrick (Anagnosti P. Agelarakis)

Japanese Unknown Women Under the Japan's Alliance Capitalism: The Complementarity of the Pre-Existing Structures and the Changing in Identity 373
Yumi Kobayashi (Jeffrey Broadbent)

Window Into the Past: Diachronic Aspects of Three Ancient Human Skeletal Populations from the Khao Wong Prachan Valley in Central Thailand 377
Anna Konstantatos (Anagnosti P. Agelarakis)

Whole Vessels from Kichpanha, Belize: Implications of Increasing Social Complexity 382
David A. McDow (Fred Valdez, Jr.)

Form and Function of Late Preclassic Maya Pottery 387
Angela Milliman (Fred Valdez, Jr.)

Southern Plains Powwow Culture: Exploring the Identity of the Drum 392
Cindy Stout (Sue Tuohy)

The Sexual Oppression of Women in South Korea 397
Tuesday M. Tamburri (Leslie Miller-Bernal)

Evaluation of a Summer Orientation Course for New College Students: Critical Reading and Reasoning 403
Hernan E. Diaz (Sharon L. Pugh)

The Association of Peer Acceptance and Social Behavior in Early Childhood 406
T. Gayle McLemore (Leslie Phillipsen)

The History of the Civil Rights Movement in Prince Edward County, VA (1951-1964) 411
Steven L. Turner (Susan H. Bagby)

Qualitative Research on the Teaching Methodology of Genetics 348: A Hands on Approach 416
Tia Fluegge (Sandra Tutwiler and Presley Martin)

Spatial Distribution and Socio-Economic Profile of Asian Indians 421
Aaron Otto (Jayati Ghosh)

Intra-Asian Direct Investment and Indian Economic Liberalization 426
Susanne Peters (Jayati Ghosh)

The Spatial Distribution of the Hispanic Population in the United States: An Analysis at Various Geographic Scales 431
Stephanie M. Sheetz (Robert Douglas)

A Quantitative Study of Communication Apprehension and Self-Esteem 436
Mattie Marie Butler (Abdul Karim Bangura)

Attraction Factors Involved in Internet Relationships 441
Karen Chain, Christopher Gill, and Dawn Kujawski (Dean Thomlison)

Wartime Benevolence: A Portrait of Northern Philanthropy During the Civil War 446
Kevin Davis (Bruce S. Greenawalt)

Media and the Construction of Identity: Young Women's use of "Friends" 451
Kristi L. Eaves (David B. McLennan)

BEST COPY AVAILABLE

Dress and Nonverbal Communications 456
Barbara Heinemann (Joanne B. Eicher)

Confronting Learning Disabilities: A Proactive Approach for Parents 461
Holly Kapp (George Sochan)

Public Perceptions of Television Versus Newspaper Credibility: A Local Study 465
Andrea Lawson (Mark D. West)

The Evidentiary Impact of the Likelihood Ration and Assessment of Diagnosticity 470
Nir Liberboim (Jonathan Jay Koehler)

Solitary Confinement: A Study of Prisoners' Access to the News Media 475
Michael O'Sullivan (Ann Marie Major)

The Conveyance of Socioemotional Cues in Computer-Mediated Communication: A Content Analysis of Internet Relay Chat 480
Kimberly K. Schaefer (Denise Bostdorff)

You Eat What You Are: An Investigation of Key Environmental Variables on Food Choice 485
Laurel Y. Shanaman (James Brancato)

The Nurse-Patient Continuum: A Nursing Model 489
Jackie Boak, Elizabeth Dickerson, Melissa Jackson, Teri O'Quinn, and Cathleen Fabiani (Margaret Erickson)

Assessing the Effects of HIV/AIDS Peer Education on High School and College Freshmen 493
Cara Catalino, Erin Clune, Megan Gordon, and Marie Neilan (Patricia A. Bailey and Donna R. Carpenter)

Relationships of Self-Perception of Balance, Technological Measures of Balance, and Fall Events Among Individuals with Parkinson's Disease 496
Kativa L. Leal (Nancy E. Dayhoff)

Depression: Prevalence, Causes, Manifestations, and Repercussions Associated with Elderly Disability 501
Nicole Lovell (Clyde B. Killian)

Medical Costs and Correlates of Gunshot Wounds in Travis County, 1995 506
Jennifer L. Moren (L. Michelle Issel)

Family Caregivers' Perceptions of Pallidotomy Surgery: Expectations, Satisfaction, and Health Dysfunction 511
Polly K. O'Brien (Jane Backer)

Living on the Health Care Drawing Board: An Analysis of the Availability of Health Care to Low-Income Families in Los Angeles 515
William Ortiz (Leslie Howard and Cheryl Swift)

Fathers, Food, and Fun: A Nutrition Education Program for Low-Income Urban Fathers and their Children 520
Donald C. Sweet, Lisa Gemlo, and Jennifer Ruffing (Debra Palmer Keenan)

Accounting for the Effects of Hurricane Hugo 523
Tulani Giscombe (Mary Jones Phillips)

Changes in Smokeless Tabacco Utilization Patters Among School-Aged Children 526
Mark A. Robinson (Don Lisnerski, Bob Yearout, and Cheryl McClary)

Detecting Hidden Periodicities in Business Cycles of Fifteen Countries Using Fourier Analysis 530
Peter Hlavaty (Edward Gamber and James DeVault)

Effects of Foster Care on Perceptions of Family and Family Functioning 534
Judy Meyer (Beverly Curry)

Retailer Country Bias Cues: An Experimental Approach 538
Erin C. Miller (Sherry L. Lotz)

Matching Cultural Value Orientations to Ad Appeals: Exploring the Role of Individualism-Collectivism in the USA Versus Mexico 543
Michael Mosley (James M. Munch and Gary D. Gregory)

Vertical Integration and Profitability 548
Cecelia Ruth Buchanan (Stephen Schmidt)

NAFTA and Jobs in the United States 553
Kristina Carrico (Rutilio Martinez)

Gender Differences in Investment Expectations 558
Teresa D. Harrison (Rosemary T. Cunningham)

Do Dollars Make a Difference? The Relationship Between Expenditures and Test Scores in Pennsylvania's Public Schools 563
Jonathan M. Klick (Charles Zech)

The Income Distribution Effects of IMF Balance of Payments Stabilization Tools: A Case Study of Monterrey, Mexico 569
Charlotte Opal (Perry Patterson, Michael Lawlor, and Dan Hammond)

Tests of the Induced Innovation Hypothesis in Indian Agriculture 574
Anthony Walsh (Kailash Khandke)

A Qualitative Study of the 1994 Voter Turnout in Prince George's County Executive Election 579
Kirk A. Gordon (Abdul Karim Bangura)

A Test of the Efficacy of the University of Maryland College Park Affirmative Action Program 584
Shamica Monique Jackson (Abdul Karim Bangura)

From Critique to Consensus: Stephen White's Pursuit of a Postmodern Politics 589
Ingrid A. Jendrzejewski (David Gugin)

A Quantitative Study of the High School Attrition in Prince George's County, Maryland 594
Dorothy Lyons-Wilson (Abdul Karim Bangura)

Race in the Balance: Case Study of Escambia Treating Company 599
LaRuby May (Carolyn Johnston)

Aid in Transition: Explaining Post Cold-War Trends in House Foreign Aid Voting 604
Scott R. Meinke (John R. Baker)

A Quantitative Study of the Essence of Federalism: Who Does it Benefit: 609
Kim Odoms (Abdul Karim Bangura)

The Concepts of Community and Individualism in Twentieth-Century Presidential Nomination Acceptance Speeches and Inaugural Addresses 614
Stephen V. Potenza (James E. Underwood)

A Comparative Study of the Levels of Political Socialization of Children in Two New Hampshire Towns 619
Kathleen M. Ridolfo (Clark Hubbard)

A Qualitative Study of Minority-Majority African-American Congressional Districts and African-American Representation in Congress 623
Marvin M. Silver (Abdul Karim Bangura)

A Quantitative Study of the Longevity of Vietnam-Era Disabled Veterans 628
Joseph L. Singleton, Jr (Abdul Karim Bangura)

BEST COPY AVAILABLE

The 1996 Albanian Elections: Corruption? Or a Catalyst for Democracy? 632
Christopher Thomas Johnson (Karen Vogel)

The Role of the International Law of the Non-Navigational Uses in International Watercourses in Resolving the Disputes Over Access to Freshwater in the Middle East 637
Jason Woolwine (Gary Prevost)

Trends in the Eisenhower Administration: A study of Inflation, Unemployment, and Presidential Popularity 642
Shadya Y. Yazback (James Lindeen)

Strategizing Advocacy: Theoretical Frameworks in Grass Roots Social Organization 646
Tamie M. Aceves (Manuel Carlos)

Peering into the Success of Peer Feedback: Understanding how Feedback Works in Elementary-Aged Writers 651
Laura Angyal (Matthew Olson)

The Impact of Acculturation Type, Stress, and Social Support Among Mexican-American Adolescents 655
Elsa C. Arroyos (Enedina Garcia-Vazquez)

Physiological Responses to Racist Stressors Among African-American College Students 660
Jamar Barnes, John A. Oliver, and Foye Smith (Vernessa R. Clark)

Gender Differences in Perceptions of Martial Infidelity: Sexual Versus Emotional Cheating 664
Anne-Marie Bartos and Allison D'Auteuil (Ralph J. McKenna)

Childhood and Adolescent Abuse, Fear of Negative Evaluation, and Social Interaction Self Statements: A Correlational Analysis 670
Patti Beth (Barbara Beaver)

Coping Strategies Among African-American and Caucasian Female College Students 675
Ayannah A. Brower, Afiya Ricks, and Foye A. Smith (Vernessa R. Clark)

The Effects of the Administration of Methysergide and Ritanserin, Two Serotonin Antagonists, on the Behavioral Repertoire of Zebra Finches (Taeniopygia guttata) 679
Megan B. Bruther (Wendy L. Hill)

Context and Quality of Social Interaction of Children with Severe Language Delays in a Full Inclusion Preschool Program 684
Amy Buchanan and Krista DeZerega (Lawrence V. Harper and Karen McCluskey)

Characteristics Associated with Premature Drop Out in Client-Centered Play Therapy 689
Valerie A. Campbell, and David B. Baker (Sue Bratton and Jennifer Cleveland)

Helping Behavior Rates and Demographics: A Comparative Analysis 694
Jennifer D. Carlson-Weiberg (Nancy Steblay)

Parents' Marital Status, Father-Daughter Intimacy and Young Adult Females' Dating Relationships 698
Kristen J. Clark (Korrel Kanoy)

Investigating Physiological Responses to Sexual Harassment 703
Shaunta K. Clark, Carina De Fazio, Jamar D. Barnes, and Foye A. Smith (Vernessa R. Clark)

Peace Builders Case Study: Combating Violence Through the Exercise of Positive Choices in an Elementary School in California 707
Charlotte M. Contreras (Manual Carlos)

The Psychobiological Effects of Narcolepsy: Its Causes and Treatments 711
Sara Cronin (Charles Kutscher)

Racial Similarity, Cost to Helper, and Sex as Determinants of Helping Behavior 717
Heather A. Dooner and Margaret M. Blake (Patricia Oswald)

Sex Role Type and Effectiveness of Women Speakers at a Religious Presentation 722
Catherine E. Dundas (Lynn New)

Alpha-Ganzfeld: An Experimental Study on Alpha Rhythms Under the Ganzfeld Condition 727
Darin Dutcher and Joshua Johnson (Dorothee Dietrich and Matt Olson)

The Relationship Between the Extent to Which Adolescents are Taught Not to Trust Strangers During Childhood and Interpersonal Skills 732
Laurie Harrier (Francis Terrell)

The Relationships Among Eating Attitudes, Loneliness, and Self-Monitoring 737
Patricia L. Hart (Cynthia Crown)

Readability of Websites with Various Foreground/Background Color Combinations, Font Types and Word Styles 742
Alyson L. Hill (Lauren F.V. Scharff)

The Relationship Between the Protestant and Catholic Religions and Guilt 747
Caramin C. Johnson (Emily Hause)

Locus of Control and Superstitious Behavior: A Visit to the Putting Green 751
Mark W. Jones (Ralph J. McKenna)

Effects of Long-Term Ad Lib. Feeding on the Weight and Health of Differentially-Reared Laboratory Rats 756
Gary L. Lawrence & Kimberly M. Murrell (Karen E. Brakke & Jeanne M. Stahl)

Drug State Dependent Performance of Rats on a Hampton Court Maze 761
Shawana N. Lewis and Gary L. Lawrence (Karen E. Brakke and Jeanne M. Stahl)

Child Abandonment in St. Petersburg, Russia: Effect of Early Intervention 766
Natalya M. Lvoff (H. Banis)

Parent and Adolescent Relationships as Predictors of Post Divorce Functioning 770
Marisa Manzi, Joan Garten (Michelle Wierson)

Doing Field Research in an Electronic Environment 775
Tracee S. Matlock (Manuel Carlos)

Irrelevant Speech Eliminates the Word-Length Effect 779
Rebecca Mazzorana (Ian Neath and Aimee Surprenant)

Activational Effects of Testosterone On Sound-Guided Spatial Navigation 782
Eric J. Moseley (Mark C. Zrull)

Effects of Employment on College Students' Academic Performance and School Involvement 787
Laura A. Schwarber (Cynthia L. Crown)

Gender Differences In Coping Strategies and Cardiovascular Responses to Stress 791
Eric Shaw and Foye Smith (Vernessa R. Clark)

An Extension of the "Two-Baskets' Theory of Self-Cognitions to Native Americans 794
Mandy D. Smith (David Trafimow)

The Relationship Between Self-Esteem and Extraversion 797
Wendy S. Peterson (Cynthia Crown)

BEST COPY AVAILABLE

Chicano Gangs in California: Analytical Analysis of the Structure and Dynamics of Chicano Gangs from Street Corner to Prison Cell 801
Brenda J. Pobre (Ruben Mendoza and Manuel Carlos)

The Relationship Between Parents' and Adolescents' Values 807
Heather Reynolds, Corinne Auman, Ilona Teleki, and Laura Batz (Maureen Vandermass-Peeler)

Attitudes of College Students Toward Using Animals in Research 813
Katina V. Robinson and Lisa Harris (Karen E. Brakke and Jeanne M. Stahl)

Transitive Inference in Undergraduate College Students 818
Rhea Watson (Julianna Lancaster and John Batson)

Conflicts of Interest in the Early Stages of Intimate Relationships 822
Susan Russell (Renate Klein)

Social Adjustment of Children and Adolescents with Juvenile Rheumatoid Arthritis: Parent Report 826
Stacie M. Arthur (Robert B. Noll)

The Relationship Between Nicotine and Alcohol Dependence: Treatment Implications: 831
Meenakshi Garg (Barbara J. Mason)

Social Isolation of Nursing Home Residents and Their Perceived Health 833
Jennnifer Langford (Jerry Pankhurst)

The Effects of Minority Influence on Group Polarization 838
Kelly Murphy (Jennifer J. Dose and Jeff Ratliff-Crain)

Scottish Soccer Violence and Religion 843
Megan O'Neill (Len Berkey)

A Content Analysis of Children's Television Commercials 848
Rachel D. Sgaglio (Michelle E. Barton)

A Critical Analysis of Current State Responses to the Problem of Child Maltreatment 852
Elise L. Siddell, Eileen T. West and Emma S. Gavino (Madeline Lovell)

The Assessment of College Students' Perceptions and Attitudes Towards Academic Dishonesty 857
Sarah Acton, Jennifer Thetford (Irene Staik and John Burling)

Changing Pedagogy: Using a Computer Simulator to Teach Ethnographic Methods 862
Gregory R. Blaza (Manuel L. Carlos)

The Influence of Pretrial Publicity on Juror Decision-Making: A Meta-Analysis 866
Jasmina Besirevic (Nancy Steblay)

North America by Bus: A Study of Interaction and Personal Space 871
Lisa Marie Bosner (Natalie Rosel)

The Assessment of College Students' Attitudes Toward the Social Aspects of Their Own Aging 876
April M. Chambers and H. Perry Swindall (John Burling and Irene Staik)

Exploring the "GenderedPerspective" in Early Adolescents' Interpretations of Popular Music 881
Anastasia M. Pharris-Ciurej and Kristine M. Ward(Jodi O'Brien)

An Examination of Gift Giving in Post-Modern Society 886
Megan Kathleen Donovan (Martha Huggins)

BEST COPY AVAILABLE

Learning to Hate Yourself: How Homophobia Teaches Girls to Devalue Women 889
Jennifer L. Engle (Harriet Adams)

The Effect of the "Year of the Woman" on the 103rd Congress 894
Emily C. James (Nadia Rubaii-Barrett)

Popularity: The Crisis and Culture of Adolescent Girls 899
Cinnamon Reiheld (Harriet Adams)

Production Scheduling of Flexible Manufacturing Cells 904
Jeffrey D. Erickson (Bijayananda Naik)

Physical Attributions of Racial Sterotypes 908
Lori Dixon (B. Runi Mukherji)

Proceedings — NCUR XI (1997)

Volume III

Mathematical and Engineering

Groundwater Nitrate Removal for the Main San Gabriel Basin, California 911
Chad Blais, Katina Burl, Adam Nazaroff, Peter Tonthat, Vinh Truong and Justine Yu (Julie Wei)

Occupant Dynamics in Stationary and Moving Vehicles Subjected to Vertical Impacts: An Experimental Study 915
Peter D. Layson (Toufic M. Hakim and Orion P. Keifer)

SubzeroCam: Design of a World Wide Web-Based Digital Camera for Sunrayce 97 920
James A. Johnson (Richard R. Schultz)

Using Java for Computational Electromagnetic Scattering 925
Jared Martin (Lyle Long)

Flat Oceans and Satellite Radar Anomalies 930
David L. Mickler (Chester J. Koblinsky)

Cyberprint: Creating Alternative Medical Visualization Tools Using Architectural Metaphors 936
Jim Agutter (Julio Bermudez)

Sustainable Building: Planning and Design of a Family Residence and Education Center Using Local Building Materials 940
Geoffrey B. Grace (Rebecca Fish Ewan)

An Analysis of Ancient Maya Obsidian Artifacts from Belize 946
Rissa M. Trachman (Fred Valdez, Jr.)

Effects of Detention Time on Sedimentation Performance 951
Ben Ehrhart (A.R. Jarrett)

Characterization of Waste Sites in Greater Newark Area Using Geographic Information Systems (GIS) 956
Jelena Balorda (Sima Bagheri)

Electrochemical AC Impedance Technique to Investigate the Inhibition Efficiency of an Inhibitor for Steel Rebar in Concrete 960
Octavio Cervantes, Elaine Lopez & Rudolph Martinez (Behzad Bavarian)

Prototype Designs of Concrete-Filled Steel Tube Composite Building Frames 965
Katherine Fetterer (Jerome F. Hajjar)

Removal of Ammonia from Contaminated Air Stream by Biofiltration 970
Annie W. Chou (Ruihong Zhang)

Comparison of Analysis Methods for Non-Classical Structures with Added Viscoelastic Damping 975
James P. Horne (Douglas K. Nims)

Field Testing of Stone Masonry Arch Bridge #143 in Chester County, PA 978
Allyson Karper (Thomas Boothby)

Determining Suitability of Irrigation in Developing Countries 983
Carl McGloughlin (Roger Ruggles)

Development of a Generic, Robust, and Reliable Networking Protocol for a Motorola Microcontroller 988
Mary Frances J. Austin (Charles Bennett)

Ideal Case Modeling of Optical Preamplifer Receivers at the 10Gb/s Data Rate 993
Deborah S. Hart (Y.K. Park, Lucent Technologies, Lightwave Subsystems)

BEST COPY AVAILABLE

Nonlinear Filtering and Enhancement of Digital Ultrasound Imagery 998
Melissa L. Kurtz (Richard R. Schultz)

Mathematical Modeling of a Fuzzy V-Chip 1002
Daniel J. Landherr (Marian S. Stachowicz)

Effect of Thin Film Disk Texture on Magnetic Recording Head-Medium Clearance Measurements 1007
Daniel Yau (Chorng H. Chang)

A Self-Evaluation Tool for Life-Cycle Cost Analysis 1012
Fabiola Gaytan and Pablo Santos (John Wilson)

Excessive Noise Levels Enhance Special Effects, Are You Aware? 1017
K. Osborne (D. Lisnerski and R. Yearout)

Surface Estimation of Machined Parts 1022
Gustavo Perez (Prasad Gavankar)

The Use of the GRAFCET Approach to Automation of PLC Programming & Control 1027
Janice R. Sansberry (Shueh-Ji Lee)

Counting Arrangements of 2's and -1's 1031
Robert S. Sielken (Donald Bailey)

Magic Squares as Matrices 1036
April Warn (Donald Bailey)

The Structural Design and Electronic Control System for a Large Segmented Space Reflector Test-bed 1041
Anibal Jaimes and Efrain Velazquez (Helen R. Boussalis, Maj Mirmirani and Khosrow Rad)

The Effects of Stretching and Aging on the Tensile Properties of A1-Cu-Li (2195) Alloy 1046
Michael C. Abernathy and Clarence Adkins (Reza Mirshams and Zhixian Li)

Resolvents of m-Accretive Operators in Banach Spaces 1050
Eric Lehr (David Kerr)

Numerical Model for Ice Melting in a Rectangular Enclosure with Density Extremum Effects 1055
Makeda Smith (Khoudir Medjani)

Nanofabrication and Resistance Testing of Metal Coated Silicon Microcontact Arrays 1060
Jeffrey A. Yap (Jack M. Blakely)

The Effect of Razor Notching Techniques on the Fracture Toughness of Polymeric Materials 1063
Dora C. Arevalo (Carlos R. Corleto)

Assessment of In-Plane Strength of Carbon/Epoxy Laminates 1067
Jill Hahl (Ronald Bucinell and Alan Nettles)

The Design and Development of a Phantom Model for Hyperthermia Cancer Treatment 1071
Jennifer Lelas (Ann Anderson)

International Virtual Design Studio: Design of a Vehicle Without Wheels or Wheel-like Contact with the Floor 1075
Carmen McMurtry (Ronald B. Bucinell)

Heat Transfer Enchancement on a Printed Circuit Board 1079
Gretchen R. Voegler (Ann M. Anderson)

A Study of Data Issues in the GIS Environment 1084
Jesus Acosta and Lori Alvarado (Ann Q. Gates)

Quick Write vs. Quick Run: Implementation Methods for Goal Definition 1088
Kellie Alexander and Yolanda McCullough (Scott Anderson)

A Study of Environments for Successful Component Reuse in System Development 1093
Debbie Bowles (Mary Lynn Manns)

Digital Simulation of the Acoustic Guitar: A Physical Model Abstraction 1098
Adam D. Bradley (Wayne Lang)

A Parallel Solution of a Second Order Elliptic System 1103
Andre Da Breau and Lwanga M. Phillip (Okon H. Akpan)

Formulation of a Parallel Recursive Substructuring Method for Finite Element and Finite Difference Solutions 1108
Derek O. Bruff (Hayden S. Porter, Jr.)

Comparing a Particle-System Based Simulation to Other Methods in Modeling Special Effects 1113
Joshua Buckner and Ryan Mitchell (Gerald N. Pitts)

An Examination of Mentoring Methodologies in Object Technology 1118
Janet E. Cody-Mehaffey (Mary Lynn Manns)

3D Special Effects: Modeling Reflective Surfaces In Real-Time 1123
Daniel P. Cornell (Gerald Pitts)

Formal Methods for Software Specifications: A Case Study 1128
Michelle Dillinger (Ken Abernethy)

Truth Maintenance Techniques for Verification of Knowledge Bases 1134
Mark R. Finn (Neli P. Zlatareva)

Computer Assisted Data Reduction: Optimizing the Astrophysicist 1139
Dan Greenspan (Karen Magee-Sauer, Michael Mumma)

Hierarchical Planning with Definite Clause Grammars 1143
Tarik Vance-Harris (R. Raymond Lang)

Algorithm Animation: Programming on the World Wide Web Using Java 1148
Stephanie Hitchcock (Kevin Treu)

Formal Methods for Software Specification 1153
Amanda Hoffman (Ken Abernethy)

RSL, A Language for Distributed Parallel Solution of Sparse Matrix Systems 1157
Chad Huneycutt (Hayden Porter)

A Parallel Solution of a Parabolic System on a SIMD Processor 1162
Adrain Ironside and Ramaiz Mansoor (Okon H. Akpan)

Evolutionary Confusion: When and How to Apply the Genetic Algorithm 1167
Michael G. Jones (Gerald Pitts)

Visualization of a Global Atmospheric Model with Iris Explorer 1171
Elizabeth C. McAliley (Hayden Porter)

Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity 1176
Ramgopal Mettu and Yuke Zhao (Vijaya Ramachandran)

An Implementation of Particle Systems for Special Effects 1181
Ryan Mitchell and Joshua Buckner (Gerald N. Pitts)

BEST COPY AVAILABLE

Parallel Programming: A Disparate Architectures Approach 1186
Jason Pounds (Maurice Eggen)

A Traceability Tool: Linking Knowledge Programs 1191
Francisco Saenz and Tom Watson (Ann Q. Gates)

Commonsense Knowledge Representation for Russian Folktales 1196
Damon Stewart (R. Raymond Lang)

Gödel's Incompleteness Theorem and Turing's Solution to the Halting Problem: Linking the Foundations of Mathematics and Computer Science 1201
Philip Rash (David B. Teague)

Java Security 1206
Hnatyshin Vasil (Bob Neveln)

DARWIN: Software to Identify Dolphins in Digital Images 1211
Daniel J. Wilkin (John H. Stewman)

Wavelength Division Multiplexing Coupler Based on Talbot Self-Imaging in Planar Optical Waveguides 1215
Cadet Diana Kuykendall and Cadet Christopher L. Reitsma
(Tristan J. Tayag, David M. Mackie, Lorna J. Harrison,
Gary W. Euliss, and Richard P. Leavitt)

414

VOLUME IV

BIOLOGY

In Search of Aspects of the Human Condition in Antiquity: The Case of A Hellenistic Population from Abdera, Greece 1220
Pia Economou (Anagnosti Agelarakis)

Abnormalities in Occlusal Surface Wear and Enamel Integrity in Tehuelche Dentition 1224
Alberto Silva (Silvia Dahinten and Daniel de Lamo)

Design of the Acetylcholinesterase Enzyme Using Brownian Dynamics Simulation: A Novel Therapeutic Approach to Alzheimer's Disease 1229
Brent A. Hanks (Walt Potter, Kerry Burns and Vicente Villa)

Postanesthesia Nausea and Vomiting 1234
Aaron Shaw III (Paul Loubser)

A Study of the Risk Factors for Cerebrovascular Accidents in African-Americans 1239
Tera R. Hurt (Dennis E. Daniels)

The Effect of Training Position on Leg Flexor Power in Untrained Males and Females 1244
Dawnelle Diedrich and Ryan H. Robinson (Anthony Caterisano)

Measurement of Anaerobic Power in Elite Wheelchair Athletes: Absolute Load Optimization of the Wingate Test Using the Monark 881 Arm Crank Ergometer 1247
Stephen E. Mercer (Pamela J. H. Beehler)

The Effects of the Raised Mutation of Sexual Behavior in Drosophila Melanogaster Females 1252
Jeannine Caesar and Joshua Bradner (Scott P. McRobert)

The Influence of Menstrual Cycle Phases on the Chaotic Behavior of Electrocardiograms in College-Age Women 1257
Maria M. Mountis, Meghan Ginty and Sharee Livingston (James J. Watrous)

Pollinated Maize Ovaries are Resistant to Infection by the Smut Fungus Ustilago maydis 1262
Margaret Carfioli (Karen Snetselaar)

Genetic Characterization of the AXR5 Gene 1267
Ibrahim Carvan, Donovan Chance, Joseph Mazzie, Rina Pineda and Shabnam Shah'(Lawrence Hobbie)

The Competitive Relationship between the Perennial Cardaria draba and the Annual Lepidium virginicum 1272
Maria Conley (Steven Carroll)

Self-Incompatibility: a Model for Pollen- and Pollen Tube-Mediated Signal Transduction in Petunia inflata 1276
Chandreyee Das (Teh-hui Kao)

Investigating Temperature Sensitive Mutants of Ustilago maydis 1282
Janet Gervaiss, Jason Lotkowski (K. Snetselaar and M. McCann)

Partial Purification and Properties of Putrescine Oxidase from Candida albicans 1287
Uma Gunasekaran, Johnny Thomas, and Louis McDonald (Muthukumaran Gunasekaran and Elias K. Manavathu)

Role of Host Plants in Egg Hatching of the Soybean Cyst Nematode 1292
Renee Poupard and Lou Casta (Paul M. Tefft)

BEST COPY AVAILABLE

Coat Protein Analysis of Tomato Mosaic Virus (ToMV) 1297
Victor Huber, Nicole Kimmes and Jesse Barthel (N. Bharathan)

Feeding Behavior of the Tropical Stick Insect Extatosoma tiaratum: A Study in Palatability of Thirty-one North American Plants 1302
Karla J. Johannes (James Poff)

Monitoring the Release of Acid Phosphatase in Pitcher Plant Fluid after Feeding with Insects 1305
Matthew Jones (Diane Melroy)

Elucidating Mechanisms of Pulmonary Fibrosis: Intracellular and Extracellular Events when the Platelet-derived Growth Factor Receptor System is Up-regulated by Air Pollution Particles and Interleukin 1-beta (IL-1ß) 1309
Patricia O. O'Brien, Annette Badgett and James C. Bonner (Sandra Gilchrist)

Determination of RNA Binding Domains of the Nucleocapsid Protein of Tomato Spotted Wilt Virus 1314
Patricia M. Stickler (Sandra Gilchrist and Tom German)

Characterization of an Auxin-Resistant Mutant of Arabidopsis thaliana 1319
Shabnam Shah, Ibrahim Carvan, Donovan Chance, Joseph Mazzie and Rina Pineda (Lawrence Hobbie)

Comparison of Microbial Consortia and Environmental Condition of Two Granite Outcrop Plant Communities 1324
Keri Randolph and Lisa M. Knauff (Sandra T. Bowden)

Characteristics and Purification of Agkistrodon controtrix laticinctus Venom 1328
Xavier G. Aranda, Elda Sanchez (John C. Perez)

The Purification and Characterization of Crotalus Viridis Oreganus Venom 1332
Gloria R. Chapa and Elda Sanchez (John C. Perez)

The Purification and Characterization of Agkistrodon piscivorus leucostoma Venom 1337
Celia Garcia and Elda Sanchez (John C. Perez)

Purification and Characterization of Crotalus viridis lutosus Venom 1342
Maria Susana Ramirez and Elda Sanchez (John C. Perez)

The Use of Electrophoretic Titration Curves as a Tool in Predicting the Separation of Crude Crotalus atrox Venom by High Performance Liquid Chromatography 1347
Maria Elisa Perez-Johnson (John C. Perez)

Development of a Rapid Detection Method for Determining Bacterial Guild Structure in Mining-Impacted Freshwater Sediments 1352
Todd Christensen (Frank Rosenzweig)

Purification and Biochemical Characterization of Antibacterial Antibiotics Produced by Soil Streptomyces 1356
Victoria C. Heverly (Robert W. Morris and Richard T. St. John)

The Microbial Activity in Saltmarsh Tidal Creek Waters Determined by Oxygen Metabolism 1360
Kenneth C. Hayes and Alan J. Lewitus (Eric T. Koepfler)

Efficiency of Latex Gloves as Barriers to bacterial and Viral Pathogens 1365
Erica Jo Hughes (Robert McLean and Carolyn Benjamin)

Oyster Reef Impact on Microbial Food Web Dynamics in Tidal Pools in North Inlet Estuary 1369
LeRoy F. Humphries, Alan J. Lewitus, Leah L. Gregory and Bonnie M. Willis (Eric T. Koepfler)

416

The Molecular Evolution of HLA-A 1374
Kristie A. Mather (Carrie Grimsley and Carole Ober)

Restriction Endonuclease Analysis of Plasmid DNA from Methicillin Resistant Staphylococcus aureus 1379
Janey Phelps (Betsy Wilson)

Macrorestriction Patterns and Genome Sizes of Two Strains of Bdellovibrio 1384
Theresa Scognamiglio (John J. Tudor)

Effects of Specific and Non-Specific Transport ATPase Inhibitors on Gill and Rectal Gland Tissues of the Little Skate, Raja erinacea 1389
Tanisha Wilkins (Gregg Kormanik)

Effects of Wood Frog (Rana sylvatica) Predation on Spotted Salamander (Ambystoma maculatum) Oviposition Site Selection 1392
Joyce E. Cacka (James W. Petranka)

Consequences of Opportunistic Predation by a Primary Consumer (Rana) on a Predator (Ambystoma) 1397
Andrea Rushlow (James W. Petranka)

The Role of Visual Cues in Determining Recognition Behaviors in Poecilia Latipinna and Poecilia Velifera x Poecilia Latipinna 1402
Joshua Bradner and Jeannine Caesar (Scott P. McRobert)

The Effect of the Lipid Content of the Diet of Blue Crabs, Callinectes sapidus, on Osmoregulation 1407
Sarah E. Hazzard (Lee Ann Clements)

Short-Term Effects of UV-B Radiation on Salt Marsh Vegetation 1412
Christopher D. Raleigh (Eva Koch & Laura Murry)

The Study of the Oxidation of CZT with H_2O_2 Using XPS 1417
Brandy Granderson (De Tang Shi, W. Eugene Collins and Muthukumaran Gunasekaran)

The Effects of Precocene 2 on The Predatory Insect Tenodera aridifolia sinensis Saussure 1422
Emily C. Whiteley (Diane Melroy)

Interspecific Interference and Resource Partitioning Among Males of Three Dragonfly Species (Odonata: Libellulidae) 1427
Michael Wolyniak (Vicky McMillan)

Habitat Selection by American Kestrels (Falco sparverius) Wintering in Northwestern Ohio 1432
Tami L. Parker (J. Eric Juterbock)

The Role of Calcium in Wound-Induced Cell Proliferation 1437
Quoc-Huong Tran (Paul J. Sammak)

Isochore Related Amino Acid Substitutional Biases 1442
Allen J. York (Dan E. Krane)

Effects of Thallium on Inositol Polyphosphate Receptors and Nitric Oxide Synthase in Rat Cerebellum 1447
Chadrick Anderson and Tanya Wright (Chellu S. Chetty and Muthukumaran Gunasekaran)

Initiation of Expression and Cell-Specific Localization of Nitric Oxide Synthase (NOS) in Pre-Implantation Mouse Uterus 1452
Preeti Gupta (Yvette M. Huet-Hudson)

Characterization of Urethral Blockage in a New Mutant Diabetic/Obese Mouse 1456
Michael Villarroel (John G. Vandenbergh)

BEST COPY AVAILABLE

One-Dimensional and Two-Dimensional SDS-PAGE of Total Protein in the fungus Ustilago maydis 1459
John G. Devlin (Karen Snetselaar and Michael McCann)

Regulation of Superoxide Dismutase Synthesis in Candida albicans 1464
Uma Gunasekaran, Anita Austin and Louis McDonald
(Muthukumaran Gunasekaran, Elias Manavathu and C.S. Chetty)

Antifungal Resistance in Opportunistic Fungi: Isolation and Characterization of Amphotericin B-Resistant Mutants 1469
Uma Gunasekaran, Anjana Challa, Dinita Scurry and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

In Vitro Susceptibility of Clinical Isolates of Opportunistic Fungi to Antifungal Agents 1474
Uma Gunasekaran, Tanya Wright and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

Aye-Aye Gruel Presentation Preference 1479
Heather Ann Lynch (Joan H. Eisemann)

Modification of the Binary TBP-DNA Complex by Pluramycins 1483
Sameer Ambady (Lawrence Hurley)

Characterization of a Mutant dnaA-dnaN Gene Region that Suppresses a Temperature Sensitive Defect in the dnaX Gene of Salmonella typhimurium 1487
Farhang Amini (James R. Walker)

Conservation of Proto-Oncogenes, Tumor Suppressor Genes, and V (D) J Recombinase Genes Across Species 1492
Lucy A. Aplan (Rob Young)

An Analysis of Lipid Bilayer Studies of Single Ion Channels using M2 as an Example 1496
Erin E. Grimm (Carl Helrich)

Metal Regulated Gene Expression in Pseudomonas fluorescens 1501
Marsha L. Kukuk (Silvia Rossbach)

The Development of a PCR-Based Test to Identify the Red Factor Coat Color Genotype in Horses by RFLP Analysis 1506
Staci Murguia (Ann T. Bowling)

Differentiation and Classification of Bdellovibrio bacteriovorus using Random Amplified Polymorphic DNA (RAPD) Analysis 1509
Bao-Dan T. Nguyen (John T. Tudor)

QTL Mapping of a Genetic Marker for Longevity in Drosophila melanogaster 1513
Amy Resler (Jim Curtsinger)

Stability of Heterochromatin in Voles from Chernobyl 1518
Lara Wiggins (Robert J. Baker)

Isolation and Functional Analysis of three Non-Human Primate CXCR4 Genes 1521
Brigitta Zoltay, Jay Vasudevan and Greg Shaeffer (David Camerini)

Volume V

PHYSICAL SCIENCES

Modification of an Interference Pattern Through Particle Statistics: Experimental Study 1526
Niranjan Sharma (Willard Fadner)

Nuclear Structure of the Stable Tellurium Nuclei 1531
Brian Champine, Peter Burkett, Christopher Davoren, Stephen Etzkorn, William Faulkner, Bernard Meehan, and Mark Skubis (Jeffrey R. Vanhoy and Sally F. Hicks)

Pulse Propagation in a 1-D Physical Lattice 1536
Jonathan Tuminaro and Joseph Winkler (H. David Sheets)

An Investigation to Measure Mechanical Strain in Structures using Optical Fiber Interferometry 1540
Satyender Mahajan (Zolili Ndlela)

CO Adsorption on Cobalt Particles Supported on Chromia - An FTIR Study 1544
Caribee Collier and Agegnehu Tsega (Murty A. Akundi and A.N. Murty)

Solar Cells Using Organic Pigment Nanoparticles 1549
D.J. Hilton and E.W. Forsythe (B.R. Hsieh and Y. Gao)

Calculating O_3 9.6 µm Absorption as a Function of Atmospheric O_2 1553
Hilary L. Justh (James F. Kasting)

Electromagnetic Field Profiles Inside Biomaterials 1558
Pedro L. Melendez, Dimaries Nieves, Ramon A. Rivera (Idalia Ramos and Fredy Zypman)

Thermal Modeling of the Marcy Anorthosite Massif, Adirondack Highlands, New York: Implications for Depth of Emplacement 1563
Kevin M. Myer (J. Alcock)

Ultra Sensitive Diode Laser Based Monitors for Toxic Environmental Gas NO_2 1568
Jessica Owens (G.N. Rao and M.N. Reddy)

Sample Heating and its Effects on Diffusion Depth 1573
J. Reed Patterson (Peter A. Barnes)

The Hyperpolarizabilities of Phthalocyanines 1578
Tiffiani R. Williams (Beatriz H. Cardelino)

Simulated Super Resolved Imaging of Compact Radio Sources 1583
Erika Barth (David Hough)

A Study of the Lobe-Dominated Superluminal Quasar 3C263 1588
Philip J. Beyer (David Hough)

Global Imaging of the Cusp Region of the Earth's Magnetosphere 1593
John W. Colson (J.D. Perez)

3D Circuit Networks Simulate Biomaterials 1596
Edsel Ruiz, Pedro Melendez (Idalia Ramos and Fredy Zypman)

A Two-Year Climatology of Radiation Budget and Cloud Properties for the ARM SGP Site 1601
Stephen G. Strum (Thomas P. Ackerman)

Nonlinear Optical Properties of Halogenated Porphyrin 1606
Angela Benloss (Beatriz H. Cardelino, Craig E. Moore)

A Novel Method for Investigating Phase Disturbances 1611
Rex L. Blair Jr. (Thomas R. Moore)

BEST COPY AVAILABLE

An X-ray and Optical Study of Galaxies in Pairs 1616
Sarah Cousineau (Mark Henriksen)

Optically Driven Pendulum 1621
David Coy and Michael Molnar (Randall Peters and LTC Thomas Moore)

Surface Morphology of CdZn Te Crystals Grown by Physical Vapor Transport 1626
Montiquilla Davis (Arnold Burger, Henry Chen, Kuo-Tong Chen and Muthukumaran Gunasekaran)

Avalanche Segregation of Granular Media 1631
James Koeppe and Michael Enz (James Kakalios)

Magnetic Susceptibility (MS) and Visual Spectral Reflectance (VIS) Measurements: Paleoclimate Estimates for Pleistocene Europe 1636
James R. Marlatt (Brooks B. Ellwood)

Diamond Film Coatings on Titanium Alloy Using Chemical Vapor Deposition 1641
Andrea Nelson (John T. Tarvin and Yogesh K. Vohra)

Purification and Crystal Growth of Lead Iodide 1646
Danielle Robinson (Kuo-Tong Chen, Arnold Burger, Henry Chen and Muthukumaran Gunasekaran)

Recalibration of the Wilson-Bappu Effect Using the Singlely Ionized Magnesium k and h Lines 1651
Frederick Scoville (Jose Mena-Werth)

Analysis of X-ray Sources in Galaxy Clusters 1656
Dean Smith (Mark Henriksen)

Using FTIR-Reflection Absorbance Spectroscopy to Study the Structure of Thin Ice Films 1659
Jennifer L. Spillman, Govind Mallick and Robert M. deGroot (Marin S. Robinson)

CHEMISTRY

Large DNA Fragment Sizing by Flow Cytometry 1664
Angela R. Cameron (Jeffrey T. Petty)

Enchancement of Asymmetric Induction in the Aqueous Diels-Alder Reaction of (L)-Menthyl Acrylate with Cyclopentadiene by β-Cyclodextrin 1669
Kristen Daniell, Terry E. McInytre, Poh Ai Ling (Moses Lee)

Effect of Lipid Peroxidation Products, 4-hydroxy-2-trans-Nonenal and Malondialdehyde, on Erythrocyte Membranes 1674
Michael Green, Ram Subramaniam (Allan Butterfield)

The Synthesis and Decomposition of Single Source CVD Precursors 1679
Tadd Kippeny (D.S. Amenta, J.W. Gilje, and T.C. DeVore)

Thermal Remediation of Model Chloropesticides Utilizing Reactions with Sodium Salts 1684
James W. Parrett, Jr. (Thomas C. DeVore)

Determining the Effect of Substitutions on the Hyperpolarizabilities of Tricyanoquinoline-Dimethanes 1689
Jamarcy L. McDaniel (Beatriz Cardelino)

Better Magnetic Resonance Imaging Contrast Agents for Tumor Detection 1694
Leah C. Saunders (Thomas R. Cundari)

Computational Analysis of the Electronics of Substituents on Aromatic Systems 1699
Lumelle A. Schmiedekamp (Judy L. Ozment)

Isolation of a Compound Responsible for the Biochemical Control of Dimorphism in Candida Albicans 1704
Joseph J. Tasto (Kate J. Graham)

Adsorption Behavior of NO and CO on Pd/Al_2O_3: An FT-IR and Mass Spectrometric Study 1707
Chad D. Marten and Barry W. Smith (Dilip K. Paul)

Structural Studies of a Modified Oligonucleotide using 2-D NMR Techniques 1712
Thanh Ta, Shannon Teeters and Brigette Semler (Dale G. Ray III, Mark McDougall, Jim Holecek, Lorraine Rellick)

Effects of Additives, pH, and Buffers on the Chemiluminescence of Phenyl Acridinium Ester 1717
Carolyn Snider, John Rollag (D.S. Hage)

Dynamic Surface Tension and Surface Adhesion Detection for the Rapid Analysis of Surfactants 1722
Dana Alloway (Robert Synovec and Kristen Skogerboe)

Interactions of the Domains of Myosin's Regulatory Light Chain with the Heavy Chain: A Photocross-linking Study 1727
Lisa Nguyen (Jennifer J. Olney and Christine R. Cremo)

Thermodynamic Melting Point Studies of a Native and Modified Thirteen Base Pair Oligonucleotide containing 5-Nitroindole using UV Spectrometry 1732
Jamie Doone and Chad Willis (Lorraine Rellick, Dale G. Ray, Jim Holecek, and Mark G. McDougall)

Chitosan-Porphyrin Films for NLO Applications and Optical Devices 1736
Celeste A. Roney (Rosalie A. Richards, Subhash C. Bhatia, Albert N. Thompson, Jr., and Beatriz H. Cardelino)

Biochemical Characterization of Amino Acid Uptake in Potential Vacuolar Mutants of Neurospora crassa 1741
Zeljka Basic and Jonathan Z. Tayco (Kelly Kennan)

BEST COPY AVAILABLE

Preparation of $\mathrm{Co(PYAN)}^{-3}$ and Progress Toward the Separation of its Optical Isomers 1745
Lori Bigler (Susan C. Jackels)

Attempted Synthesis of a Precursor of an Anti-tumor Marine Alkaloid: Shermilamine B 1750
William Buitrago (Yvette Jackson and Michael Lyon)

Determination of the Vanadate-Mediated NAD(P)H or NADH Oxidation Mechanism in Biological Systems 1755
Carlos J. Olivo-Delgado (Ileana Nieves-Martinez and Ronald P. Mason)

Möbius Kekulenes: Semiempirical and ab initio Hartree-Fock Calculations of Their Structures and Properties 1760
Patricia L. Frisch (Robert W. Zoellner)

Synthesis of (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d Diisopropyl 4b,8b,8c,8d -tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate: A Project on Absolute Asymmetric Induction 1765
Kimberly Johnson and Jacob E. Simpson, Jr. (Moses Lee)

The Polymerization of Dicyclopentadiene for use in the Undergraduate Organic Laboratory Utilizing Computational Methods 1769
Jason Logan (James W. Hershberger)

Examination of the Decarboxylation of Ketoisovalerate Using Pyruvate Decarboxylase from Saccharomyces cerevisiae 1773
Michael B. Meek (Betty H. Stewart)

Synthesis, Purification, and Activity of Glutaryl-CoA Analogs 1777
Shannon L. McKinney, Carrie L. Donley, Gregory K. Sewall, Patricia L. Kultgen (Colleen M. Byron)

The Synthesis of Rigidin -- A Tetrasubstituted Pyrrole 1782
R. Jordan Shuford (Keith Krumpe and John Gupton)

Molecular Modeling of Vanadium-Oxo Complexes 1787
Laura L. Sisterhen (Thomas R. Cundari)

Characterization of Liquid Crystalline Thermoset Networks 1792
Jeffrey M. Valentine (Christopher K. Ober)

Faraday Rotation of a Photogenerated Organic Triplet Molecule in Polyvinyl Alcohol Films 1797
Paul Trotto (David Hall and David Dwyer)

HPLC Analysis of Eicosanoids in Response to Valproic Acid (VPA), Endotoxins (LPS) and Tumor Necrosis Factor (TNF) 1802
Matthew Thomas McKevitt (J.R. Stephens)

Preparation of an Iron Complex of $\mathrm{Pyo_2[18]dieneN_6}$ 1807
Shane O'Mahony (Susan C. Jackels)

The Plasma Etching of Metals and Metal Compounds 1811
Gordon Shaw (Judity Halstead)

ENVIRONMENTAL SCIENCES

Pipelines and Potential Disaster: An Introduction to Cathodic Protection 1816
Joy J. Burwell (Brian Hale and Verne Lehmberg)

Twin City Water Quality Initiative Program 1821
Valerie Kuntz (Kenneth Brooks)

Lead Contamination of Canned Food Products from Argentina 1825
Margaret M. Ryan (Richard P. Maas)

Don't Die with TDI: Dynamic Calibration of MDA Isologgers for Toluene Diisocyanate 1830
Clare E. Smith (Herschel A. Elliott and V. Dharmarajan)

The Effect of Carbon Content on the Redox Potential and Fermentation Products of Wetland Soils 1835
Wendy Rash and David Cahan (Kevin K. Moorhead and Keith E. Krumpe)

The Invasion of Carrotwood (Cupaniopsis anacardioides): A Study Comparing the Impact of an Exotic Species on two Islands in Sarasota, Florida 1840
Lisa Downey (Sandra Gilchrist, John B. Morrill and Terry Palls)

Urban Forests and Wildlife: A Web Document 1845
Katrina M. Simon (John Bishop)

Effects of Stratification on Germination of Two Oak Species in Southeastern Arizona 1849
Kimberly Suedkamp (Guy R. McPherson)

Seasonal Fluctuations in Central Greenland Ice Sheet Radar Altimeter Return Characteristics 1853
Philip Dennison (Richard Alley)

Results of a Microseismic Survey of the Front Range of Colorado 1857
Noah Daniel Hughes (Anne Sheehan)

Atmospheric Teleconnections and United States Regional Climates 1862
Dana M. McCracken (Anthony J. Vega)

Extracellular Acid Phosphatase(s) Activity of the Protozoan Parasite Perkinsus Marinus 1866
Christine M. Forsythe (Aswini K. Volety, and Fu-Lin E. Chu)

Microhabitat use by Fish Populations within the Little Miami River 1871
Daniel J. McGarvey (Horton H. Hobbs III and John B. Ritter)

Water Chemistry Habitat Assessment in Eastern Tiger Salamander Ponds 1876
Sara E. Wirtz (Daniel M. Downey)

The Derivation of United States Temperature and Precipitation Regions 1881
Donna M. Fiscus (Anthony J. Vega)

Cloud Masing of Normalized Difference Vegetation Index (NDVI) Images 1885
Heidi Zeleznik (Barry Lesht)

Preclassic Maya Pottery From Colha, Belize

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An analysis of ceramics from the ancient city of Colha, Belize indicates a dramatic change in the social, economic, and political systems of the Maya from ca. 1000 B.C. to A.D. 250. The characterizations of the social systems are reflected in the fragmented ceramics. The analysis of the pottery has provided a means for observing the changes in the social systems over time. Specifically, changes in pottery styles and distribution indicate a more interactive society by A.D. 250.

INTRODUCTION

Colha located in northern Belize, was first investigated by the Corozal Project in 1973(Hammond 1973). Initial survey of the area confirmed the existence of a major chert procuring and manufacturing center. The Colha Project began in 1979, and at the end of the 1986 field season, had generated more than 250,000 pottery sherds, including partial and whole vessels (Valdez 1987). The northern area, near Cobweb Swamp, contains remains of the main ceremonial center(Hester, Shafer, Eaton 1994). The site is sectioned into quadrants, divided by the Northern Highway(Figure 1). The focus of this paper is on the Preclassic ceramic material(1000 B.C.-A.D. 250), which is most significant in the northern quadrant (2000), and the densest in population(Valdez 1987).

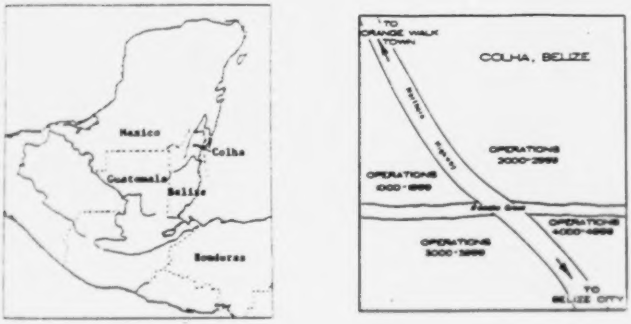

Figure 1 The Colha Archaeological Site and Research Quardrant at Colha

Colha was almost continually occupied from the Middle Preclassic, until the Late Postclassic time period of A.D. 1400(Hester, Shafer, Eaton 1994). The following chart (Figure 2) can be used to compare significant complexes of the surrounding major sites in the Maya area. Please note the inclusion of several other sites with similar sequences.

Adams and Valdez completed the first field season's report, analyzing ceramics in 1979. They used the type-variety system established by Smith, Willey, and Gifford(1960), and Gifford (1976).

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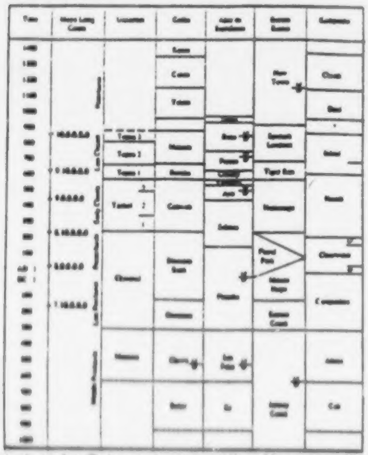

Figure 2 Chronological chart for Colha and several other Maya sites(Meskill 1992)

PURPOSE

The use of ceramics is one of the many tools incorporated by the interdisciplinary field of archaeology to recreate the social behavior and lifestyle of ancient societies. These pottery sherds are remnants of people, with their own particular shared belief and ideological systems that are culturally, socially, and economically integrated. These belief systems enable them to create survival mechanisms- in their unique environmental location.

Ceramic vessels are characteristic of each specific time period reflecting the degree of technological skills, and display societal preferences of style. By examination of pottery forms, we can endeavor to trace communication and exchange with other ancient sites. Using comparative studies, archaeologists can trace trade routes and alliances.

Ceramics can be useful in chronologically dating occupations at ancient sites. Ceramic stratigraphy is based on the concept that the oldest material resides under the younger(or more recent). It is one of the more important methods employed to date material in the archaeological record. Comparison with similar materials from other sites can help to secure time frames, and reference communication between various locations.

GENERAL HISTORY OF THE MAYA

The first occupants of the Maya lowlands were opportunists. They roamed the plentiful river ways taking advantage of the terrain. Their needs were met as long as environmental opportunities were available. However, as their numbers increased, the practice of exploiting their own specific economic niche became more advantageous.

Pottery made of durable and accessible clay, rather than lighter and perishable materials, such as straw and gourds, became more practical at this time. Simple utilitarian wares became more visible. Concentrating on exploiting their surroundings, the Maya could now, manipulate their unique resources to satisfy the desires of the complex lifestyle they created.

Utilitarian vessels may have become a necessity for preserving surplus crops. Ceramics were beneficial in transportation and storage of the most desirable of all resources--water.

BOLAY COMPLEX (1000-600B.C.)

By the Middle Preclassic, the simple agriculturists of Colha had exhibited a similar complex of ceramics with their contemporaries at Cuello, Santa Rita, Kichpanha, and San Estevan. Red monochrome ceramics are representative of the southern Maya lowlands at this time Period. Forms that comprise the Bolay complex are utilitarian bowls, dishes, and plates(Valdez 1987).

Two of the most important groups introduced in the Bolay complex are Consejo Red and Ramgoat Red. A "proto" dichrome may have been created by the introduction of Consejo Red with the application of a red slip over a white or cream base(Valdez 1987). Decoration is represented by pre-slip groove incision.

Fragments of Chicago Orange jars display direct rims and round or square lips on out flaring necks. These jars may have cylinder loop handles or slab handles "incised to give the appearance of loops"(Valdez 1987).

Some of the earliest burials excavated at Colha are from Op. 2031, comprised of several house platforms. Three distinctive Bolay vessels were found. One was a Ramgoat Red placed on the head of a juvenile. Another discovery was a Conejo Red vessel, contemporaneous with Ramgoat Red, placed over the skull of an adult male. Associated with this burial were shell beads, and a small jade celt(Hester, Shafer, and Eaton 1994).

A censer (with burn marks), the Bolay "fat man"(Figure 3) is one of the more unusual artifacts in this context. There may be some similarity between this Ramgoat Red modeled human figure and the pot-bellied boulder carvings of Kaminaljuyu dated at 500 B C (Adams 1977) However the Bolay complex dated 1000-600 B C . is earlier than the numerous boulder carvings of Pacific Guatemala

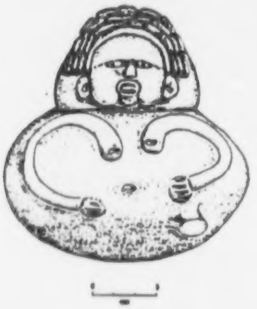

Figure 3 Bolay "Fat Man" Censer(Courtesy of the Colha Project)

Op 2012 and 2031 render other diagnostic sherds For example one type is Tapalo Red-and-Cream of the Bolay complex which developed chronologically into the later Muxanal Red-and-Cream of the Chiwa Complex The Xe sphere at Altar de Sacrificios Seibal and Tikal share similar types Thus, we can begin to see specific changes through time and communication or exchange over long distances

A lack of specific resemblance or replication of certain attributes in the Maya lowland may indicate regionalism in the early Middle Preclassic Perhaps access to other ideas(templates) or lack of need for outside resource, in this time period, allowed for regional expression, and more creative differences could be explored locally

CHIWA COMPLEX(600-300B C)

Joventud Red monopolizes the majority of the Chiwa Complex Joventud is an extension of the Ramgoat Red of the Bolay Complex Joventud is dark red not fire-clouded, with crackling or fire-crazing observable A definite "waxy" red slip is developed in the later facet of the Chiwa Complex Dichromes of red-on-cream are a direct reflection of the Bolay Complex, as well Pre-slip incising and grooved horizontal line is prominent at this time The complexes at Altar de Sacrificios Seibal, Tikal Uaxactun, Becan, Cuello(late facet) and many of the Maya lowlands share similarities with the Chiwa Complex, and belong to the Mamom Sphere(Valdez 1987)

Tecomates (neck-less jars) are introduced in the early facet of the Chiwa Complex This diagnostic vessel is not identified in the previous complex at Colha, and not represented after the conclusion of the late Chiwa Complex(Valdez 1987) Spouted vessels sometimes called "chocolate pots" are another new form introduced at this time They appear in the late Chiwa Complex, as both red and black slipped jars (Valdez 1987)

As noted above regionalism is still reflected with the use of a few unique vessels However by the late facet of the Chiwa there is a distinct homogeneity that developed throughout the Maya lowlands

ONECIMO COMPLEX(300-100B C)

Sierra Red is the predominate type found in this complex Again, there is a definite correlation established between the complexes An exact distinction between Jovetud Red and Sierra Red is convoluted at best in the early facet Society Hall another diagnostic red slip exhibits a "streaky" finish due to a probable method of wiping the red slip over the vessel(Valdez 1987)

Found as a cache and defined in the Onecimo/Blossom Bank Complex are two Sierra Red bowls found lip to lip at Op 2012 by Potter There is post-slip, post-fire inciaing on the interiors of both vessels The designs are unique and debatable but evidence of hieroglyphic writing is conceivable Laguna Verde incised is the type name given(Valdez 1987) Kichpanha also has evidence of writing at this time with form of an ancient bone(Gibson Shaw and Finamore 1986)

BLOSSOM BANK(100B C -A D 250)

This Late Preclassic period follows the Onecimo Complex and is somewhat comparable to the Floral Park of Barton Ramie The Blossom Bank Complex is a continuum of the elaborate techniques of the earlier Complex but is composed of ceramics that are definitive of this time period Although associated with Floral Park of Barton Ramie the ceramics of Colha have an expressed degree of technology and decoration beginning to expand in the preceding Onecimo Complex

Slips that are hard and glossy-- bichromes, trichromes polychromes and mammiform feet are all examples of the achievements of this Late Preclassic site(Figure 4) Decorative styles include geometric patterns and an increase in resist design

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Included in this complex are several unique vessels, and sherds that were recovered from Op. 2012. Seven sherds with tan to buff paste display specular hematite(maroon) rim bands, with another brown horizontal band below the rim oh the exterior. Usulautan decoration is found on two sherds with straight to wavy lines of brown or black.

Ixcanrio Orange-polychrome is a diagnostic type. The bowl form is decorated with an orange-red slip and has a red and black geometric design. The vessel type is often supported by distinctive hollow mammiforin feet. Unnamed Positive Painted is another inclusive vessel with painted red stripes down the interior on a light orange base (Valdez 1987).

All of these spectacular vessels, with such elaborate techniques help establish the Late Preclassic, also known as the Protoclassic. These attributes usually associated with the Classic, are firmly entrenched in the Blossom Bank Complex, at Colha.

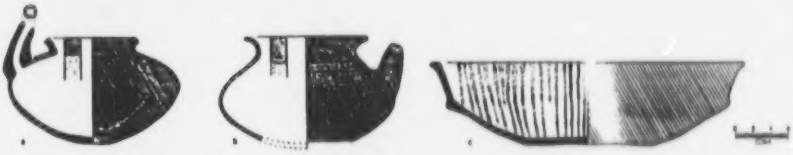

Figure 4. Late Preclassic Pottery from Colha(a and b are spouted jars, c is a positive- painted bowl)

SUMMARY

The first interest in Colha was generated by the realization that this ancient site was once a major lithic production center. Midden samples revealed a society very familiar with the importance of their surroundings, and the knowledge of how to manipulate it. Colha was surrounded by swamps and riverways. Agriculture, which could be supported by this environment, combined with possible trade paths to other sites, may have assisted in forming alliances between Colha and neighboring centers. Manufacture of trade items and their distribution would require supervisory positions. Control of water resources, and agricultural logistics are other operational problems created by interactions of different technological segments of society.

Management of these resources would require some means of recording. The discovery of the hieroglyphic type writing with the Late Preclassic Sierra Red bowls at Colha may indicate these ancient people possessed the capabilities to initiate this major accomplishment. Colha's neighbor, Kichpanha, also, possesses a inscriptive writing at the same time period.

By comparitive studies of the ceramics of Colha and the northern Belize region, the interaction of these sites in the Preclassic may enable a better understanding of the social changes that occurred. Preclassic ceramic evidence supports continuous occupation of Colha from 1000 B.C. to A.D. 250. Each complex exhibits vessels that denote influence from other other sites in Belize, Guatemala, and much of the southern Maya lowlands. However, Colha continues to produce vessels that are particular to its own location. Perhaps, this conveys stability in the functioning of society. There is no evidence of another group or region exhibiting control over the ceramic production in the Preclassic period.

Ceramics associated with burials were evident from the beginning of the Bolay complex, and continued with the mortuary evidence in Chiwa, Onecimo, and Blossom Blank. The burials included ritualistic items such as the Bolay "fat man" censer, modeled bottles, and unique effigy vessels. Special attention and prestigious objects separate individuals and their possessions. This distinctive occurrence expresses the qualifications of a stratified society, especially with the inclusions of particular objects that indicate significant concentrations of wealth. Objects that occur in a ceremonial atmosphere may represent a segment of society that has higher status over the rest. It is important to observe that the ceremonial features do not only imply reverence to a specific individual or ruler. There is also indication of attention to familial or ancestral association.

CONCLUSION

Preclassic Colha utilized their assets to transform their existence into a major center. Contacts with their neighbors extended their influence into Guatemala, northern Belize, and much of the Maya lowlands.

Ceramic analysis illustrates contact with major centers. Trade items, jade, shells, elaborate goods, coupled with ceremonial artifacts reflect a more stratified society over time. An early form of writing is already in place by the Blossom Blank Complex(100 B.C. - A.D. 250). Colha was producing an inventory of sophisticated ceramics usually attributed to the Classic Period reflecting a more complicated and hierarchial society by the close of the Preclassic in A.D. 250.

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REFERENCES

Adams, Richard E. W. Prehistoric Mesoamerica. University of Oklahoma Press, Norman and London, 1992.

Gibson E. C., L. C. Shaw, and D. R. Finamore. "Early Evidence of Maya Hieroglyphic Writing at Kichpanha, Belize." Center for Archaeological Research, The University of Texas San Antonio. Working Papers in Archaeology, No. 2, 1981.

Hammond, Norman. British Museum - Cambridge University Corozal Project, Interim Report. Cambridge, England. 1973.

Hester, T. R., G. Ligabue, J. D. Eaton, H. J. Shafer, and R. E. W. Adams. Archaeology at Colha, Belize: The 1981 Season. In Archaeology at Colha, Belize: The 1981 Intermin Report, edited by Hester, Shafer, and Eaton: 1-260. Center for Archaeological Research, The University of Texas at San Antonio, 1982.

Hester, T. R., Harry J. Shafer, and Jack D. Eaton. Continuing Archeology at Colha, Belize. Texas Archeological Research Laboratory, The University of Texas at Austin, 1994.

Meskill, Frances K. "Ceramics and Context: A Protoclassic Perspective from the Sites of Kichpanha and Colha, Northern Belize." Thesis University of Texas at San Antonio, 1992.

Valdez Jr., Fred. "The Prehistoric Ceramics of Colha, Northern Belize." Diss. Harvard University, 1987.

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DECIPHERING THE SECRETS OF SKELETAL REMAINS FROM HELLENISTIC ABDERA, GREECE

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This research project conducted in-depth interdisciplinary analyses of physical anthropological and forensic nature concerning a Hellenistic skeletal collection from the city of Abdera, located in coastal Thrace of northern Greece. It was proposed that such a study would provide pertinent information elucidating undocumented aspects of the human condition in antiquity. The collection comprises 45 individuals which were excavated and documented in the field by a previous team of researchers in 1993, and represents a random sample of the 4th-century B.C./B.C.E. population of Abdera. Assessments in skeletal biology, paleopathology, and trauma had been conducted in the field.

Laboratory evaluations and computer tabulations of the existing anthropological records, carrying statistical implications on a population-environmental approach, focused on interrelations between skeletal "Markers of Habitual and Occupational Stress" (MHOS), permanent markers recorded on human osseous surfaces, and the organizational capacities of this population. Specific skeletal characteristics unique to this population were revealed which are indicative of their techno-economic abilities and certain patterned behaviors which traditional archaeology has had limited potential to discover on its own. These research results are of significance to anthropologists, archaeologists and historians in their efforts to better perceive and understand facets of the living conditions of the citizens in Hellenistic Abdera.

INTRODUCTION

Archaeo-Anthropology, specifically skeletal biology and paleopathology play a significant role in deciphering aspects of the human condition in the past. Rarely does the Physical Anthropologist bask in the riches and ruins of discovered ancient civilizations. Instead, the Physical Anthropologists' temple are the human skeletal collections, and their hieroglyphics are the muscular imprints and wear patterns on the osseous white walls. Their most precious metal is not gold or silver but copper, because its oxidation preserves organic tissues for chemical analysis. The riddles and secrets Physical/Forensic Anthropology attempt to solve, concern the daily life of individuals within larger groups, not only what types of tools a person or persons used but also how they used them.

This paper presets aspects of an ongoing Archaeological project run by the Greek Archaeological Service in Thrace in collaboration with Dr. A. Agelarakis of Adelphi University. The excavation relevant to this discussion was carried out in 1993-94 in an archaeological site of a town called Abdera located in the Thracian region of Northeastern Greece. The skeletal collection dates to the 4th century B.C./B.C.E. in what is commonly referred to as the Hellenistic period. This paper will provide a general inventory of the pathologies and significant skeletal characteristics unique to this population. These

429

findings will ultimately be used in conjunction with the archaeological record, historical record, and known cultural history of the area to elucidate aspects of the daily life of this population.

Abdera is presently locate. 6 Km from the coast and is surrounded by mountainous, wooded areas and open fields, which today are used for farming. Today Abdera is a fraction of what it once was. Its mythological name comes from Abderus, friend of Hercules, who was killed by Diomedes horses in that area. Its historical origins are equally as fascinating, as it became an established city in the 7th century B.C./B.C.E. founded by Timesius of Clazomenae (Herodotus Clio I. 168 p.73). In its peak, the city stretched from its present day location 6 Km south to the Agean Sea. The city was home to Democritus, Protagoras, and Anaxarchos, the counselor of Alexander the Great. Xerxes along with his army of approximately 2.5 million military personal and over a million pack animals inhabited the city. The society was agriculturalist and as well as pastoral and the products produced by the city were maize and wheat. With its marble streets and public fountains made of solid gold and fine stone Abdera became the third richest city during the Delean League (Agelarakis, Personal Communication). There were two harbors, one for commercial use and the other used solely for military purposes, both of which were the site of many historical events (ibid). Yet, by the Hellenistic time period in which this particular excavation was focused, the historical record states that the city of Abdera is in a predominant state of continuing success.

Despite the multitude of historical and archaeological data some aspects of the past remain unclear. One of these aspects revolves around the details surrounding the lives of Abdera's inhabitants and an overall picture of what daily life was like on these people's physical bodies.

METHODS

The physical anthropological and paleo-pathological data relevant to this skeletal population had been gathered by extensive laboratory studies by a previous team of researchers in 1993-94, headed by Dr. A. Agelarakis of Adelphi University. These records (Agelarakis in manuscript) were developed in and around an excavation of a necropolis just outside the walls of the ancient city of Abdera and consisted of a collection of systematic notes written to uniform lab sheets. Each lab sheet represented information on single or multiple burials and relevant information on certain criteria. These lab sheets provided information in reference to skeletal biology, morphology, epigenetic variation, the identification and distribution of disease entities, trauma, and other permanent skeletal markers concerning this skeletal population. This included cranial, dental and post cranial measurements, a description of the skeletal remains, tentative age and sex assessments, dental observations, and any skeletal pathologies, Markers of Habitual and Occupational Stress (MHOS) (Agelarakis 1993), suspicion of trauma, and epigenetic variation. Approximately 60-70% of lab reports contained additional documentation making inferences, through illustrations, of skeletal surfaces containing emphasized muscular attachments.

The information obtained from these lab sheets was broken down into individual components and entered into a computer database. Doing so allowed for easy and efficient data manipulation and examination. The database was used to run queries isolating certain individuals that fit any number of specified criteria, defining relationships and highlighting significant occurrences of pathologies, or MHOS within the skeletal record. Aspects of this data were converted into more easily manageable forms, with emphasis on the MHOS. Each known MHOS (Kennedy, 1989) had been assigned by Dr. Agelarakis in 1994 sequential numerical designations for purpose of simplification of descriptions of such anatomical loci on all skeletal structures (Agelarakis, 1994) and is presented below as such (ie: Phalanges #1 represents a specific MHOS).

With this information interest was centered on the interrelations between MHOS, pathologies and trauma, and the implications this had in determining the relationship of the represented individual and the social and physical aspects of their environment.

RESULTS

SEX/AGE

The following is a chart detailing the age/sex disbursement of the represented population.

	Males	Females	Indeterminate
Sub-Adult (16-19)	0	0	3
Young-Adult (19-25)	3	3	1
Middle-Adult (25-35)	7	10	0
Late-Adult (35-45)	9	3	0
Maturus (45-55/60)	0	1	0
Senilus (55/60+)	1	1	0
Indeterminate Age	0	0	3

MHOS

Of the 45 individuals represented, 32 had revealed characteristic manifestations considered as skeletal traces of MHOS while there were no cases of MHOS in the skeletons with an indeterminate sex assessment. The absence of MHOS on some of these individuals is most likely due to incomplete or fragmentary skeletal remains. MHOS are skeletal manifestations which result from the use of specific muscles, or combinations of muscles, which locally stimulate the osteoblastic activities of the periosteum and the cortical bone surfaces (Agelarakis, personal communication). MHOS can also be seen in skeletal joint surfaces through the of afflictions of osteoarthritis and osteoarthritic based symptoms. The study of MHOS on osseous surfaces can aid in the interpretation of daily habitual and occupational activities including aspects of their socio-political, and economic circumstances (Agelarakis, personal communication).

Some specific markers appearing in the skeletal record are more prominent than others, the most dramatic prevalence of MHOS was observed among both male and female skeletal groups. This was designated Phalanges #1 and occurred in 7 males and 6 females. The MHOS Phalanges #1 is seen when the phalanges, or the fingers, exhibit emphasized flexor muscle attachments along the palm side, between the first and second joints. This condition is suggestive of flexing or grasping objects with the hand (Kennedy 1989). A number of actions could be inferred, all involving the action of grasping in similar ways. In pastoral and farming societies, this can be seen on individuals who milk domesticates on a routine basis throughout most of the year (Agelarakis, unpublished ethnographic work at Abdera).

Apart from this particular example, there are many cases of statistically significant MHOS in this skeletal record that reflect sexual dimorphism. A higher occurrence of these skeletal markers appears in the assessed male skeletons verses the females. This is significant in its indication of a division of labor between males and females in at least some of the more prevalent habitual and/or occupational activities partaken during any given day of these people's lives. The following MHOS markers are illustrative of this in particular, and at the same time have displayed significance by appearing alongside other related markers and/or skeletal pathologies in the skeletal record creating relevant combinations.

Out of the male population, 7 individuals were classified with MHOS Femur #4, more commonly named Poirer's Facet. This marker is observed on the femoral head and neck where bone mass from the articular surface of the head begins to extend distally towards the neck of the femur (Kennedy 1989). This condition is caused by flexing the knee in conjunction with extending the hip up towards the chest. Commonly this action is from squatting repeatedly and/or for long periods of time (IBID).

The calcanei have three statistically significant skeletal markers which occur in this population, classified here as Calcaneus #'s 1, 2 and 3. Calcaneus #1 is an exostosis, or bony build-up located at the insertion point of the Achilles tendon and can be indicative of long distance running, especially on hard surfaces, as well as being commonly found on the skeletons of obese females (IBID). There were 4 males and 1 female observed with this affliction. Calcaneus #2 is characterized by exostoses and small fractures associated with repeated sharp impacts with the ground. This can be associated with the riding and dismounting of a horse. Again there were 4 males and 1 female exhibiting these characteristics. Calcaneus #3, represented by 5 males and 3 females, is characterized by bursitis and a bony spur caused by walking on hard pavements. In this skeletal collection there are 2 male individuals who display evidence of all three Calcanea MHOS and 2 males who show Calcaneus #'s 1 and 3 (Agelarakis in manuscript).

Another prevalent MHOS, a marker classified as MHOS Humerus #3, appears dominant in the male population. It is seen in 5 male individuals, but is non-existent in the female population. This is seen as osteophytic growth on the medial epicondyle caused by the hyperactivity of the flexor muscles throughout the arm (Kennedy 1989). This MHOS trait is observed in individuals who regularly throw javelins or in more modern times play golf (IBID). Also present on the upper extremities is a marker classified here as Ulna #1, which occurred in 7 males and 3 females. This marker is indicative of the flexing and subsequent hyperextension of the arm, again similar to the action of javelin or spear throwing (IBID). Also present, but in less significant percentages, is a marker classified here as Scapula #3 which is osteoarthritis of the glenoid cavity or otherwise the location where the rotator cuff attaches to the shoulder. Overall men have 7 instances combined of the four types of Scapula MHOS, Scapula #1-3 which are osteoarthritis of the shoulder and Scapula #4 is due to a tearing of the rotator cuff, while women have only one instance of either Scapula MHOS (Agelarakis 1994).

Significant MHOS appear in the claviculae of a number of individuals. The marker classified here as Clavicle #1 is the emphasized robusticity of the clavicle end where it attaches to the second rib (Kennedy 1989). This robusticity also occurs on the second rib. The causative agent of this skeletal affliction is force applied in a downward direction onto the lateral end of the clavicle and rib 2, possibly as a result of carrying heavy loads such as pails of liquid. The marker classified as Clavicle #2 is the robusticity of the sternoclavicular joint surfaces. This also includes minute bone fragments ossified together into a dense fibrous wedge replacing the fibro-cartilaginous tissue attachments (Kennedy 1989). This is caused by the same force seen in Clavicle #1 as well as force applied in a backwards direction. Markers Clavicle #1 and Clavicle #2 have important implications in the skeletal record in that they represent a clear case of sexual dimorphism. Clavicle #1 occurs in 4 males and 3 females while Clavicle #2 occurs in 5 males and no females. There are three instances where both are present in the same individual (Agelarakis 1994).

Osteoarthritis

In relation to the MHOS found in the clavicle, there are two cases of eburnation. Both instances occur in males; one found in the age sub-group Late-adult, and the other in Maturus. Eburnation indicates an advanced stage of osteoarthritic activity (post-arthritic condition) where the loss of cartilaginous matter in the joint cavity causes the remodeling of the articular bone surface. This remodeling is the result of bone on bone contact which leads to the bone becoming denser and in some cases even polished (Schwartz 1995). Both cases exhibit the emphasized muscular attachment in correlation with the MHOS Clavicle #2 as well as traces of inflammatory processes and severe osteoarthritic activity in these areas. In one individual there is the evidence of a healed fracture which could be indicitive of the arthritic condition being trauma related (Agelarakis 1994).

In these areas of increased stress, there are vestiges of inflammatory processes. Osteoarthritis (OA) occurs in synovial joints containing synovial lining and fluid or basically all joints with socket formations. OA is an inflammatory disease affecting the cartilaginous contents of the joint cavity, constituting habitual exertion involving the specified joint. Manifestations of this, seen in the skeletal record, become evident at approximately 35 years of age. Aspects of this can present themselves as porosity on or around the affected area; osteophytes may be present as small bone growths on the specified articular surface and an affliction known as lipping forms along the edges of the articular surface surrounding the area of destruction (Schwartz 1995). Also apparent, are Spondyloarthropathies: osteoarthropathic conditions occurring specifically in vertebral bodies.

Of the skeletal record, 80% exhibited symptoms of OA; 43% bore indications of spondyloarthropathies. There are eight individuals who did not exhibit characteristics of

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these types of OA. Two of these were under the age of 18, five individuals could be found between the ages of 18 and 25, and one individual was placed in the age sub-group, Late-Adults (35-45 years of age). The majority of these aforementioned specimens were in fragmentary condition when excavated. Because of this poor preservation, it is possible that epiphyseal ends (where OA can be detected) were incomplete, or missing all together.

Despite this, OA characteristics are well dispersed throughout this population. Sixteen percent of the individuals who exhibited symptoms of OA displayed traces of osteophytic growth and 89% exhibited evidence of lipping. These characteristics were found in individuals beginning in the age sub-group, Sub-adult (16/17-18/19 yrs. of age).

There are six cases where characteristics of OA appear in relatively young individuals, three of which are especially unique because of other pathologies involved. Two of these three individuals were assessed to be female, belonging in the age sub-group Sub-Adult, and the third, a male, was placed in the Young-Adult group. The first female had pronounced muscular attachments in the lower extremities. Osteoarthritic characteristics for that individual included porosity and lipping in areas of the metatarsals and the phalanges of the manus (specifically the thumb). The second female exhibited lipping in the acetabulum as well as spondyloarthropathies expressed as osteophytes and lipping. These signs of OA and spondyloarthropathies in this second female could be characterized as traumatic arthritis, due to a traumatic event evidenced by a Schmörl's node. A Schmörl's node is an indentation present in the body or the spongy bone of the vertebra (Schwartz 1995). These herniations are caused by impaction of the spine from actions such as jumping off a horse or off walls (Agelarakis personal communication). The third individual, a male, had traces of Spondylo-arthritis manifested as osteophytes, as well as a range of osteo-arthritic activity occurring in all areas of the skeleton. In these cases many areas affected by OA had correlating MHOS. For example MHOS Clavicle #1, #2 and #3 as well as MHOS Scapula #1 and #3 were consistent with significant porosity and lipping in the same areas.

Trauma

In this sample, there were 8 male and 2 female individuals that exhibited overt incidences of trauma, spread almost equally throughout all age sub-groups. These ten incidences are as follows: two located on the skull cap; one well healed fracture on the clavicle; one pulled M. pectoralis major at the location where it attaches to the humerus; a stress fracture on the ulna; and five incidences of trauma on the lower extremities. The five incidences of trauma on the lower extremities are as follows: two are healed fractures in the tibia; two show examples of an ossified hematoma; and one shows a split in the tibia containing a cloaca, or a drainage area in the middle of the split.

The prevelence of these traumatic incidences becomes increasingly significant with the unusually high appearance of periostitis throughout the population (Agelarakis in manuscript). Of the twenty-two percent affected by this condition, six are male and four are female. Periostitis is the inflammation of the periosteum, or the outermost surface of the bone, which in the process of healing creates an interwoven buildup of osseous material over the affected area (Schwartz 1995). This is seen in the skeletal record as a disturbance on the normal surface of the bone by this reaction site having a porous or even lamellar appearance (IBID).

From the examination of this skeletal record, it was postulated that periostitis was influenced in two specific ways. One possible cause was physical trauma to the affected bone surface. Periostitis can be a long term reaction caused by repeated trauma to areas such as the limbs. For example, horseback riding through dense brush (Agelarakis, personal communication). The other cause was the infiltration of bacterial manifestations through the epiderm, contributing to infection. These infiltrations can be induced by traumatic events, specifically wounds. There are other causes of periostitis, inclusive of secondary periostitis, that can range from general bacterial infections to specific diseases, however they are usually supported by other evidence. Most of these causes were ruled out due to the lack of this supporting evidence. There were certain cases in this study that appear to be secondary based on the location of the reaction. Nonetheless, there are more cases where the reaction occurred on bone surfaces that would be susceptible to external trauma since the bone is located close to skin surfaces with little protection provided by soft tissue. These cases occur in the tibiae, fibulae and on the ulnae.

DISCUSSION/CONCLUSION

This paper has illustrated aspects of daily life in Abdera through in-depth analysis and research of a random sample of the skeletal remains of its inhabitants. Despite the wealth of this city, even at this time in history, there is a great deal of evidence that life was physically demanding for these people. This can be seen in the fact that OA, sometimes even the most severe cases, was found in relatively young individuals as well as the fact that the OA found in this skeletal population statistically correlates with particular MHOS factors. Incidences of trauma in conjunction with observed periostitis support this conclusion as well.

There seems to be a division of labor between males and females however the women of this city led by no means a sheltered existence. It appears that much of the physical labor was spread equally throughout the population, however each gender group appears to have been designated different tasks as well as possibly partaking in some shared activities.

All this is not to say that the inhabitants of Hellenistic Abdera were slaves to the land, attempting to scratch out an existence on this earth while living in a constant struggle for survival. Based on the skeletal record, these people were healthy, hard working individuals who were receiving adequate nourishment and proper health-care. Furthermore some of the MHOS that is recorded can also be caused by extracurricular activities such as sports and other recreational past-times which the historical record has shown existing in this time period. By examining the historical, archaeological, and skeletal biological data one gets the distinct impression that this population led rich full lives through strong cultural and physical ties with the land.

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REFERENCES

Agelarakis, A. 1994. Paper Presented at the 1θ' Ephoreia of Prehistoric and Classical Antiquities of Komotini, Greece.

Aglearakis, A. Manuscript of Hellenistic skeletal population.

Herodotus, Herodotus. Henry Cary, Trans., New York: Harper & Brothers, Publishers, 1864.

Kennedy, K.A.R. "Skeletal Markers of Occupational Stress." In Iscan, M.Y. and K.A.R. Kennedy (eds). Reconstruction of Life From the Skeleton, pp. 129-160. New York: Alan R. Liss, Inc., 1989.

Schwartz, Jeffrey H. Skeleton Keys. New York: Oxford University Press, 1995.

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JAPANESE UNKNOWN WOMEN UNDER THE JAPAN'S ALLIANCE CAPITALISM: THE COMPLEMENTARITY OF THE PRE-EXISTING STRUCTURES AND THE CHANGING IN IDENTITY

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BACKGROUND

A characteristic of Japanese women's participation in the labor market by age is a strong M-shape curve: Japanese women's labor participation keeps increasing until approximately age 20 to 24; then, the ratio of participation decreases rapidly until women reach the ages of 35 to 40; at that point, the ratio again increases until ages 50 to 54; and finally, the women's participation in the labor market decreases again after the second peak (Takenaka, 1989; Brinton, 1993; Takahashi, 1994; Yoshizumi, 1995; Sugimoto, 1997). This phenomenon is primarily caused by a temporary retirement from the labor market for motherhood and child rearing, which is strongly embedded as a gender role and identity for women in Japanese society and culture. However, this M-shape curve does not explain the women who do not retire from the labor market despite their motherhood duties, but it emphasizes the impact of traditional gender roles. Therefore, it is important to gain insight into women who do not retire from the market in order to comprehend the range of concept of Japanese women.

I focused on women working in small family businesses without pay; particularly in family businesses operated solely by a husband and wife. These businesses are typically the bottom of the subcontract system--the system of business networks consisting of a core firm and its allied satellite firms (Gerlach, 1992). Each satellite firm makes goods to order only when the core firm demands, and the core firm controls the amount and price of goods. The subcontract firms are dependent on their core firm orders, and they have subordinates who are similarly controlled and dependent on them. Therefore, the smaller a firm, the more unstable its business situation. The middle- and small-size firms make up the bottom of Japan's economic system (Ueda, 1989).

There are two significant points to highlight in this group of people. First, scholars have focused on the young women in textile mills and in agriculture partially because they know that the women's role as cheap labor is a key for industrial development in any country (Hunter, 1993). Second, there are no precise historical records of how the women working in their family business lived under Japan's rapid economic growth in the post World War II years. Those women did not have a conscious concept of themselves as laborers and therefore did not form labor organizations (Ueda, 1989).

My interest in these women arose due to my own experience of witnessing my mother and women in my neighborhood who worked hard in their husband's businesses as well as performing domestic work without retiring from the labor market. They usually did the same work as their husbands, typically, physical work such as construction. Based on these observations, my specific research question is: besides economic reasons, what makes those women perform their three roles (wife, mother, and worker) without being paid.

DATA COLLECTION

The women in my research were in Osaka, Japan. I designed a survey consisting of open-ended questions mainly. Thirty nine women (ranging in age from 31 to 78) answered the survey. The types of businesses they worked in were construction, ironworks, painting, lumber processing, and grocery or liquor retail. Then, I selected 5 women at random (their ages were: 33; 48; 54; 61; and 63) from those who answered the survey, and each of whom agreed to be interviewed. I interviewed them more than 5 times per person (around 30 minute- to 2 hour-interview at one time) from September through December in 1996.

DATA ANALYSIS

In the process of both working in the businesses and in the home, the women fulfill the identities required by pre-existing social and cultural structures. What I mean by "pre-existing social and cultural structures" is any external sanctions that impose "identities" on us. In other words, external sanctions exist prior to "self" and assign "identities" to us or affect those identities by our experiences and expectations from society and culture. Even if we come into conflict with one (or all) of the "identities" given by the pre-existing social and cultural structures, our cognition of identification of "self" can not react to the pre-existing structures without being influenced by those very structures. The cognition of identity itself is conveyed by the structures, which affect the way in which we conceive ourselves.

There are two kinds of external sanctions: one is abstract or conceptual sanctions, which we practice unconsciously. We call this in general, "culture." The other is conspicuous and explicit sanctions, which we practice consciously, such as legislation, political formulations and economic systems. I will take finances as an example of the two kinds of external sanctions in order to explicate the correlation between the pre-existing social and cultural structures and identities. According to the literature on Japanese families, family finance management is the wife's task in general. The relationship between a wife and a husband in terms of finance management is the relationship of a wage-earner and his partner. Wives receive their husbands' salary and make plans for its usage, even determining how much spending money the husband will receive. Yet they have no right to manage large amounts of money like negotiating house loans. Usually, husbands make the decisions for the immense funds. A wife is the head of the family in terms of house care, whereas a husband is the decision maker for major money management (Long, 1987; Okura-sho Insatsu kyoku, 1987; Roberts, 1994).

According to my data, the same functions in the women's families of my research. Their husbands manage the business funds, while the women manage the family budget. The women working in their husband's family business accept this general role, conceive of it as natural, and conclude that this is a part of their role as "wife," i.e., the women unconsciously identify themselves as a "wife" by exercising this implicit cultural or social practice.

The legal paper work for funding such as applications for funding from banks is a pragmatic and explicit sanction. Since the papers require the signature and *hanko inkan* (stamps of name--usually family name) of the household (most cases are males), the women working in their family businesses typically must ask their husband for his signature and *hanko inkan*. This inability to sign the document enhances the women's consciousness that they are culturally seen as subsidiaries of their husbands, for they can't subscribe their name to the document. In other words, the document makes them recognize that they are neither the householder nor a proprietor of the business by not subscribing their name. Hence they train or cultivate their identity as a wife of the householder or the proprietor. The women in their family businesses discipline their identity as wife by exercising both the explicit and implicit structures/sanctions.

However, the women's identity is not always the same: identity is changing, according to what kind of pre-existing social and cultural structures the women encounter and how they react to the structures. Their identity changes tremendously from wife to mother, usually after they deliver their first child, though this doesn't mean they lose their previous identity. The women typically identify themselves as mother rather than wife when they have to select either identity. Thirty seven women who answered the survey wrote that children were their *ikigai* (whole life) or *takaramono* (precious things) and they felt strongly that they were mothers rather than wives. Some of the informants said that their husbands were like air, i.e., they needed it to live but it was too natural to have it with them to consider it as an important thing. This phenomena occurs partially because these women follow the pre-existing cultural structure, in which womanhood includes the gender roles in family (a father is an economic sustainer of the household, while a mother is a caretaker of the household). In short, once the women have children, they perform the part of womanhood more than before, paying attention to their children. So, they define themselves as mother rather than wife.

In the beginning of their marriages, the women working in their family business did not expect that they would help their husband's business. Yet they started working because of the cultural norm that a wife is *en no shita no chikaramochi* (a hidden helper) of her husband: they were expected to work without being paid. However, they did not stop working even when they did not have to help the business, because they had already established the identity, worker, by performing the way of the pre-existing cultural structure. In this point, their identity is no longer the extended role of the other two identities, wife and mother as *en no shita no chikaramochi*, but an independent identity from the other two.

Although the women working in their family businesses accept the identities assigned by the pre-existing social and cultural structures, they sometimes had conflict or dilemmas. Some women felt that they wanted to draw a salary from the family business as a laborer, on the other hand, they did not want to draw a salary because they still had the sense that their labor was part of their extended role of helper for their families. When they confront such a dilemma, they tend to select the latter. This may show that the influence of the pre-existing structure has more impact on them, yet their reactions have been changing gradually, as they incorporate other information which gives them more options to determine their identities.

CONCLUSION

The three identities (wife, mother, and worker) are coexistent in the women working in the family business, and these identities are reconstructed, first, by their perception and reaction to the pre-existing social and cultural structures, and second, by polishing their identities through enacting the roles. These three roles show at different times and situations, depending on how the women perceive and react to the preexisting structures. When the women react to the structure in the way that the norm indicates, they exercise the identity that the structure assigns to them, and they reconstruct/reconfirm the normative identities. However, when the women react to the structure in a different way than the norm indicates, the women usually are incorporating other information that results in a women's new identity or a new connotation of their identity. For example, the identity, "worker." Before, it implied mostly the extended role of wife and mother acting to protect her family, yet it also contains the sense of the laborer who is entitled to wages. As a result of this shift, the women started organizing their labor union.

Identity/identities and self are contradictory and multiple, depending on how we approach the structures and train or cultivate ourselves. Once the women find out that their identities do not always fit the categories precisely, they discipline and construct their identity by following or resisting the norms of the structures. The more they become conscious of the relationship between the self and the structures and its complexity, the more they themselves become inwardly multiple and contradictory because those structures are not always consistent, involving political economic, cultural, and power relations as well as identities and perceptions.

REFERENCES

Brinton, Mary C. Women and the Economic Miracle: Gender and Work in Postwar Japan. California: University of California Press, 1993.

Gerlach, Michael L. Alliance Capitalism: The Social Organization of Japanese Business. California: University of California Press, 1992.

Hunter, Janet, ed. Japanese Women Working. New York: Routledge, 1993.

Japan. Okura-sho Insatsu kyoku. Nihonjin no Kateikan: Kazoku , Kateini Kansuru Seronchosa Hokokusho. Tokyo: Okura-sho, 1987.

Long, Susan O. Family Change and the Life Course in Japan. New York: China-Japan Program Cornell University, 1987.

Roberts, Glenda S. Staying on the Line: Blue-Collar Women in Contemporary Japan. Honolulu: University of Hawaii Press, 1994.

Sugimoto, Yoshio. An Introduction to Japanese Society. New York: Cambridge University Press, 1997.

Takahashi, Mutuko. "The Issues of Gender in Contemporary Japanese Working Life: A Japanese 'Vicious Circle'." Feminist Issues 14 (1994): 37-55.

Takenaka, Emiko. Sengo Joshi Rodoshoron. Tokyo: Yuhikaku, 1989.

Ueda, Akiko. "Shoto no Gyoshafujintachi: Kenko to Zeikinmondai ni Torikumu." In Onnatachi no Sengoshi: Osaka karano Lepoto, Ed. Etuko Shibata, Osaka: Sogensha, 1989: 208-216.

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Window Into the Past
Diachronic Aspects of Three Ancient Human Skeletal Populations From the Khao Wong Prachan Valley in Central Thailand

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This paper presents significant results of archeo-anthropological research conducted on three human skeletal collections from the Non Pa Wai and Nil Kham Haeng sites in the Khao Wong Prachan Valley of central Thailand, dated from the middle of the 3rd to the middle of the 1st millennia B.C./B.C.E. respectively. These human skeletal remains were excavated by the Thailand Archeometallurgy Project, yielding a total sample size for the three populations of 57 individuals. Methods used for this research project included forensic inspectional techniques (for studying dental morphology and variation, pathology, and dietary patterns for the three populations), and mensurational analyses (for comparative statistical evaluations). Using such procedures, suspected diachronic bio-cultural similarities and differences between the populations were verified. These results provide a "window" into the human condition of these peoples in antiquity--for interested scholars in the social sciences, natural sciences and humanities alike--on two levels. On one level, this project reveals aspects of the biological and paleo-epidemiological conditions, as well as the socio-economic context of each population. On a broader level, it also elucidates facets of the chronological continuum of this region, taking into consideration changes in socio-economic organization, technological capacities of food production, ecology and distribution of diseases, and other relative forces which affected these ancient populations.

INTRODUCTION

Without written records, the responsibility of providing an understanding of ancient populations rests in part in the hands of anthropologists. Using techniques common to a variety of other disciplines, anthropologists retrieve, study, interpret and preserve the cultural remains of earlier peoples, thus slowly creating an ever-widening "window" through which others can observe and examine the human condition in the past. Physical anthropologists play a very important role in this process since they do not study the artifacts that were left behind, but rather they study the actual skeletal remains of the people. This rather unique specialization places physical anthropologists in an equally-unique position to provide relevant information regarding the bio-cultural setting in which our ancestors lived.

As we rapidly approach the 3rd millennium and we ponder the problems which plague our own lives, it is somewhat appropriate to examine populations from as early as the 3rd millennium B.C./B.C.E. to determine aspects of what their lives were like. The Khao Wong Prachan Valley is located in central Thailand, in which the Thailand Archeometallurgy Project located and investigated at least two human settlements, namely the site of Non Pa Wai (NPW), which spans the 3rd to the 1st millennia B.C./B.C.E., and the 1st-millennium B.C./B.C.E. site of Nil Kham Haeng (NKH), only one kilometer southwest of NPW (Pigott, 1989). The evaluation of forensic inspectional and mensurational analyses of human skeletal remains from each site reveals interesting insights into the bio-cultural, paleo-epidemiological, and economic conditions of each site, as well as aspects of the diachronic cultural continuity of the region, during a period of technological changes.

In 1986, the Thailand Archeometallurgy Project (TAP) began its initial investigations in the Khao Wong Prachan Valley under the direction of Dr. Vincent C. Pigott of the University of Pennsylvania Museum. Since both NPW and NKH are located near natural ore deposits, the inhabitants of these sites were amongst the earliest in Southeast Asia to engage in systematic copper and bronze production (and later iron production), and in long-distance trade and exchange of such "luxurious" items. Metallurgical artifacts were also retrieved from human burials from these sites. During the 1986 and 1992 field seasons, human burials were excavated from NPW, and excavations conducted in 1990 uncovered human burials at NKH. The NPW site is comprised of two cultural components which reflect the continuous occupation of the site for almost 2000 years. The earliest component of NPW dates from 2500-1600 B.C./B.C.E.

Because it is the earliest component of the site, it is also the lowest stratigraphic layer, and was therefore excavated in 1992. The later component of NPW was excavated in 1986 and dates from 1600-700 B.C./B.C.E. The NKH site (excavated in 1990) dates from 700-300 B.C./B.C.E. Thus, the three burial groupings/skeletal collections excavated by TAP correspond to stratigraphically-superimposed and temporally-sequential cultural components of the Khao Wong Prachan Valley (Ibid). All human skeletal remains excavated by TAP have been under the direction of Dr. Anagnosti P. Agelarakis, and are currently housed in the Department of Anthropology at Adelphi University.

SAMPLE SIZE AND METHODS

The 1992 excavations of NPW yielded a total of 26 individuals, excavations in 1986 yielded 13 individuals, and the 1990 excavations of NKH yielded a total of 18 individuals. Due to the relatively poor degree of preservation of a number of burials from these sites, the focus of this study turned to dental remains, which tend to preserve better because of their largely inorganic composition (Bass, 1987). The number of individuals with preserved dental remains from the 1992 NPW component is 19 (73%), from the 1986 NPW component is 10 (77%), and from the NKH site is 15 (83.3%). Since approximately three-quarters or more of the individuals of each collection had preserved dentitions, it was determined that dental remains could safely be used as the criterion for representative population samples.

Laboratory analyses of the 1986 NPW and 1990 NKH collections were completed prior to 1996 at Adelphi University (Brower, 1992; Loeb, 1993; Agelarakis, in press). In 1996/1997, the dental remains of the 1992 NPW collection were analyzed for the first time. The dental surfaces were carefully cleaned of soil and/or taphonomic deposits using dental tools and various types of brushes. In the cases where the dental remains were found *ex situ*, they were identified and sorted according to anatomical structure. They were then forensically inspected under low magnification (40-50X) to determine ante-mortem processes of dental eruption and development, morphology, variation, trauma and pathologies, and wear patterns. Age assessments were made according to eruption and developmental stages (Bass, 1987), as well as Brothwell's (1981) occlusal wear classification chart. Various morphological characteristics and pathological manifestations were identified and measured using a sliding caliper and a hand-held monocle with a millimeter scale. Upon completion of the analysis of the 1992 NPW dental remains, the laboratory records of the other two collections were reviewed, and the dental remains were re-examined in a similar fashion to insure the accuracy and compatibility of the data. [Data from the 1986 NPW and NKH collections used in the remainder of this paper refer to Brower (1992), Loeb (1993), and Agelarakis (in press and 1996).]

RESULTS

The nineteen (19) individuals with preserved dentitions found at the 3rd-millennium component of NPW in 1992 represent the full array of age subgroups, ranging in age from neonatal to older than 45 years of age at the time of death. Five (5) individuals belonged to the Middle Adult age subgroup (>25-35 years), which was the most represented age subgroup. Three (3) individuals belonged to the Late Adult age subgroup (>35-45 years) and one (1) belonged to the Middle/Late Adult age subgroup (>30-40 years). Three (3) individuals also belonged to the Infancy I age subgroup (0-6 years), and two (2) individuals belonged to each of the following age subgroups: Infancy II (>6-12 years), Juvenilis/Subadult (>12-18 years), and Young Adult (>18-25 years). Finally, one (1) individual belonged to the Maturus age subgroup (>45-55 years).

A somewhat different demographic profile emerged for the 1st-millennium component of NPW excavated in 1986. Of the ten (10) individuals with preserved dentitions four (4) individuals--the greatest number--belonged to the Infancy I age subgroup, followed by two (2) in the Late Adult age subgroup. One (1) individual belonged to each of the Infancy II, Juvenilis/Subadult, and Young Adult age subgroups, thus revealing some similarities between the two cultural components of NPW. Unlike the 1992 NPW collection, however, only one (1) individual belonged to the Middle Adult age subgroup and there was an absence of individuals belonging to the Maturus age subgroup.

In great contrast to both of the NPW collections, the NKH collection revealed a higher prevalence of subadults and young adults rather than very young and older individuals. Of the fifteen (15) individuals with preserved dentitions, four (4) individuals belonged to the Juvenilis/Subadult age subgroup and another four (4) individuals belonged to the Young Adult age subgroup. Two (2) individuals belonged to each of the Late Adult and Maturus age subgroups. In addition, one (1) individual belonged to each of the Infancy I, Middle Adult and

Middle/Late Adult age subgroups. No individuals were assessed to belong to the Infancy II age subgroup.

Measurements of bucco-lingual and mesio-distal surfaces revealed that virtually all dentitions found in the three collections had larger diameters than contemporary *Homo sapiens sapiens* dentitions (Kraus et al., 1969; Agelarakis, 1996). In addition, greater than 60% of the individuals in the three collections exhibited shovel-shaped incisors. The shovel shape trait is an epigenetic morphological variation which appears with greater prevalence among Asian populations (Tsai et al., 1996). The trait of Carabelli is a trait of non-metric variation expressed in the form of a cusp, tubercle or pit, most frequently appearing on the mesio-palatal surface of the first maxillary molars (Ibid.). This epigenetic manifestation appears in low frequencies among many populations around the world at percentages that range from >4 to ≤20% (Agelarakis, personal communication). In the 1992 NPW collection, 23.5% of the individuals with preserved maxillary molars exhibited Carabelli's trait, as did 30% of the 1986 NPW population, and 33.3% of the NKH population.

Forensic evaluations of the dental remains revealed a number of dental pathologies. Fourteen individuals (73.7%) from the 1992 NPW collection exhibited multiple Linear Enamel Hypoplasias (LEH), as did seven individuals (70%) from the 1986 NPW collection. On the other hand, none of the individuals from NKH exhibited Linear Enamel Hypoplasias. LEH are permanent markers of periodic cessations and subsequent re-activations of enamel production during times of stress (due to illness and/or malnutrition). They appear as distinct grooves in tooth enamel which run perpendicular to the vertical axis of the tooth, and can provide the age at which the period of stress occurred when their distance from the cemento-enamel juncture is measured (Goodman et al., 1980). Periodontal disease was another relatively common dental pathology among the three collections, noted by resorption of alveolar bone, varied degrees of flattening of inter-dental surfaces, and calculus accumulations on supra-gingival dental surfaces (Ortner and Putschar, 1981). Periodontal disease affected eleven (11) individuals (57.9%) from 1992 NPW, as opposed to only four (4) individuals (40%) from 1986 NPW and five (5) individuals (33.3%) from NKH.

It is of great interest to report that no significant differences were observed among the dentitions of the three populations regarding ante-mortem tooth loss and cariogenic lesions affecting dental surfaces. Carious cavities are lytic lesions caused by bacteria which feed off of sugar residues on dental surfaces (Mandel, 1979). Caries were identified on the dental surfaces of five (5) individuals (26.3%) from 1992 NPW, two (2) individuals (20%) from 1986 NPW, and three (3) individuals (20%) from NKH. The ante-mortem loss of teeth provided further information about infectious and/or traumatic conditions which had affected one or more dentitions. Upon the loss of a tooth from its alveolar socket, osteoblastic activity occurs to "heal" the bone surface. From the 1992 NPW collection, six (6) individuals (31.6%) exhibited osteoblastic recovery due to ante-mortem tooth loss, as did two (2) individuals (20%) from 1986 NPW and three (3) individuals (20%) from NKH.

Various aspects of dietary patterns could also be determined from the analysis of dental remains. Half or more of the individuals in the three collections had supra-gingival calculus deposits. Calculus accumulates on dental surfaces as a result of dental hygiene, as well as the preparation and nature of the foods consumed. Also, small cracks and flaked-off enamel around the rings of occlusal surfaces may be indicative of the use of buccal teeth for cracking nuts and other hard foods, or of the presence of an abrasive component in the diet. In the 1992 NPW collection, eleven individuals (57.9%) exhibited such enamel cracks, especially on the occlusal surfaces of buccal teeth. In the 1986 NPW collection, the number of individuals decreased to three (30%), and in the NKH collection, only four individuals (26.7%) exhibited enamel cracks.

Individuals in the three collections also revealed a rather high prevalence of occlusal wear. The occlusion of maxillary and mandibular dentitions slowly erodes the enamel on occlusal surfaces, revealing patches of secondary dentine. Dietary grit and/or partially-processed foods can accelerate the wear of occlusal surfaces, usually resulting in irregular platforms (Hillson, 1979). In the case of the three populations, relatively uniform, oblique surfaces were common, which may be indicative of the presence of dietary grit. Eleven individuals (57.9%) from 1992 NPW revealed moderate to severe cases of occlusal wear, as did nine individuals (60%) from NKH. However, the scenario for the 1986 NPW collection is very different. Nine individuals (90%) from 1986 NPW exhibited occlusal wear, in addition to five individuals (50%) exhibiting another form of dental wear which resulted from mechanical modifications of incisal surfaces of the labial teeth. This did not appear in the other two collections. Mechanical wear differs from occlusal wear in that it is characteristic of the use of teeth as a "third hand" when habitually performing a particular function. Another interesting phenomenon which was present in both of the NPW collections, but not in the NKH collection is the bi-lateral ante-mortem loss of maxillary canines and/or lateral incisors. Three male individuals from 1992 NPW and one male individual from 1986 NPW displayed this, and it may be related to the habitual and/or occupational use of the teeth for certain activities, such as rope-making (Agelarakis, 1996).

DISCUSSION

Having attained these results, it was observed that, from skeleto-biological, morphological and paleopathological points of view, little bio-distance exists between the two components of the NPW site. Great similarities between these two components are evidenced not only through the paleo-epidemiological record, but also through the biotic and abiotic components of their environmental contexts (Pigott, 1989, Agelarakis, personal communication). Hence, for the purposes of this study, the two cultural components of NPW were considered as a relatively homogenous bipartite population-unit--to reflect the two sequential cultural components--which could then be compared with the NKH site.

The differences in the demographic profiles in conjunction with the paleo-epidemiological record of the NPW and NKH populations provide insights into the socio-economic conditions which "affected" these peoples. The high ratio of individuals from NPW assessed to be in the Infancy I age subgroup is coupled by a very high percentage of LEH manifestations (nearly 75%). On the other hand, relatively few individuals from NKH were assessed to be infants, and there was a complete absence of LEH throughout the population. These conditions indicate that by the middle of the 1st millennium B.C./B.C.E., and with the introduction of iron production, better cultural buffer mechanisms existed for the care of infants during their crucial early developmental stages (Agelarakis, 1996). The other peculiar characteristic of NKH demography is the high mortality rate of juveniles, subadults, and young adults. It is possible that the mining of iron ores and the production of iron items proved to be so lucrative, that more young people were put to work in order to increase production.

The slightly higher prevalence of ante-mortem tooth loss and periodontal disease in the NPW populations reveals a low degree of oral hygiene which improves somewhat in the NKH population. The varied amounts of calculus deposits are similarly indicative of a lack of oral hygiene, and also implicate a slightly "rougher" diet than that of contemporary societies which consume highly-refined foods. According to Hillson (1979), the combination of the relatively high frequency of calculus deposits and the low frequency of dental caries demonstrates that the composition of the foods consumed in the region for three millennia was consistently low in carbohydrates/sugars and high in proteins. In addition, the degree of dental wear on occlusal surfaces partly supports the notion of a rougher diet (dietary grit), yet the uniform, oblique surfaces which resulted from mastication reveal that their foods were relatively well-prepared (Agelarakis, 1996). However, it is important to note that enamel cracks were identified on more dentitions from NPW (especially those from the earlier component of the site) than from NKH, which indicates the possibility that they were cracking harder foods, such as nuts.

While mechanical wear and the bi-lateral ante-mortem loss of maxillary canines and/or lateral incisors do not reflect dietary patterns, they are indicative of cultural influences and behaviors, such as habitual and occupational stress. The four male individuals from NPW who exhibited the bi-lateral ante-mortem loss of teeth ranged in age from one juvenile to one young adult and two middle adults. The completed osteoblastic recovery of maxillary bone in the areas where tooth/teeth had been lost indicates that they were probably engaged in similar activities, namely manipulating fibrous materials using their teeth (Ibid.).

Finally, the genetic variations of morphological characteristics, namely the shovel shape trait and the trait of Carabelli, provide a picture of an overall genetic continuity of the populations. The overwhelming number of individuals from both sites of the Khao Wong Prachan Valley which exhibited the shovel shape trait--a typical Asian type trait--is indicative of a retention of a dental epigenetic type trait of a base population, which was, however, open to gene flow (Agelarakis, personal communication). This is further supported by the rate of prevalence of Carabelli's trait (20-30%) amongst these people, especially when one considers that the prevalence of this trait increases consistently through time.

CONCLUSION

Forensic analyses of the dental remains of the peoples of the Khao Wong Prachan Valley have brought to light various aspects of the human condition in one geographic area in the course of nearly three millennia. The unique location of the NPW and NKH sites to copper and iron ore deposits affected every aspect of these peoples' existence. The foods they ate, the care given to children, and the dental pathologies from which they suffered are just a few examples of bio-cultural characteristics which were determined by their engagement in metallurgy. Their choice of occupation in turn determined their environmental conditions, economic system, and social groups. The shift in technologies, from copper to iron mining and production, resulted in certain cultural changes detectable in the skeletal record, but there remains a general view of cultural continuity in the region.

The window into the past of these peoples has now been opened and awaits further analysis by other scholars. The Thailand Archeometallurgy Project has already located skeletal remains from another settlement in the region which would greatly add to the existing database of knowledge and information. In addition, a complete synthesis of information from other TAP researchers is necessary to further reconstruct aspects of the living conditions and bio-cultural environments of these metallurgists in central Thailand. As we peer into this window, it is important to keep in mind just how much we do not know about these populations, and what we may never learn because it was not reflected in the archeological record. Only continued research in the future by a variety of scholars can provide more answers as more interest for such information is stirred.

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REFERENCES

Agelarakis, A.P. "The Archaeology of Human Bones: Prehistoric Copper Producing Peoples in the Khao Wong Prachan Valley, Central Thailand," Indo-Pacific Prehistory: The Chiang Mai Papers, Volume 1, IPPA Bulletin 14, (1996) 133-139.

________ "Some Reconstructions of the Human Condition During the 3rd Millennium B.C.E. in S.E. Asia Through the Bio-Archaeological Studies of Human Skeletal Remains." Proceedings of the 4th International Conference of the European Association of Southeast Asian Archaeologists (in press), Instituto Italiano per il Medio ed Estremo Oriente, Rome.

Bass, W.M. Human Osteology: A Laboratory and Field Manual, 3rd Ed. Columbia, Missouri: Special Publication of the Missouri Archaeological Society, 1987.

Brothwell, D.R. Digging Up Bones. Ithaca, NY: Cornell University Press, 1981.

Brower, J.S. "Reconstructions of Human Bio-Cultural Conditions During the 3rd Millennium B.C. in S.E. Asia Through the Bio-Archaeological Studies of Human Skeletal Remains," Proceedings of the Sixth National Conference on Undergraduate Research (1992).

Goodman, A.H., Armelagos, G.J. and Rose, J.C. "Enamel Hypoplasias as Indicators of Stress in Three Prehistoric Populations From Illinois," Human Biology 52 (1980) 515-528.

Hillson, S.W. "Diet and Dental Disease," World Archaeology 11 (1979) 147-162.

Kraus, B., Jordan, R. and Abrams, L. Dental Anatomy and Occlusion. Baltimore: Williams & Wilkins Company, 1969.

Loeb, J.R. "Skeletal Markers of Stress: The Human Condition in Bronze Age Thailand," Proceedings of the Seventh National Conference on Undergraduate Research (1993) 558-562.

Mandel, I.D. "Dental Caries," American Scientist 67 (1979) 680-688.

Ortner, D.J. and Putschar, W.G.J. Identification of Pathological Conditions in Human Skeletal Remains. Washington, D.C.: Smithsonian Institution Press, 1981.

Pigott, V.C. National Science Foundation Grant, 1989.

Tsai, P.L., Hsu, J.W., Lin, L.M. and Liu, K.M. "Logistic Analysis of the Effects of Shovel Trait on Carabelli's Trait in a Mongoloid Population," American Journal of Physical Anthropology 100 (1996) 523-530.

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Whole Vessels From Kichpanha, Belize: Implications of Increasing Social Complexity

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Archaeologically excavated whole vessels from the ancient Maya site of Kichpanha, Belize have been analyzed using the type:variety method. This system of pottery analysis allows for defining chronological developments and serves as a means for comparative assessments. The Kichpanha collection provides a direct view of an ancient Maya community in terms of developing complexity i. e., social interaction, political alliances, and economic growth from approximately 1000 BC to AD 1150.

INTRODUCTION

This paper focuses on the excavated and analyzed whole ceramic vessels from the ancient Maya site of Kichpanha, Belize. The analysis has identified these vessels and placed them into associated time periods seen at other sites in the Maya lowlands. The site is located southeast of Orange Walk Town, Belize (Figure 1) within a chert bearing zone surrounded by water resources (Gibson 1982). The site was recorded by the Corozal Project in 1973 (Hammond 1973) and the Colha Project in 1979 (Kelley and Valdez 1979) with excavations commencing in 1983 and continuing until 1990 (Shaw 1992).

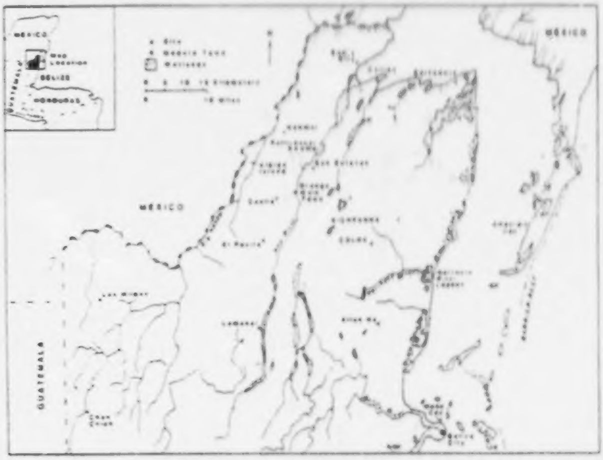

Figure 1: Belize, Central America with the site of Kichpanha indicated (Shaw 1992).

ANALYSIS OF WHOLE VESSELS

The time span at Kichpanha is represented by 33 reconstructable whole vessels, along with several thousand analyzed potsherds, that date the site from ca. 1000 BC to AD 1150 (Reese and Valdez 1987). Dates were derived by using the type:variety method of pottery analysis and comparisons to dated collections from other sites. The type:variety system of analysis isolates individual pottery elements into units that are similar (Willey et. al.

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1967). Conformity of the material places it into intervals of years that are bounded by upper and lower limits; these limits are defined by change in the elements showing development in culture process (Gifford 1976).

The Middle Preclassic (ca. 1000-300 BC) is characterized by unslipped and monochrome slipped vessels. Red, white, black, and cream are the monochrome colors of this period (Sabloff 1975). Simple incised lines, fingernail impressions, and horizontal fluting occur as surface decoration (Adams 1971). Low-walled flat plates and medium to low necked jars are diagnostic forms (Willey et. al. 1975). There are two whole vessels in the Kichpanha collection of this period. Figure 2 shows general forms of Middle Preclassic Maya pottery.

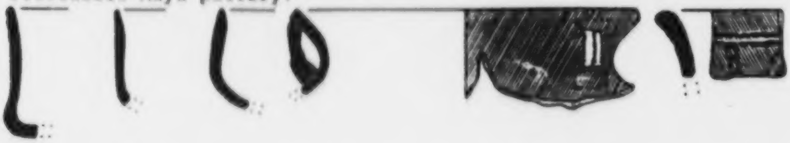

Figure 2: Examples of Middle Preclassic Maya pottery (Courtesy of the Colha Project).

The Late Preclassic (ca. 300 BC-AD 0) is dominated by the monochrome tradition of the previous period with the addition of orange as one of its colors and dichromes (the use of two colors) appear in small amounts during this period (Sabloff 1975). The labial-flanged bowl dominates and the jars of the previous period go unchanged (Adams 1971). The incision and surface modification are not as prevalent as the previous period (Adams 1971). Uniformity in form and technical aspects are refined typifying this time period (Adams 1971). Five whole vessels represent the Kichpanha collection during this time period. Figure 3 shows common Late Preclassic forms in Maya pottery.

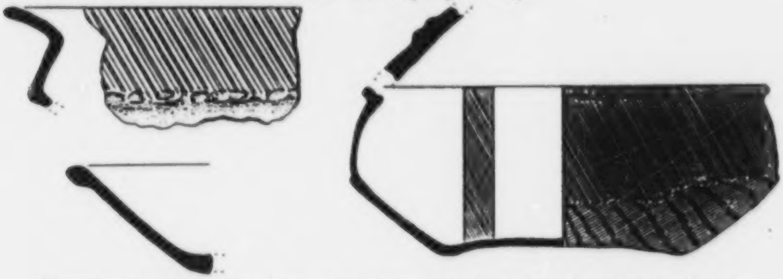

Figure 3: Pottery from the Late Preclassic (Courtesy of the Colha Project).

The Protoclassic (ca. AD 0-250) continues the same monochrome convention as in the previous two periods with dichrome frequency increasing (Willey et. al. 1967). The introduction of polychromes, the use of three or more colors, is seen in the Protoclassic, but they are limited in number (Gifford 1976). Parallel grooves and other abstract designs are seen also (Meskill 1992). Mammiform-footed vessels, Z-angles, and ring bases see introduction and medium necked jars continue during this period (Sabloff 1975). 14 whole vessels have been recovered from Kichpanha for the Protoclassic. Examples of Protoclassic Maya pottery are shown in Figure 4.

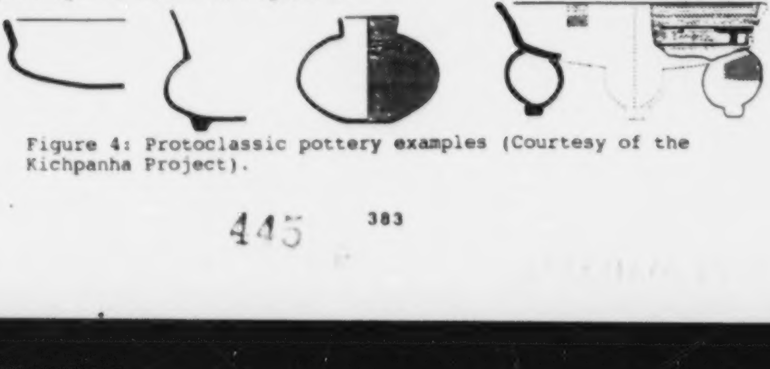

Figure 4: Protoclassic pottery examples (Courtesy of the Kichpanha Project).

The Early Classic (ca. AD 250-600) is dominated by orange and black monochromes and polychrome decoration on vessel interiors and exteriors (Willey et. al. 1967). Decorations are elaborate naturalistic animal motifs, glyph bands, and incision (Adams 1971). The ring base from the previous period is combined with a new basal flange and,a slab-footed cylindrical tetrapodal vessel emerges (Sabloff 1975). Kichpanha is represented by seven of these types of whole vessels. Figure 5 illustrates Early Classic Maya pottery.

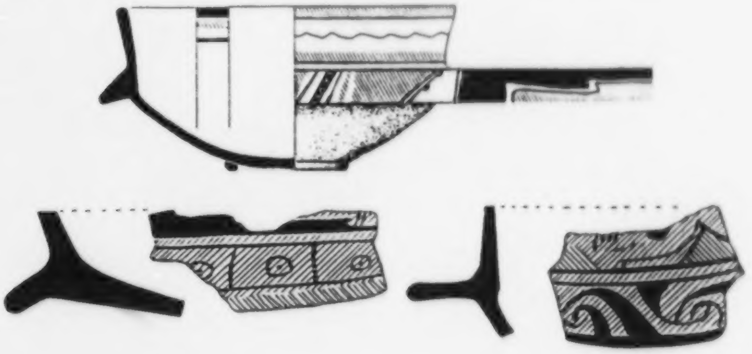

Figure 5: The Early Classic illustrated (Courtesy of the Colha Project).

The Late Classic (ca. AD 600-850) is represented by the greatest development in Maya lowland pottery (Adams 1971, Gifford 1976, Sabloff 1975, Valdez 1987, Willey et. al. 1967). Polychromes dominate with well conceived and executed motifs; red monochromes and unslipped vessels are quantitatively represented also (Willey et. al. 1967). Vessel forms consist of basal-ridged tripod footed plates, flat-bottomed cylinders, and thin walled jars (Adams 1971). Four whole vessels are represented at Kichpanha during this time period. Figure 6 presents a variety of vessels that occur during the Late Classic time period.

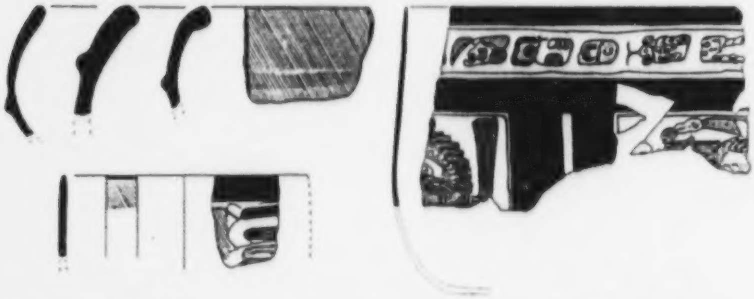

Figure 6: Late Classic characteristic forms (Courtesy of the Colha Project).

The Postclassic (ca. AD 850-1150) is characterized by unslipped and monochrome red or orange vessels. Although polychromes are present in the Postclassic (Gifford 1976) none are known from Kichpanha. A blue wash is also seen during this period (Valdez 1987). Diagnostic forms consist of anthropomorphic figures and vessels with scroll shaped feet (Willey et. al. 1967). One whole vessel occurs at Kichpanha during this time period. Figure 7 illustrates some characteristic elements of the Postclassic period.

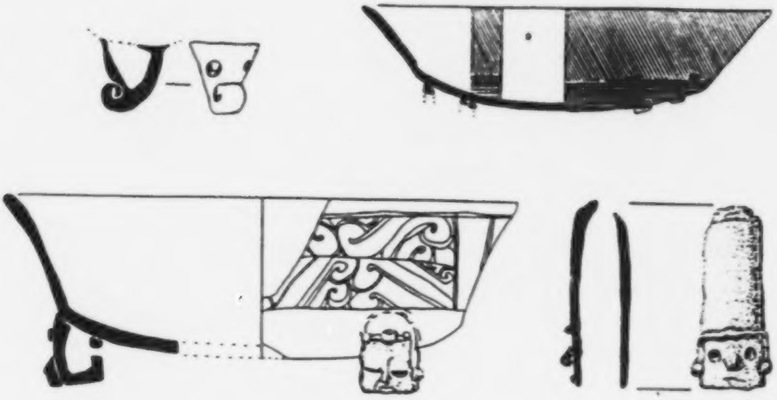

Figure 7: Examples of Postclassic Maya pottery (Courtesy of the Colha Project).

SUMMARY

A review of the attributes of each time period shows a shift from a modest pottery to an elaborately detailed pottery. Middle and Late Preclassic (ca. 1000 BC-AD 0) features include an emphasis on monochrome colors and surface decoration consisting of fingernail impressions and incised lines. The Protoclassic (ca. AD 0-250) is typified by an increase in the number of monochrome colors, wavy line incising with more complicated arrangements, and the introduction of mammiform feet on bowls, dishes, and plates. The Early Classic (ca. AD 250-600) sees an elaboration of polychromes, basal-flange bowls and incised abstract and geometric designs. The Late Classic (ca. AD 600-850) provides the greatest increase of polychromes and elaborate glyphic representations on the interiors and exteriors of vessels. The Postclassic (ca. AD 850-1150) represents a re-occupation of the site after a 100 year cessation. The styles represented in the Kichpanha collection are in the form of unslipped effigy censers and fragments of red slipped vessels and a blue pigment rather than a slip.

IMPLICATIONS

Early in a society's development everyone in that society is expected to contribute to its survival. As population increases less emphasis is placed on subsistence and the increase in specialists is seen. The support of these specialists is provided in return for the manufactured good that they generate. Through time the detail of these produced goods is mastered and artistic expression, in some cases, is seen. The variation in pottery form, decoration, and the expansion of colors used indicates this specialization.

The abundance and preservation of pottery serves as an excellent indicator of political, social, religious, and economic change throughout time in the Maya lowlands. Clay constitutes the raw material from which pottery is made which can be manipulated into an infinite number of shapes. The ability to vary shape and design allows an artisan to create a vessel according to what society demands at that time.

Through ceramic analysis it is possible to observe increasing specialization and complexity by the way pottery is manipulated as expressed by vessel forms and decoration. The lowland Maya began with relatively simple forms in the Preclassic terminating Classic life with detailed polychromes and glyphic expressions. This increased complexity observed in the pottery reflects similar developments in stone tool (i. e. chipped flints), jades, architecture, and in corresponding social institutions. A ceramic study cannot stand alone in determining social complexity; along with other artifact categories, minute changes in pottery attributes help to illuminate changes in cultural complexity.

REFERENCES

Adams, Richard E. W. "The Ceramics of Altar De Sacrificios." Papers of the Peabody Museum No. 63 (1971) Cambridge, Massachusetts.

Gibson, Eric C. "An analysis of the Late Classic Maya Settlement Pattern at Kichpanha, Northern Belize." In Archaeology at Colha, Belize: The 1981 Interim Report, Edited by T. R. Hester, H. J. Shafer, and J. D. Eaton. Center for Archaeological Research, The University of Texas at San Antonio, and Centro Studi e Ricerche Ligabue, Venezia, San Antonio, 1982: 152-166.

Gifford, James C. "Prehistoric Pottery Analysis and the Ceramics of Barton Ramie in the Belize Valley." Peabody Museum of Archaeology and Ethnology Memoirs 18 (1976) Cambridge, Massachusetts.

Hammond, Norman. British Museum - Cambridge University Corozal Project, Interim Report. Cambridge, England, 1973.

Kelley, Thomas C. and Fred Valdez Jr. "Site Survey at Kate's Lagoon (Kichpanha)." The Colha Project, 1979: A Collection of Interim Papers, Edited by T. R. Hester. Center for Archaeological Research, The University of Texas at San Antonio, San Antonio, 1979: 164-165.

Meskill, Frances K. "Ceramics and Context: A Protoclassic Perspective from the Sites of Kichpanha and Colha, Northern Belize." Diss. University of Texas at San Antonio, 1992.

Reese, Kathryn V. and Fred Valdez Jr. "The Ceramic Sequence of Kichpanha: 1979-1985 Seasons." Maya Ceramics: Papers from the 1985 Maya Ceramic Conference. Edited by P. M. Rice and R. J. Sharer. BAR International Series No. 345, 1987: 37-45.

Sabloff, Jeremy A. "Ceramics. Excavations at Seibal, Department of Peten, Guatemala." Peabody Museum Memoirs 13.2 (1975) Cambridge, Massachusetts.

Shaw, Leslie C. "The Kichpanha Project: Summary of the 1990 Season." Report Submitted to the Belize Department of Archaeology, 1992.

Valdez Jr., Fred. "The Prehistoric Ceramics of Colha, Northern Belize." Diss. Harvard University, 1987.

Willey, Gordon R., T. Patrick Culbert, and Richard E. W. Adams, "Maya Lowland Ceramics: A Report from the 1965 Guatemala City Conference." American Antiquity 32 (1967): 289-315.

Form and Function of Late Preclassic Maya Pottery

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Late Preclassic Maya Pottery (ca. 300 BC - AD 250) excavated from several sites in northwestern Belize has been evaluated for function based on form and context(s). The collection analyzed is from the Programme for Belize Archaeological Project (1992 - 1996) and serves as a model for understanding ceramic shapes and their uses. Aspects of pottery form and function also provide information about aesthetic values, preferences, and interactions among the ancient Maya societies of the Late Preclassic Period.

INTRODUCTION AND BACKGROUND

The Programme for Belize Archaeological Project began its first season in 1992, with continuing research still in progress, to provide information about the ancient Maya of northwestern Belize. The project goals are to identify, through survey and excavation, the remains of the Maya in the Rio Bravo Conservation and Management area (Figure 1). The last five field seasons, from 1992 to 1996, produced more than 50,000 pottery sherds from several sites including My Lady, Ma'ax Na, Guijarral, Dos Hombres, and El Arroyo (Hughbanks 1995; Brown 1995; Houk 1996; Tovar 1996). The collection of pottery sherds used for this research is Late Preclassic, which dates from 300 BC to AD 250. During this time period, pottery characteristics changed rapidly with great advances in the technological abilities of the Maya. It is these changes that allow for interpretations of stylistic preferences. Pottery styles can indicate trade and exchange locally as well as long distance concerns while vessel forms (bowls, jars, etc.) are the basis for determining function.

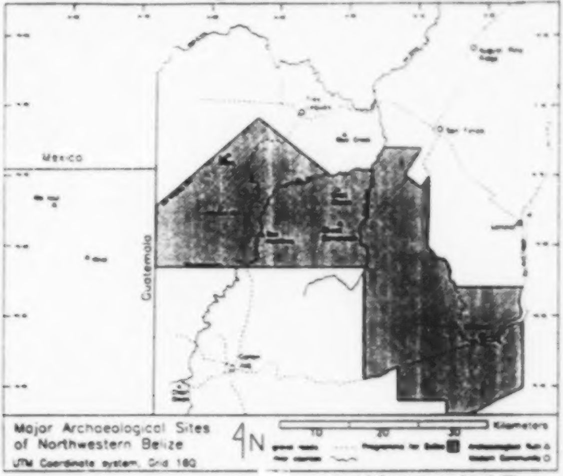

Figure 1. Map of the Rio Bravo Conservation and Management Area (shaded).

The objectives of this research is to provide information about: 1) the function of pottery; 2) aesthetic values and preferences of pottery; and 3) show the societal interactions of the Late Preclassic Maya as determined from the pottery. Each of these three objectives will be discussed below followed by an overview concerning the use of ceramic analysis for reconstructing ancient Maya life and belief (Adams 1971; Sabloff 1975; Gifford 1976; Valdez 1987). While not all encompassing, this research serves as a general point of reference for a potential use of pottery analysis.

POTTERY: FUNCTION, AESTHETICS, AND INTERACTIONS

The function or use of pottery is based upon vessel form which provides a practical perspective. Ethnographic analogy serves to verify the function of certain pottery forms. Bowls for example may be plain (i.e., non-slipped)or slipped (red predominates). Bowls may also have appendages such as a basal flange. Generally bowls are considered to function as storage and/or serving vessels. Unslipped bowls may be used for holding dry goods such as corn or beans. Slipped bowls are often used to contain liquids. The basal flange mentioned before may serve as a means for carrying hot liquids such as soups. The flange allows for greater carrying control and keeps fingers away from direct contact on what may be the hot surface of the bowl (Figure 2).

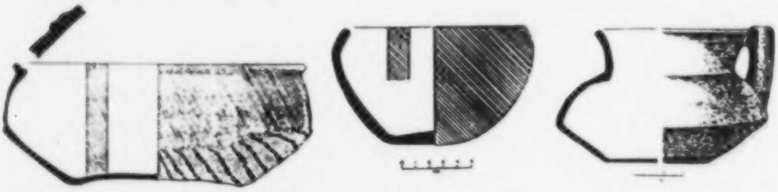

Figure 2. Selected Preclassic vessel forms.

Jars vary in size and surface treatment according to required function. For example, large jars represent communal serving and storage while smaller jars function as family consumption vessels. Surface treatment includes plain surfaces (unpainted) which allows the vessel wall to breathe or sweat helping to keep water cool in the container.

Slipped jars hold in liquids better than unslipped versions and can be used for cooking as well. All jars can also be used for storage, often long term, of dry foods. Appendages such as strap handles are common on slipped jars for ease of carrying while unslipped jars are often striated and without handles. The straps on the slipped vessels serve as a safe way of carrying the containers. The unslipped jars are striated to prevent the vessel from slipping, especially when wet (Figure 3).

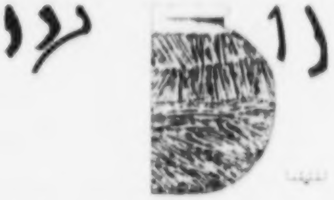

Figure 3. Example of a striated jar.

Other forms that indicate specific function include plates and bottles. Plates (or dishes) are considered to be serving vessels from which prepared food may be consumed. Bottles are most often used for holding a liquid. Bottles are also among the most elaborate inform. from simple undecorated forms to elaborate effigies i.e., in human and animal shapes.

One function, that of ritual or ceremonial activities may use almost any vessel form. However, the ancient Maya did make a censer ware, usually somewhat coarse in texture, that was used exclusively for ritual purposes. This function for the coarse surfaced pottery is determined from the consistent context in which these vessels are found, near temple tops and in caches which are defined as ritual offerings.

The aesthetics of Maya pottery can be observed on a great range of pottery types. Plain wares or monochromes exhibit preferred styles and what were probably the aesthetic values for these vessels by Maya society. More complex pottery includes dichromes (the use of two colors) and polychromes (the use of three or more colors) on various vessel shapes (Figure 4). Added to the use of color(s) is surface modification such as punctating, incising, and molding or modeling.

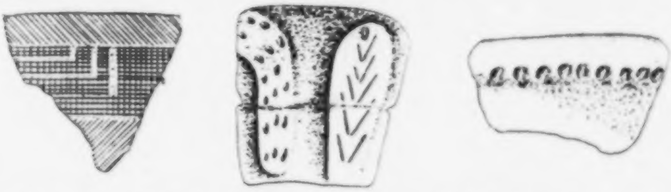

Figure 4. Various decorative techniques (bichrome, incising, punctating).

In the Late Preclassic period (300 BC - AD 250) Maya pottery changed dramatically in form variation and decoration (Meskill 1992). By the last century of the phase, pottery was quite elaborate setting the stage for Classic Maya expressions. Although monochromes are made and used throughout Maya history, surface modifications and specialized techniques of color enhancement become more commonplace as the Late Preclassic develops. Surface modifications include the use of punctation such as thumbnail impressions, reed punctating, in addition to incising, and carving to achieve certain decorative effects. Bichromes and polychromes are often accomplished through the use of several pigments for color (slip) differences. However, these color effects are also possible by resist or negative painting techniques, through the slip incising, and differential firing to name a few. These techniques are more commonplace on vessels from ceremonial contexts and burials. Some of these elaborate pots represent social status differences as expressed through access to these often unique items. In terms of aesthetics, the new and complex decorations and decorative techniques reflect a society becoming more varied in its artistic expressions and in what the ancient Maya society accepted as useful vessels.

Above surface modifications as a means of decorative effect, the modeling or shaping of vessel form was also an aesthetic concern. While most vessels are in the usual shapes of plates, bowls, and jars with the new decorative techniques, the production of effigy vessels becomes more apparent in the Late Preclassic. The latter is expressed through a range of bottles, bowls, and jars often depicting humans or animals (Figure 5). These Preclassic shapes are most often naturalistic forms.

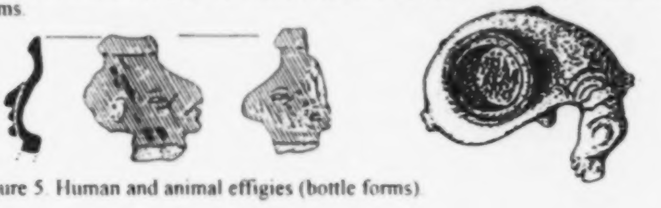

Figure 5. Human and animal effigies (bottle forms).

The Late Preclassic pottery allows a very special look at Maya society as it grew, became more complex, and set the scene for the Classic period to follow. It is possible to view increased interactions through the ceramics as pottery types become more uniform and the increase in form variation is duplicated at different sites. These systematic, but coordinated developments show an increased interaction and communication between Maya settlements.

Thus, interactions as commented above are those involving communication between sites and the Maya world in general. For example, in the Late Preclassic the pottery type called Sierra Red is recognized across the Maya lowlands. Local or site specific interactions are also apparent in the ceramic assemblage. These are best demonstrated in middens (trash deposits), burials, and caches (or special offerings).

Middens provide common or daily use pottery fragments. These can be correlated across a settlement to determine intrasite exchange. Particular households may share certain ceramic types indicating a social and/or economic relationship. Burials may serve a similar purpose when trying to determine access to selected pottery types. Especially important in burial vessels of the Late Preclassic is the opportunity to observe class or status differentiation. By the Late Preclassic, social ranking is very distinct as observed by the contents of burial furniture (Figure 6). These social differences in status are continued through the Classic Period as demonstrated by more complex types and greater numbers of pots placed with the deceased individual.

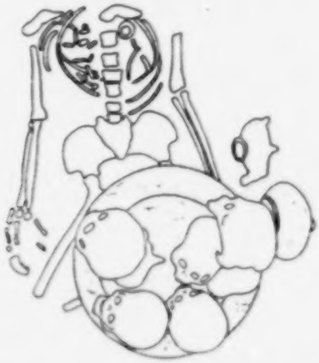

Figure 6. Late Preclassic Burial of a high status female (from Meskill 1992).

SUMMARY AND IMPLICATIONS

In summary, vessel function is determined from several lines of evidence including archaeological context, historical observations, and contemporary use. Thus, most designations of function for excavated pottery is securely founded. The defined functional use of storage vessel, serving item, for food preparation, etc. indicate the most common and probable use, but not necessarily the only use.

The aesthetics for Late Preclassic Maya pottery grew in various directions and expressions. The use of multiple colors accomplished through pigments, incising, and differential firing are but one expression of this society's aesthetic values. The increased use of naturalistic forms (human and animal) may reflect the ancient Maya world view during this period of rapid development.

The use of ceramics to determine interactions occurs at the regional and local level. These interactions may be family related, generally social as in obligation(s), or economic. Long distance trade of pottery or the ideas behind certain styles may be seen through the occurrence of similar materials at distant sites. Within a site similar interactions can be studied through distribution patterns.

Included in social interactions as determined from ceramic studies is the degree of ranking and status development most often observed from burials.

Ceramic analysis serves to define a number of valuable attributes of ancient life. From this study of Late Preclassic Maya pottery it can be said that ceramics had a wide range of functions as defined primarily from vessel form. Aesthetics become increasingly important through this phase and interactions can be described through the distribution of certain pottery types. While pottery analysis alone cannot answer all of the questions about ancient Maya life, it is certainly a very reliable scale from which to compare the development of social complexity.

REFERENCES

Adams, Richard E. W. "The Ceramics of Altar de Sacrificios." Papers of the Peabody Museum No. 63 (1971) Cambridge, Massachusetts.

Brown, M. Kathryn. "Test Pit Program and Preclassic Investigations at the Dos Hombres, Belize. Unpublished M.A. thesis, The University of Texas at San Antonio, 1995.

Gifford, James C. "Prehistoric Pottery Analysis and the Ceramics of Barton Ramie in the Belize Valley." Peabody Museum of Archaeology and the Ethnology Memoirs 18 (1876) Cambridge, Massachusettes.

Houk, Brett A. "The Archaeology of Site Planning: An Example from the Maya Site of Dos Hombres, Belize." Unpublished dissertation, University of Texas at Austin, 1996.

Hughbanks, Paul J. "Research at Guijarral (RB-18), 1994." The Programme for Belize Archaeological Project: 1994 Interim Report, Edited by Richard E. W. Adams and Fred Valdez Jr. The Center for Archaeology and Tropical Studies and the University of Texas at San Antonio, 1995.

Meskill, Frances K. "Ceramics and Context: A Protoclassic Perspective from the Sites of Kichpanha and Colha, Northern Belize." Unpublished dissertation, University of Texas at San Antonio, 1992.

Sabloff, Jeremy A. "Ceramics. Excavation at Seibal, Department of Peten, Guatemala." Peabody Museum Memoirs 13.2 (1975) Cambridge, Massachusetts.

Tovar, Lynne C. "Maya Lithic Production and Consumption in the Late Classic." Unpublished M.A. thesis, University of Texas at Austin, 1996.

Valdez Jr., Fred. "The Prehistoric Ceramics of Colha, Nothern Belize." Unpublished dissertation, Harvard University, 1987.

453

Southern Plains Powwow Culture: Exploring the Identity of the Drum

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When beginning research on Southern Plains powwow culture, confusing information is encountered about the instrument used in the performance of powwow songs. Singers refer to the drum as an 'instrument', and as a 'relative', and they refer to themselves as the 'drum'. This paper will analyze the processes by which the multiple identities of the instrument are constructed both as physical entity and in performance. The analysis extends to human participants because the identities of the singers are combined with the drum. These identities connect to beliefs about the power inherent in the drum, the personal power of male and female singers, and the power of performance felt by participants in the powwow events. This ethnographic study is based on interviews and participant observation from the summers of 1995-96.

Identity of the Drum

The drum is at the center of the powwow event and the focus of most participants' attention. The word "drum" signifies more than an instrument; it is inclusive of all singers that join in performance during the powwow. Without a drum (singers), there would be no powwow. The drum is a physical instrument and a separate entity. In Indian powwow culture, the drum is the single most important sign; the drum's spirit or heartbeat is alive within it and is believed to be a gift from the Great Spirit. Singers told me that the way a drum is put together will determine the quality of the drum's sound. A man wishing to have a drum made will often seek out a trusted and good drummaker. The thoughts that the drummaker has while constructing a drum influence the sonic outcome, because the sound that a drum produces is not just the sound of the instrument but also the thoughts of the drummaker. If a drum is properly constructed from the beginning, with good feelings and thoughts, it will have great strength and power. The two concepts of the drum as an instrument and the drum as referring to singers are tightly interwoven, contributing to the idea that the drum has a dual identity (Stout, 1997).

Elders believe the drum possesses great strength and exists as a person. Many people refer to the drum as an old man, and they treat it as a human with respect. Lamont Brown, a Ponca singer, explained

> Now, about that drum that we sing by. Our old people say when the drum is brought to you--when you accept the drum--it's just like adopting through Court as of today, another member in your family. You've got to be good to

> other people as they were good to bring you the drum--you got to take care of the people that brings the drum to you and everybody that's connected with it. Now that's the way our old people thought about the drum. (Maker, 1968:3)

Singers look after the drum, keep it covered and warm, and often keep it in the corner of a living room or bedroom. When a drum is used for powwows it is usually blessed. Blessing a drum does not involve an elaborate religious or sacred ceremony, but means it has been prayed over and smoked with cedar. The people praying ask that the drum be used in the right way, that it be used with good thoughts. A blessing is also asked for the singers that sit around the drum because they are considered part of it. Some singers told me when they think of this blessing, it reminds them that they are to come to sit around the drum with respect and good feelings. Head singers and other singers sit at their drum before a powwow begins and say a short prayer, asking for all these blessings and good things to be realized at that drum.

After a drum has been blessed it will not be used for certain things. For instance, a drum that has been blessed will never be used around alcohol, which is considered to be a contaminator. Drums used during a dance session for a powwow are never the same drums used at a 49 event. A 49 is an informal session that takes place after the dance session is over for the evening and may be held in a secluded place away from the dance arena if alcohol is involved.

The Drum's Power

The drum is the nucleus of the powwow event. This concept is obvious in the physical setting at Southern Plains powwows, where the drum is placed in the center of the dance arena. Dancers form the next concentric circle as the activity and attentiveness radiates outward. Normally, the head singer makes sure he has a drum--the instrument--and whoever wants to support the head singer will show up to sing. If a head singer is popular, two or more drums may be lined up in the center of the dance arena to accommodate the singers.

The contest powwow has changed the placement, although not the power of the drum. Today, due to drum competitions for contest powwows, singers practice as structured and fixed groups and choose to come to powwows as pre-formed groups with names. To allow enough space for drums and singers at contest powwows, groups of singers are often located at the outer edge of the dance arena. For instance, the 1996 Comanche Homecoming powwow in Walters, Oklahoma, featured six drums--one northern and five southern--around the outer edge of the arena. Although the arrangement of drums around the outer edge of the arena historically is seen at Northern powwows, the growing popularity of the contest powwow has helped this system find its way into Southern powwows.

The power manifest in a drum remains intact even though the central location of the instrument has changed. The drum--the instrument--acquires power and personality from its conception. The wood and hide used for construction of a drum bring the influence of nature and animals in contact with the drummaker and his prayerful, meditative thoughts. Treatment of a drum thereafter helps the instrument to become a social being.

Men's Power

Viewing the singers as extensions of the drum help to explain cultural expectations about and social pressures on singers which are inherent in the powwow. Head singers emphasize that to become a good solid singer, and to take on the responsibilities of a head singer, they have to know the songs, a knowledge that goes beyond remembering the words and melodies. They have to know which songs can be sung anytime and which songs are restricted in their use, which songs are personal songs and which are family songs. When asked, head singers will often say they have permission to sing a song, indicating that the song is owned by someone and that person has told this singer he may sing it anytime he wants. Head singers have background knowledge of nearly all song genres. Head singers are familiar with when and why they came to be used as powwow songs, including songs from ceremonies which are no longer performed.

When a singer accepts the position of head singer for a powwow he makes a commitment to bring his knowledge and ability as a singer, as well as enough other singers to sing with him. It is his responsibility to start at least the first four songs and to handle special requests for songs. He also should know which other singers have the ability to start songs, because he may pass the lead around to others. The pressure of musical leadership and singing at a powwow is placed on men. A successful drum and a successful powwow begins with male singers and their knowledge and ability (Stout, 1997).

Women's Power

During the course of my interviews with male singers, I asked them to tell me about the role of women as singers. Some answered with, "yes, there are women singers." When I tried to get more information, male singers simply said, "I don't know why they sing, I don't know anything about it. You have to ask a woman singer." The first female singer that I asked gave me the most perplexing answer. She told me women don't sing; they just sit back in their lawn chairs and take it easy. Later she said, "I sing because my Dad said, baby girl you're gonna help me out. You'll know when to come in and sing, just listen." Another female singer responded, "Women don't have any responsibility when it comes to singing. It's the man's responsibility." Later in our conversation, she also talked about helping out (Stout, 1997).

These kinds of answers to my question led me to search deeper, and I discovered that the role of women in singing is an unspoken, performance linked one. A singing performance sets up an interpretive frame in which to understand what women are telling me that they are doing. Women sit in their lawn chairs behind male singers at the drum, and they also listen very closely to the songs and start singing at loosely prescribed points in a song. Loosely prescribed, because women's singing is related more to the cultural aesthetics of powwow songs than to the formal structure of songs. Women don't just sit in their comfortable lawn chairs; they also sing. When a woman singer says she is not doing anything, just sitting there taking it easy, she means something very different than what a spectator watching the powwow would mean.

Beliefs concerning the relation between women and the drum vary from tribe to tribe in the Southern Plains; but there is a consistent view which relates to personal power possessed by women which at the time may conflict with the power of the drum. Women are included and needed in singing, but their contact with the drum is indirect. A woman's power during her menses could be strong enough as to have a counter-productive effect on the drum. The menstrual taboo is practiced by many women of child-bearing age when in close proximity to the drum. One woman explained that the feminine power might take power away from the drum. Because of this, women are not involved in the drum's guardianship. Some tribes believe women can touch the drum to receive its healing effects and blessings in times of need; other tribes believe women should never touch the drum. Many older women go to the extent that they will not touch men's drum sticks. One female singer told me that women should not be involved in making phone calls for a head singer to see which singers can show up for an event because those calls involve the drum directly and, therefore, only men should do it (Stout, 1997).

A preference for symmetry and duality conditions the need for female participation in singing to conform to a worldview of balance between feminine and masculine roles. One male singer expressed this desire for balance as a "hope" that women bring vital and passionate emotions with them when they sing. One younger singer told me she likes to sing behind a certain older man who is like an uncle to her. When he hears her behind him, he always turns his head a certain way, just a little, as an acknowledgment that he hears her. He told her that he sings better when he hears her voice behind him (Stout, 1997).

CONCLUSION

The power of the drum, meaning the instrument and singers as extensions of the drum, begins with the interaction between a drummaker and his raw materials and extends through the performance event. The careful prayers of drummakers and singers and their need to have only good thoughts while in contact with the drum display a conscious distinct effort and deliberate philosophy. The interaction of good thoughts and feelings continues as the drum is cared for and respected as a family member, and as singers let go of negative thoughts and search for good feelings. While men do not have to have women to help with powwow singing, they respond in a positive way when their help is given. All these conscious efforts heighten the power in the identity of the drum.

Among the reasons singers give for working hard at their role within their culture are personal, intangible, and spiritual rewards received from anyone that their singing touches. Many singers expressed a strong desire on their part, in cooperation with a group of singers at the drum, to relieve their listeners' personal stress and bring them strength--not to nostalgically transport listeners to a happier time and place, but to deeply touch and infuse listeners with inner strength. The songs make dancers feel strong and confident not only in their dancing but also in their personal lives. Listening to the singing of old songs and new compositions by the drum and watching the different styles of dancing can be a potent expression of sacredness, comradeship, and spiritual healing for spectators. Within the intercultural frame of the powwow, participants believe in the sacrifice of the individual and his/her identity for the spiritual well being, betterment, and continuation of the whole. Singers participating at the drum want everyone to enjoy themselves, to forget about their hardships. Singers [or the drum] strive to transmit a type of inner power to those in attendance; which makes the old person, whose strength is diminishing, forget his pains, standup and dance.

BIBLIOGRAPHY

Maker, Leonard, and Brown, Lamont. American Indian Oral History: The Duke Collection 50.T-344-2 (1968). University of Oklahoma, Norman.

Stout, Cindy. Hummers, Drummers, and Singers: Socio-cultural pressures experienced by Southern Plains singers and the expectations of their people. (forthcoming) Honor's thesis, 1997. Anthropology and Folklore, Indiana University, Bloomington.

The Sexual Oppression of Women in South Korea

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INTRODUCTION

South Korean women's sexual oppression came to the attention of the international community in December 1991 after three South Korean women filed a lawsuit in Tokyo District Court, publicly disclosing the sexual abuses of women and girls by the Japanese Imperial Forces during World War II. These women, along with tens of thousands of other victims, became known as the military "comfort women" of World War II. Other forms of sexual abuse, occurring today on a daily basis in South Korea, such as rape, sexual harassment and forced prostitution, also began to surface at this time. This paper illustrates the experiences of the Korean "comfort women," as well as the sexual violence and lucrative sex industry in contemporary South Korea. As a means of fully understanding South Korean women's current sexual oppression, its historical and religious roots, as well as various modern perpetuants of women's subordination, are discussed.

THE SEXUAL OPPRESSION OF WOMEN IN SOUTH KOREA TODAY

The Korean Comfort Women of World War II

During World War II experts estimate that between 100,000 to 200,000 women and girls were "recruited" by Japanese military authorities for war-zone sex slavery in China, Southeast Asia and the South Pacific islands (Davis 1994; Hicks 1995; Hoon 1992). Approximately 80 to 90 percent of these "comfort women" came from Korea as a direct result of Japan's colonization of Korea during that time (Chung 1995; Hicks 1995; Hoon 1992).

Most documentary evidence relating to the actual numbers and locations of these battalions of "comfort women" was ordered destroyed by Japanese government officials at the end of the war, as a means of keeping this atrocity secret (Chung 1995; Hoon 1992). Some records, however, still survive, and more are emerging as researchers continue to dig through Japanese archives. Five reports found by a researcher looking through official records showed that "comfort women" were drafted as early as March of 1938 (Hoon 1992). They also showed that the Japanese Imperial Army first attempted to recruit these women through civilian agents, but as the war zone expanded a more violent approach was taken (Hoon 1992). Korean villages were raided in order to seize women, and Japanese officers even pressured schools to provide girls as young as twelve years old to feed the sexual desires of their armies (Hoon 1992).

Each "comfort girl" assigned to a military base was supposed to "entertain" twenty-nine Japanese soldiers per day, but in reality this number may have been higher in many battalions (Hoon 1992). For example, documents estimate that in China there were 1,000 "comfort girls" for every 50,000 or so Japanese troops (Hoon 1992). The conditions these women lived in were unbearable. One "comfort woman" recalled that the "rooms were very small. Each was big enough for two people to lie down in. At the entrance of each hung a blanket in place of a door. The walls and floor were laid with wooden boards, and there was nothing else. We were given a military blanket and had to sleep on the bare planks" (Yi 1995, p. 92). These conditions, however, varied by military brothel. The "comfort women" were heavily guarded by day, forced to slave away washing troops' clothes; and in the evenings, they were systematically raped by Japanese soldiers who were often times cruel, drunk, and physically abusive (Davis 1994; Hoon 1992). Under these conditions very few escaped, and many chose suicide.

The mark left upon these women was horrendous, and many never returned to Korea in fear of having to endure the harsh stigmatization placed upon women who engaged in sexual activity outside of wedlock (Howard 1995). The shame a Korean "comfort woman" felt was insurmountable because it was believed that the "shame of a woman was the shame of her whole family" (Howard 1995, p. vi). In Korea, "sexual defilement tended to be associated with promiscuity," even if it was against her will (Howard 1995, p. vi). Only since the 1990s have these "comfort women" publicly spoken about the horrors they underwent at the hands of the Japanese Imperial Army during World War II, and were able to unburden themselves of this terrible secret. It wasn't until August 1993 that they received a formal apology from the Japanese government (Corelli 1993). However, they have still yet to receive any official monetary compensation from the Japanese government, though they have from private funds.

Sexual Violence and Harassment in Contemporary South Korea

Today, sexual violence is one of South Korea's most severe social problems. The majority of South Korean women experience sexual violence more than once in their lifetime (*Women's International Network News* 1993). Women and girls from all age groups, including young children, are assaulted by men in the home, on the streets, in the work place and even in protective agencies, such as the police force (Davis 1994; Nam 1994; *Women's International Network News* 1993). An estimated 250,000 women were reported to have experienced rape or other forms of sexual assault in 1990, a threefold increase since 1988 (Davis 1994). A report by the National Police Agency, two years later, estimates that 9.8 women per 1000 are raped in South Korea; however, the Korean Women's Development Institute (KWDI) published a study which found that only 2.2 percent of rape cases are reported in South Korea. Even with only 2 out of every 100 rapes being reported, according to the International Criminology Institute (1992), South Korea has the third highest number of *recorded* sexual offenses in the world (Davis 1994; United Nations 1995; *Women's International Network News* 1993).

South Korea's Modern Sex Industry

South Korea has a thriving sex industry, and it is one of Korea's most lucrative tourist trades (*Christian Century* 1988). Since the 1970s, the number of high class prostitutes has dramatically increased with the promotion of prostitution tourism (*Christian Century* 1988; Clifford 1989; Lie 1995). The Korean government used the sex industry in national policy as one way to accumulate foreign exchange reserves (Lie 1995). In 1978, there were approximately 40,000 women in the sex business with this number increasing by the 1980s to at least 200,000 professional prostitutes (Lie 1995). Today, there are as many as one million women employed in the sex industry (Savada and Shaw 1992). Ironically, prostitution and other "decadent acts" have been illegal since 1962 (Morgan 1984). As a means of legitimizing the "tourist industry" the government issued identification cards to prostitutes that ostensibly declared them as "hostesses" (Morgan 1984). Later, sex tour prostitutes were required to go through a certification process which required them to have completed their junior high school education, pass periodic health examinations, and attend orientation lectures which ranged from practical knowledge – how to behave towards clients – to being indoctrination with the belief that they were aiding in the economic growth of their country (Lie 1995).

Prostitutes' clients include Japanese and Korean men, military personnel, European, American and Australian tourists, as well as businessmen and government officials. The Japanese, however, are their biggest clientele (Kim 1987; Lie 1995). Up until the 1980s, travel agencies, tour magazines, sports papers, and popular magazines advertised tour packages to South Korea which included the price of a female "companion" (Kim 1987; Lie 1995; Morgan 1984). The women working in these sex services are found in a large number of areas, including brothels, high class kisaeng bars, on the streets, erotic barber shops and coffee shops, masseuse parlors, and "room salons" which usually consist of a series of private rooms where approximately 2 to 10 men are entertained in each room by an equal number of women (Lie 1995).

THE HISTORICAL ROOTS OF SOUTH KOREAN WOMEN'S SEXUAL OPPRESSION

Religious Components

In order to fully comprehend the nature of South Korean women's sexual oppression, it is necessary to have an understanding of the religious doctrines and ideologies which underlie the cultural norms and beliefs. South Korea, though an economically advanced country, is a complex society that is rooted in many cultural and religious traditions which have oppressed women for many centuries. Though Confucianism was the major religion in Korea during and after the Choson Dynasty, Buddhism had previously been the dominant religion and had a significant role in shaping pre-Confucian Korean society.

Before the late 1300s, Buddhism was the primary religion in Korea (Haboush 1991). Under Buddhism, men and women, though not equal, were closer in status than later seen during the Choson Dynasty. Women were allowed a great deal of freedom and equality. They had equal inheritance rights, socialized and interacted with men relatively freely outside the home, were viewed as equal and active members of their family, even after marriage, and family lineage passed down through females, if they were the last member in their family's blood-line (Choi 1994; Haboush 1991; Park 1994).

During the late fourteenth century Confucian teachings began to dominate Korea, replacing the Buddhist system that previously governed the nation. The Korean Confucian state that emerged at this time redefined the entire culture, completely reconstructing the society in order to transform it into an ideal Confucian normative state. Social customs and norms previously held were completely overhauled and new one implemented.

According to traditional Confucian writings, the human world and the cosmic order were fundamentally intertwined (Deuchler 1977; Kelleher 1991). Confucianists believed that the human world had to model itself after the cosmic order and that both had to be in perfect equilibrium with each other in order for the human world to function smoothly (Deuchler 1977). If this equilibrium became unbalanced, disaster would strike mankind. Confucianists also believed that only men had the power and the means to prevent such disaster, and as a result men were the moral imperatives in the society (Deuchler 1977). Thus a belief in male superiority was indoctrinated into the culture on all social,

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political and ideological levels. Consequently, women were degraded to an inferior and subordinate position.

Confucianism also penetrated the core of humanity in Korea by objectifying women's bodies. The *yin-yang* complementarity, the fundamental basis for the code of ethics in South Korea, established a static dichotomy between the sexes, delineating the sexual standards and cultural norms for men and women under Confucianism (Deuchler 1977; Kim 1993). According to the interpretation of the Korean Confucianists, males were regarded as the morally superior being, and they had the right to control and regulate women's bodies and sexuality.

The threat of rape and other sexual abuses to control women's activities and behavior began to be used by men more openly and frequently as a means of exerting their power and dominance over women (Nam 1994). "The use of sexual violence is an effective mechanism in controlling women's behavior...[It] reflects the patriarchal nature of the society in which men dominate women's sexuality and in which extreme forms of double-standards are applied to men's and women's sexuality" (Nam 1994, p. 61). Females were not believed to be individuals with rights, but rather mere objects. Women's purity, virtue and chastity were idolized in the culture, though a small segment of women were sexually exploited to serve the desires of upper-class officials. The majority of women were made to suppress their own erotic desires and to see their bodies as *men's* property. At the same time men's promiscuity and sexual desires were accepted and encouraged (Nam 1994). As a result of the double standards in the society, severe sexual oppression of women became entrenched in Korean society.

Korean women's subordinate roles, dictated by Confucian ideologies, are being marketed today (Kim 1987). Women's roles have traditionally been to take care of their men, and contemporary sex services use that ploy – "taking good care of men" – to lure in customers (Kim 1987). Traditional sex inequities in South Korea, based on Confucian beliefs and ideologies, have also contributed to the development of the sex service industries (Kim 1987). The devaluation of women and the objectification of their bodies aid in promoting Korea's sex trade. "Certainly the sale of women for foreign exchange is easier in a society where women have been regarded as objects for use by men," rather than people with rights and an inherent value (Kim 1987, p. 133).

Kisaeng Entertainers

Korea's tradition of using women as "entertainment" has deep historical roots beginning around the seventh century, during the Silla Dynasty, with the *kisaeng* (Jayawardena 1986; Lie 1995). The *kisaeng*, a state organized group of female "companions" were exploited sexually to service the carnal indulgences of upper-class men, were assigned to duties in both capital and local jurisdictions (Lie 1995; Savada and Shaw 1992). During the Koryo Dynasty (918-1392), when Buddhism was the major religion in Korean society, the *kisaeng* became an institutionalized form of entertainment for men in the upper classes and nobility, and by the Choson Dynasty (1392-1910) they were firmly entrenched in Korean society, completely dependent on state patronage (Lie 1995). This ironically came at a period in Korean history when women's chastity and virtue were idolized and regarded as their key to social standing.

The *kisaeng*, who were required to be beautiful, came mainly from the lower classes (Jayawardena 1986). These women formed their own caste, as daughters of the *kisaeng* usually followed in their mother's occupational footsteps (Lie 1995). Male children of the *kisaeng*, on the other hand, were often adopted and legitimized by the father and taken into his family, as bearing males was a sign of status for him. The *kisaeng* also functioned as a guild system because a woman's "trade skills" were passed down to younger generations within the caste (Lie 1995). The caste had a hierarchical structure, with different levels of power and esteem among the *kisaeng* (Lie 1995). The lowest rank consisted primarily of prostitutes who specialized in sexual work (Lie 1995; Savada and Shaw 1992). In the second tier, there were entertainers and part-time courtesans (Lie 1995). The highest rank was similar to the Japanese *geisha* (Savada and Shaw 1992). These women were exceptionally beautiful and/or artistic. They served high officials and performed at state functions (Lie 1995).

In some ways, the *kisaeng* had more freedom than non-*kisaeng* women. The *kisaeng* interacted on nearly equal terms with their male patrons, which was very uncommon during the Choson Dynasty (Savada and Shaw 1992). Although they could not officially marry, the *kisaeng* were often taken by the *yangban* (the ruling elite) and government officials as concubines or secondary wives (Lie 1995). Others had "surrogate" husbands (*kibu*) who acted as their managers (Lie 1995).

The *kisaeng* were trained at a special institute called the *Kyobang*. It was there that they learned to perform and perfect their "talents" as professional entertainers (Jayawardena 1986). These women were trained to provide a number of tasks and functions. Not only did they learn to sing, dance, play musical instruments, engage the royal court in lively and witty conversation and serve their masters, but were also taught to perform such duties as medical work and needlework (Jayawardena 1986; Lie 1995; Savada and Shaw 1992). Their function was to entertain, sexually and non-sexually, at court and at the houses of the nobility (Jayawardena 1986). The talented *kisaeng* excelled at all these traits, as well as the fine arts of painting and poetry (Savada and Shaw 1992).

By the end of the Choson Dynasty, there were approximately 20,000 to 30,000 *kisaeng* (Lie 1995). These female entertainers also often became the victims of severe sexual aggression, such as, rape and other forms of sexual assault and physical abuse, which laid the foundation for future widespread sexual oppression against women in Korea.

Prostitution Under Japanese Occupation (1910-1945)

During Japan's colonial rule over Korea, the sexual exploitation of women changed dramatically. The Japanese transformed the small *kisaeng* system for the Korean elite into an entrepreneurial sex industry for the masses (Lie 1995). State patronage for female entertainment and sexual services ended, giving way to Japanese commercial interests (Lie 1995). Women's bodies and their sexuality became a monetary commodity in the society, moving female "entertainers" into full-time prostitutes, creating a distinctly polarized division between respectable, virtuous women and the sex divas of Japanese entrepreneurs.

Three distinct forms of sexual work arose under Japanese rule, creating a hierarchy in the sex industry similar to that of the *kisaeng* system: elite call-girls, prostitutes, and military sex slaves. The *kisaeng* training program, however, did not completely erode. The Japanese established *kisaeng* schools, which replaced the Korean guild system, to train elite prostitutes (Lie 1995). The first school started in 1926 in Pyongyang (currently the capital of North Korea) (Lie 1995). Interestingly, the high tuition costs precluded poorer women from enrolling in these schools; this was unlike the caste system where this training usually passed down from mother to daughter (Lie 1995). Instruction was given over a three year period; girls learned both Japanese and Korean languages, as well as math, ethics, music, dance and the "art" of entertainment (Lie 1995). These well-trained call-girls created the upper echelons of the sex market, and were frequented by high government officials, *yangban*, and rich urbanites (Lie 1995).

Sexual work also expanded into urban areas, catering to both Japanese and Korean men (Lie 1995). Japanese sexual entrepreneurs (*zegen*) recruited and organized young Korean women from the lower classes, mainly from poor rural families (Lie 1995). Impoverished families often sold their unwanted daughters to these men in exchange for money, further devaluing female children in Korea, because girls were not regarded as important members of Korean Confucian society, and were expendable (Lie 1995). This second sector of the industry were primarily sexual workers, though they did perform and entertain like the *kisaeng*, only to a much lesser extent. Japanese colonial officials, soldiers and businessmen were their primary clientele (Lie 1995). The final stage of Japan's sexual labor force was the creation of "comfort divisions" for the Japanese Imperial Army stationed throughout much of Asia and the western Pacific (Lie 1995). These women became known as the "comfort women" of World War II, and they faced horrors about which they kept silent for nearly fifty years.

CONTEMPORARY FACTORS IN WOMEN'S SEXUAL OPPRESSION IN SOUTH KOREA

The Perpetuation of Women's Sexual Oppression in South Korea Through the Current Legal System

The present legal system upholds women's subordinate position through some of its laws and judicial proceedings. Rape is seen as a criminal act under Article 32 because women's chastity is the *property* of men and such acts violate men's *ownership*, not that rape is wrong in and of itself (*Women's International Network News* 1993). In order for a complaint to be filed and pursued, a woman must go to the court herself for a claim to be processed, and the complaint has to be filed within six months of the crime. In the courtroom she has to defend herself against accusations and insinuations that she invited the assault; that she did not resist hard enough; and that she does not deserve respect because of her reputation and sexual behavior (*Women's International Network News* 1993). This seems to be a fairly universal standard for the treatment of women who have been sexually violated.

Victims of sexual assaults, worldwide, tend to blame themselves for what happened. South Korea is no exception. Many Korean women avoid going to the hospital or counseling centers, especially in cases of rape, for fear of social stigmatization (Palley 1994; *Women's International Network News* 1993). Female chastity is still idealized in South Korea, and is one of the primary reasons why there is a very high percentage of unreported sexual crimes (Palley 1994).

Sex tourism is another area where the government and the legal system have failed to protect South Korean women. The blatant marketing of women's bodies ended in South Korea only after mounting opposition from various women's groups reached a level where the government was *forced* to act (Kim 1987; Lie 1995; Morgan 1984). The government had little intention of acting on its own accord. Kim Yung Chung, a cabinet member of the thirteenth National Assembly, stated that only about one-third of her colleagues in the cabinet took the issue of human trafficking seriously (Clifford 1989). She saw the problem as being not one of morality but rather one of violence (Clifford 1989).

Sexual Violence as a Control Mechanism to Suppress South Korean Women's Labor Movements

Sexual violence is used in the labor force and the police force as a mechanism to control and suppress women's labor movements in South Korea. Company owners encourage the patriarchal notion of female docility by relying on male supervisors to maintain order through any means necessary; this is reflected in various managerial tactics, such as verbal abuse, sexual harassment, and physical assaults on women (Seguino 1995). Sexual violence is also used in the course of police interrogations and in arresting striking female workers (Davis 1994; Nam 1991). Physical and sexual abuse are used by the state as a mechanism to control and suppress struggles and disputes. "Sexual assaults such as stripping, kissing, fondling, threat of

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rape, and rape itself [are] used to control women's behavior ... [s]ince being raped or sexually harassed is such a stigma to an unmarried Korean woman" (Nam 1991, p. 60). These practices are reflective of the unequal gender roles in South Korea's patriarchal culture. Women tolerate such treatment because they see no alternative, and, until recently, they have had few places to turn to when such incidents occurred.

Economic Factors Contributing to South Korean Women's Sexual Oppression

The majority of South Korea's female prostitutes come from rural populations that are rapidly migrating into metropolitan areas (Lie 1995; Savada and Shaw 1992). As more and more rural women saturate the urban job market, fewer jobs are available to them. Prostitution offers a relatively attractive venue to women in economic distress, since they earn more than twice the amount of laborers (Lie 1995). These girls, however, only take in a small portion of the fee charged to clients, making it extremely difficult to escape the sex industry. The night's income at one Kisaeng House, for example, is approximately $1,700 for the house and $10 for each girl (*Christian Century* 1988). Out of a girl's nightly profit, she has to pay for her clothing, food, medical care, tips for the madam and furnishings for her room, and still try to send money home to her family (*Christian Century* 1988). The lack of police support to press charges against brothel owners, and the shame, humiliation and physical violence that women feel and endure are other reasons why women remain in the profession.

Pimps and madams recruit many young rural women who just moved into the city through false advertising (Lie 1995). They hang job advertisements in cafes or shops which offer three times the wages of factory work. Girls and women respond, only to find themselves working in bars or on the streets as prostitutes. There are also an increasing number of women, reaching into the thousands, that are being kidnapped, forced or coerced into prostitution to appease the increasing demand for prostitutes (Clifford 1989; Giarelli 1989; Lie 1995). "Korea is one of those sexually paradoxical societies where...women have to be virgins when they marry, [but] young girls are kidnapped off the streets to cater to the booming prostitution trade" (Giarelli 1989, p. 44). Women fear going out at night in certain areas of the country because of the thought that they might be abducted off the street. Human trafficking is not only perpetuated through terrorist means, but also through various employment agencies who sell women's work contracts to brothels (Clifford 1989). Rape and incest victims who are ostracized by the society, as well as women who have engaged in sexual activity with more than one man, often find prostitution as their only viable means of employment (Kim 1987). For many women, prostitution is their only alternative, if they want to survive.

CONCLUSION

The plight of South Korean women has been difficult. These women have had to endure extreme forms of sexual oppression since the late fourteenth century after the complete infiltration of Confucianism throughout Korean society. Women were not treated with respect and dignity, but rather as objects to be used at the mercy of men. Their bodies have been violently, sexually exploited during wartime, and enslaved into prostitution during peace. Today sexual oppression continues to plague South Korean women. Rape, sexual assaults and harassment are constant fears in women's lives, while South Korea's sex industry is still booming. There seems to be little effort on the part of the South Korean government to end these atrocities against women, perpetuating women's inferior status in the society. There are, however, reforms taking place by other sectors of the society, such as women's groups and organizations which are fighting to improve women's status and to bring an end to women's sexual exploitation. South Korea's economic move into the international arena, as well as women's increasing educational levels and economic independence, are also helping to bring about positive changes for women. As a result, South Korean women are gaining a greater awareness about their inferior position in the society and are coming to the realization there are avenues and international support systems that they can utilize as a means to improve their status and to fight for their rights as equal and vital members of South Korean society.

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REFERENCES

Choi, Elizabeth. 1994. "Status of the Family and Motherhood for Korean Women." Pp. 189-205 in *Women of Japan and Korea: Continuity and Change*, edited by Joyce Gelb and Marian Lief Palley. Philadelphia: Temple University Press.

Christian Century. 1988. "Prostitution Tourism." v.105 (September 28):833.

Chung, Chin Sung. 1995. "Korean Women Drafted for Military Sexual Slavery by Japan." Pp. 11-30 in *True Stories of the Korean Comfort Women*, edited by Keith Howard. London: Cassell.

Clifford, Mark. 1989. "Shanghaied for Sex." *Far Eastern Economic Review* 145 (September 28):125-126.

Corelli, Rae. 1993. "An Apology for Degrading Acts." *Maclean's* 106 (August 16):32-33.

Davis, Lisa Kim. 1994. "Korean Women's Groups Organize for Change." Pp. 223-239 in *Women of Japan and Korea: Continuity and Change*, edited by Joyce Gelb and Marian Lief Palley. Philadelphia: Temple University Press.

Deuchler, Martina. 1977. "The Tradition: Women During the Yi Dynasty." Pp. 1-46 in *Virtues in Conflict: Tradition and the Korean Women Today*, edited by Sandra Mattielli. Seoul, South Korea: Published for the Royal Asiatic Society, Korea Branch by the Samhwa Publishing Co., Ltd.

Giarelli, Andrew. 1989. "Regional Report: Asia/Pacific-Crimes Against Women." *World Press Review* 36 (April):44.

Haboush, Jahyun Kim. 1991. "Korea: Traditional Period." Pp. 280-282 in *Women's Studies Encyclopedia: History, Philosophy, and Religion. Volume III*, edited by Helen Tierney. New York: Greenwood Press.

Hicks, George. 1995. *The Comfort Women: Sex Slaves of the Japanese Imperial Forces*. London, England: Souvenir Press.

Hoon, Shim Jae. 1992. "Haunted by the Past." *Far Eastern Economic Review* 155 (February 6):20.

Howard, Keith, ed. 1995. *True Stories of the Korean Comfort Women*. London, England: Cassell.

Jayawardena, Kumari. 1986. *Feminism and Nationalism in the Third World*. New Jersey: Zed Books Ltd.

Kelleher, M. Theresa. 1991. "Confucianism." Pp. 95-97 in *Women's Studies Encyclopedia: History, Philosophy, and Religion. Volume III*, edited by Helen Tierney. New York: Greenwood Press.

Kim, Myung-hye. 1993. "Transformation of Family Ideology in Upper-Middle-Class Families in Urban South Korea." *Ethnology* 32 (January):69-85.

Kim, Elaine. 1987. "Sex Tourism in Asia: A Reflection of Political and Economic Inequality." Pp. 127-143 in *Korean Women in Transition: At Home and Abroad*, edited by Eui-Young Yu and Earl H. Phillips. Los Angeles, California: Center for Korean-American and Korean Studies, California State University.

Lie, John. 1995. "The Transformation of Sexual Work in 20th-Century Korea." *Gender and Society* 9 (June):310-327.

Morgan, Robin. 1984. *Sisterhood Is Global: The International Women's Movement Anthology*. Garden City, New York: Anchor Press/Doubleday.

Nam, Jeong-Lim. 1994. "Women's Role in Export Dependence and State Control of Labor Unions in South Korea." *Women's Studies International Forum* 17 (January):57-67.

Palley, Marian Lief. 1994. "Feminism in Confucian Society: The Women's Movement in Korea." Pp. 274-294 in *Women of Japan and Korea: Continuity and Change*, edited by Joyce Gelb and Marian Lief Palley. Philadelphia: Temple University Press.

Park, Kyung Ae. 1994. "Women and Revolution in South and North Korea." Pp. 161-191 in *Women and Revolution in Africa, Asia, and the New World*, edited by Mary Ann Tetreault. Columbia, South Carolina: University of South Carolina Press.

Savada, Andrea Matles and William Shaw (eds.). 1992. *South Korea: A Country Study*. Washington, D.C.: Federal Research Division of the Library of Congress.

Seguino, Stephanie. 1995. "Trade Secrets: Sexism and Export-Led Growth in South Korea." *Dollars & Sense* 197 (January):18-21.

United Nations. 1995. *The World's Women 1995: Trends and Statistics*. New York: United Nations Publication.

Women's International Network News. 1993. "Korea: New Legislation Against Sexual Violence Proposed." v. 19 (Autumn):43.

Yi, Yongsu. 1995. "Return My Youth to Me." Pp. 88-94 in *True Stories of the Korean Comfort Women*, edited by Keith Howard. London: Cassell.

Evaluation of a Summer Orientation Course for New College Students
Critical Reading and Reasoning

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ABSTRACT

The purpose of this project was to determine the effectiveness of a summer orientation class given to new college students entering the TRIO funded Student Support Services Program at Indiana University (referred to as Groups). Groups offers academic and financial assistance to a select number of students who are primarily low income and first generation college students. X152 Critical Reading and Reasoning is a class that all Groups participants are required to take the summer before their undergraduate studies begin. By acting as a participant observer in two different classrooms and by conducting interviews with the instructors and students from each class, the researcher was able to gather a great deal of qualitative data which was then used to evaluate the course. The class curriculum is designed to push students into a new mode of thinking. Teachers help their students' thought processes to grow beyond the concrete and into a more abstract way of analysis. At the end of the study, the researcher drew conclusions from the data and suggested possible improvements that could benefit both the students and the program itself for years to come.

LITERATURE REVIEW ON STUDENT LEARNING

William Perry Jr. (1970) developed the model that has provided the basis for subsequent models of student intellectual development. Kloss (1994) describes the nine levels of development that Perry determined from his interviews with college students, moving from dualism to commitment in relativism. Kloss considers movement from a dualistic to a multiplistic way of thinking as the goal for beginning college students. He describes dualistic learners as those who expect teachers to reveal absolute truth to students. Learning is memorizing, and peers are not seen as sources of knowledge. However, as dualists hear more opinions and interpretations, they begin to feel that no one knows all the answers, this is the beginning of multiplicity. As instructors demand evidence to back up opinions, students learn a new way of managing information and ideas. Eventually, they will move into relativism where they are able to argue their own positions and value those of others. Finally, these views are transferred from the classroom to a real world situation, and the final stage is reached -- commitment in relativism. Kloss' interpretation and application of Perry's scheme provided the basic framework for setting up this study and analyzing the data.

RESEARCH SETTING

At Indiana University, a course entitled "Critical Reading and Reasoning for New College Students" is offered in the summer for all students entering Indiana University through a federally funded U.S. Department of Education TRIO program (Student Support Services) referred to on the campus as the Groups Program. The course curriculum is designed to orient new college students to the academic culture and expectations of a university. The six objectives of the course given to the students appear below and these objectives, particularly the first two, seemed comparable with Kloss' goal of moving students from dualistic to multiplistic thinking.

- To help you improve your reading, extend your range of strategies, and especially increase your ability to read and think critically.
- To give you experiences with a variety of texts that represent the kinds of reading you will be doing throughtout your college career.

- To encourage you to identify and reflect on problems that will affect your future society and occupation or profession
- To familiarize you with resources and methods for doing your own research, answering your own questions, and solving your own problems
- To help you develop your own learning strategies, coping skills for success in college, study groups and other support structures
- To give you tools and resources for making informed decisions about your major and future career (Pugh, 1993)

METHODOLOGY

The specific research questions were as follows:

How do students perceive the content and their learning experiences in the course?

How do instructors perceive the content and their students' learning experiences in the course?

What are the strengths and weakness of the course, and how can it be improved for the next group of students?

The researcher chose a qualitative methodology employing participant observation in two sections of the course and interviewing students and teachers. Class A was observed eight times and class B ten times during the eight week session. As Bodgan and Taylor (1975) state "prolonged contact in the setting allows them [researchers] to view the dynamics of conflict and change and thus see organizations, relationships, and groups and individual definitions in process". In this role the researcher "blended in" as a member of the class, though students were aware that they were being observed. Extensive field notes were kept both during and at the conclusion of each class.

Open ended interviews with each of the instructors separately and focus group interviews with groups of four students from each class section augmented information gleaned from observation-only sessions. Instructors were interviewed at the end of the course, and each focus group was interviewed twice, once in the middle and once at the end of the course. All interviews were audio recorded. In addition, a research assistant attended all interviews and took notes.

Data analysis consisted of going through all the audiotapes systematically and grouping comments from them under each of the initial research questions (see above), categorizing students' and instructors' perceptions separately. Then perceptions and comments from field observation notes were added to appropriate categories as well. From these categories themes were drawn that were then organized into answers to the research questions.

FINDINGS AND INTERPRETATIONS

Both instructors agreed that the curriculum served two main purposes: (1) to provide an introduction to the academic culture of college where they would be responsible for their own decisions and actions, and (2) to move students from a high school mode of thought, which is very concrete and straightforward, to a more complex and abstract mode of analysis and argument. However, the instructors also agreed that the students perceived the curriculum as too hard and often would be confused about how to complete an assignment without the instructors' help at every step. Both pointed to lack of maturity as well as lack of skills. Both were evident when students were unable to articulate their thoughts in an organized manner and showed resistance to the level of demand of the course. Instructor A stated that many students did not want to engage in the thinking processes necessary to be successful in college. They were afraid to take the leap between the concrete to the intangible. She also stated that "confusion is the beginning of the analytical process, it is okay to be confused."

In general there seemed to be two kinds of students -- those with a positive-minded, self-confident attitude, and those who, for whatever reasons, were not sure of their reasons for being in college or taking a course like this one. These attitudes were expressed in their evaluative comments about the course. One problem that seemed to be shared by both groups was a discrepancy between what they said they wanted and what they actually pursued. They seemed to have difficulty setting priorities and taking full responsibility for their choices. For example, when asked whose responsibility it was for them to learn, they characteristically replied that it was their responsibility, but they would not utilize opportunities to get help from the instructor. This ambivalence shows a dualistic stance in that they expected the authority to take responsibility.

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Teachers were pushing students toward a more complex way of thinking while many students refused to let go of their concrete mode of thought The instructors wanted the students to experience ambiguity because this confusion would eventually lead to discovery and new ways of thinking, but the ambiguity made the students uncomfortable

The final project required that the students engage in research about the field in which they might pursue a career There were no definite right or wrong answers, just a world of possibilities The final project caused some students to put their goals into perspective and experience a reality check on what it would take to achieve these dreams Several students commented that they had changed their original purpose for being in college after doing this project In conclusion, the course was working as the instructors wanted it to because the students complained about the discomfort of being asked to think and deal with the instructors' refusal to give the right answer However, students were doing their own research, finding new information, and using that to find their own answers Both teachers felt that the program had pushed students into the beginning stages of cognitive development where they would eventually move toward more complex modes of thinking This stage would be comparable to beginning the move from dualism to multiplicity in Perry's terms

CONCLUSIONS AND RECOMMENDATIONS

Below are recommended actions which could could improve the program

- Start the selection process earlier in high school and offer the chosen high school students an introduction to advanced thinking at that time This way, students will be more prepared for college before arriving on campus for the initial Groups summer Both instructors thought that this was a necessary change because eight weeks is such a short time frame for an introduction to analytical thinking processes One of the instructors suggested that former IU Groups students could be matched with the prospective students during their junior year in high school and perhaps work once a week together analyzing current event issues She felt that even reading the newspaper together would give these students an advantage before arriving to the summer class
- Students show some misconceptions about the purpose in the course The curriculum should help students understand that thinking strategies are provided as tools, not as the primary focus of the class
- Students need to know that they will have to be accountable for knowledge that is not accommodating to them, that is, does not relate to them personally The curriculum should make students aware of this point and help students develop strategies for taking in information they do not immediately relate to themselves
- Instructors should make sure there is ample time for feedback after all quizzes and assignments despite the short amount of time in the summer session
- Speakers could be included as sources of information as well as texts, which was effective in one class and could be used in all classes in the program
- The course should be structured so that all students know what is expected of them and how to fulfill these expectations Different instructors may have different structures which work, but it is important to have a strong structure for students at this maturity level

REFERENCES

Bogdan, Robert and Steven Taylor *Introduction to Qualitative Research Methods* New York John Wiley & Sons, Inc , 1975 25-94

Carter, Carol *Majoring in the Rest of Your Life: Career Secrets for College Students* New York The Noonday Press, 1990

Eisner, Elliot W *The Enlightened Eye Qualitative Inquiry and the Enhancement of Educational Practice* New York Macmillian Publishing Co , 1991

Kloss, Robert J "A Nudge is Best Helping Students through the Perry Scheme of Intellectual Development " *College Teaching* 42(4) 151-8, Fall 1994

Perry, William Jr *Intellectual and Ethical Development in the College Years: A Scheme*. New York Holt, Rinehart and Winston, 1970

Pugh, Sharon L and Noritah Omar *The World of Work: Life after Graduation* Bloomington, IN Tichenor Publishing Summer 1996

The Association of Peer Acceptance and Social Behavior in Early Childhood

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The personality characteristics and interaction styles of least-liked children in kindergarten were examined to determine why they are not liked by their peers. Gender and race were also investigated. The children who were least-liked by their peers were identified through individual sociometric interviews. Personality characteristics and interaction styles were assessed through observer's completion of the Baumrind Preschool Q-set(1976), and teacher ratings (Cassidy & Asher, 1992). Results showed that children who were observed and rated as more withdrawn were less liked by peers. Girls were more prosocial than boys. Boys were more aggressive and disruptive than girls. No differences in social interaction were found for race. The findings have implications for classroom interventions to prevent children's withdrawal from peers.

BACKGROUND/LITERATURE REVIEW

During early childhood, peers play a significant role in the development of social competence. It is during this time that children learn how to be a friend and how to have friends. These lessons are important for a child's long-term social and emotional development. As they mature, children rely more on their peers and less on adults. For some children, peer relationships come easily (Eisenberg & Mussen, 1989). Some children have many friends and are considered socially competent. Other children have difficulty establishing and maintaining friendships. In a study by Sanderson and Siegal (1995), children who were classified as rejected reported feeling more lonely than did their popular, average, and neglected peers. However rejected children who had stable, mutual friendships reported levels of loneliness similar to their nonrejected peers. Parker and Asher (1987) and Hartup (1983) have established that having at least one friend is important for validation of children's self-worth. Children who have poor peer relationships are "at risk" for problems in social adjustments later in life (Eisenberg & Mussen, 1989; Parker & Asher, 1987). Problems range from dropping out of school to more severe criminal activities.

Researchers have investigated the relationship between group acceptance and social behavior. Much of the research is based on observations of children's behavior. In a study by Ladd, Price, and Hart (1988), children who played cooperatively with peers throughout the school year were more accepted by peers as assessed by sociometric ratings at the end of the year. In contrast, children who argued frequently had declining peer acceptance over the year. Putallaz and Wasserman (1989) showed that the peer entry attempts of high-status and average-status children were significantly more likely to be accepted and less likely to be ignored than the attempts of low-status children were. Howes (1988) found that popular children had an easier time entering into play with peers than rejected children did. Denham and Holt (1993) showed a positive association between likability and social behavior. Children who were friendlier, more cooperative, less aggressive and less difficult were more well-liked by their peers.

Another way of assessing children's social behaviors has been through teacher ratings. Rubin, Daniels-Bierness, and Hayvren (1982) asked teachers to rate children on three types of behavior, aggression/hostility, anxiety/fearfulness, and hyperactivity/distractibility. Children who were rated by teachers as aggressive/hostile were also likely to be rejected by their peers. Denham, McKinley, Couchoud and Holt (1990) also used teacher ratings, and finding a positive relationship between peer likability and prosocial behaviors. Children whom teachers rated as fairly friendly, skilled socially and not very aggressive were more liked by their peers.

Most of the research investigating links between group acceptance and children's social behavior has not examined the influence of gender on the association between acceptance and behavior. According to Hartup (1983), children of all ages interact with members of the same-sex more frequently than with members of the opposite-sex. Denham et al. (1990) discovered that gender exerted indirect effects on acceptance and behavior. Girls were more likely to engage in prosocial behavior which also resulted in higher peer acceptance. Fishbein and Imai (1993) also found that gender influenced peer acceptance. Both boys and girls showed a same-sex relative preference and opposite-sex relative avoidance. In a study by Urberg and Kaplan (1989), all subjects made more same-sex choices of play partners with increasing age

The influence of race on the association between acceptance and behavior has not been fully examined by research. Fishbein and Imai (1993) found that race did influence peer acceptance White boys, black boys and Asian boys preferred playing with white boys. All three races of girls preferred playing with same-race girls. However, Urberg and Kaplan (1989) showed that race did not seem to be a basis for choice of play partners. In fact, a review of racial influences on children's play behavior by Hartup (1983) supports the idea that race may be more of a factor in children's choice of play partners and friends after they enter the primary grades.

RESEARCH QUESTIONS AND HYPOTHESES

The overall purpose of this study was to examine the interactions of children with peers in kindergarten. Specifically, I identified the children who were least-liked by their peers and sought to answer the following questions: 1.)Why are these children least-liked?; 2.) How do least-liked children interact with their peers?; and 3.)What personality characteristics contribute to their low peer acceptance?

The Baumrind Preschool Q-set (Baumrind, 1967) was used for the observations of children's social interactions. Baumrind factors identified in previous research (Howes, Phillipsen & Hamilton, 1993) were used to see if there were differences in the factor scores of the least-liked and most-liked children. These factors include prosocial, outgoing, aggression and withdrawn behavior. I expected the most-liked children to show higher levels of outgoing and prosocial behavior than the least-liked children.

Teachers' ratings of children's social behaviors were also examined for their association with group acceptance. The Cassidy and Asher teacher rating scale (Cassidy & Asher, 1992), which includes four factors of aggression, disruption, prosocial behavior and shy/withdrawn behavior, was used. I expected children who were rated as highly prosocial to be most-liked. I hypothesized that children who were rated as highly aggressive would be least-liked.

Furthermore, this study examined the influence of race and gender on social behavior. Past research has not fully explored these influences. I predicted that race would not be a determining factor on social behavior in this kindergarten sample. I also expected girls to show higher levels of both observed and rated prosocial behavior and observed outgoing behavior than boys. I expected boys to be show higher levels of observed and rated aggression and rated disruptive behavior than girls.

METHODOLOGY/APPROACH

Twenty-nine children in two classrooms participated in the study. Ethnically, the sample was 62% Caucasian, 31% African American, and 7% Asian American.

Each child's social behaviors and peer interactions were observed by two independent observers during the winter and spring of 1996 and 1997. Observations of children's social behavior took place between 9:00 a.m. and 3:00p.m., the school's regular operating hours. These observations primarily occurred when children were free to interact with their peers.

The Baumrind Preschool Q-set (Baumrind, 1967) was used to measure the classroom behavior of individual children. The four factors derived from the Q-set are prosocial, outgoing, aggressive and withdrawn behavior (Howes et al., 1993). Observers rated the 72 items by placing them in a rectangular distribution: 8 items in each of 9 piles from least characteristic to most characteristic. Reliability (percent agreement = 70) was established between all observers before coding began.

Teachers were asked to complete the Cassidy and Asher teacher rating measure (Cassidy & Asher, 1992). This measure yields four factors of teachers' perceptions of children's behavior: aggressive, disruptive, prosocial and shy/withdrawn.

To measure group acceptance, children participated in a sociometric interview. For this interview, each child was photographed with a Polaroid camera. Children were presented with all of the pictures of their classmates and asked to place each picture in one of three bowls according to how much they like to play with each child. They placed the pictures of children they liked to play with "a lot" in the largest bowl, the pictures of children they liked to play with "a little" in the medium sized bowl, and the pictures of children they liked to play with "not at all" in the smallest bowl. Ratings of peer acceptance were standardized by sex within each classroom.

RESULTS

It was predicted that most-liked children, as rated by peers, would show higher levels of outgoing and prosocial behavior than least-liked children. Pearson product moment correlations were computed between the four Baumrind Q-set factors (prosocial, outgoing, aggression, and withdrawn) and peer acceptance. As shown in Table !, only one of the four correlations was statistically significant. Children who were observed to show less withdrawn behavior had higher levels of peer acceptance. It was hypothesized that children who were rated by teachers as prosocial would be most-liked by peers. Also, I predicted that children rated by teachers as highly aggressive would be least-liked by peers. Correlation were conducted between teachers' ratings of children's social behavior and peer acceptance. These results are also shown in Table 1. Children who were rated as less withdrawn by teachers had higher levels of peer acceptance.

Table 1: Children's Social Behavior and Peer Acceptance

Q-Set Factors	Peer Acceptance
Prosocial	.02
Outgoing	.31
Aggressions	.31
Withdrawn	-.57**
Teacher Rating Factors	
Aggression	.25
Disruption	.22
Prosocial	-.08
Shy/Withdrawn	-.39**

**p<.01

In order to determine if gender influenced children's observed or rated social behaviors, a series of t-tests was conducted. As shown in Table 2, boys were observed as significantly more aggressive than girls. A marginally significant trend was found for prosocial behavior. Girls were observed to have higher levels of prosocial behavior than boys. According to teacher ratings, boys were significantly more disruptive than girls and girls were more prosocial than boys.

To examine race differences in children's social behaviors, t-tests were also used. there were no significant differences found between Caucasian and African American children on observed or rated social behaviors.

Table 2: Children's Social Behavior by Gender

Q-set Factors	Girls (n=8)	Boys (n=21)	t value	p value
Prosocial	6.21 (1.02)	5.44 (.96)	1.89	.07
Outgoing	7.16 (1.05)	6.65 (1.42)	.84	n.s.
Aggressive	2.52 (.79)	4.06 (1.93)	2.17	.04
Withdrawn	4.22 (2.49)	3.56 (1.57)	.85	n.s.
Teacher Rating Factors				
Aggression	1.13 (.35)	1.75 (1.07)	1.60	n.s.
Disruption	1.29 (.33)	2.18 (.97)	2.52	.02
Prosocial	4.58 (.50)	3.83 (.64)	2.95	.01
Shy/Withdrawn	1.29 (.28)	1.43 (.55)	.69	n.s.

Note. Numbers in the table are means. Numbers in parentheses are standard deviations.

DISCUSSION

The purpose of this study was to examine the social interactions of children with peers in kindergarten. children with lover levels of peer acceptance were more withdrawn. this withdrawn behavior was observed by both teachers and researchers. Thus, it appears that children who are reluctant to engage in social interactions may prevent themselves from developing positive peer relationships. this lack of social interaction with peers in kindergarten may have adverse effects later in life due to underdeveloped social skills (Eisenberg & Mussen, 1989); Parker & Asher, 1987). to circumvent this possible outcome, teachers should be aware of children's withdrawal from the peer group and engage in intervention efforts. Such interventions might include careful pairing of socially skilled with unskilled children, facilitating peer group entry into play, and other social skills interventions.

Gender differences were found in both observation and teacher ratings. Girls were more prosocial than boys. Boys were more aggressive and disruptive than girls. These findings are in accordance with previous research (Denham et al., 1990). They also highlight the differences in girls' and boys' play styles, which may serve to enforce the gender segragation that is prevalent at this age (Maccoby, 1990).

The finding that race did not influence observed or rated behavior is not surprising due to the particular sample studied. children attended a university lab school known for having a multicultural curriculum. Furthermore, most of the children in this study were from middle- to upper-middle-class families. Previous research finding racial differences in peer relationships sampled a group of children from a lower socioeconomic class (Fishbein & Imai, 1993). It is quite possible that social and economic context play a role in race and peer relations.

This study found that children's social behavior was related to their peer acceptance. Differences were also found between girls' and boys' social interactions with peers. These findings suggest that classroom interventions should be undertaken to keep children from missing out on opportunities to develop social skills in early childhood.

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REFERENCES

Baumrind, D. (1967). Child care practices anteceding three patterns of preschool behavior. Genetic Psychology Monographs, 75, 43-88.

Cassidy, J., & Asher, S. R. (1992). Loneliness and peer relations in young children. Child Development, 63, 350-365.

Denham, S. A., & Holt, R. (1993). Preschoolers' likability as cause or consequence of their social behavior. Developmental Psychology, 29, 271-275.

Denham, S. A.., McKinley, M., Couchoud, E., A., & Holt, R. (1990). Emotional and behavioral predictors of peer status in young preschoolers. Child Development, 61, 1145-1152.

Eisenberg, N., & Mussen, P. (1989). The roots of prosocial behavior in children. New York: Cambridge University Press.

Fishbein, H., & Imai, S. (1993). Preschoolers select playmates on the basis of gender and race. Journal of Applied Developmental Psychology,14, 303-316.

Hartup, W. (1983). Peer relations. In P. H. Mussen (Series Ed.) & E. M. Hetherington (Vol. Ed.), Handbook of child psychology: Vol. 4. Socialization, personality, and social development (4th ed., pp. 103-196). New York: Wiley.

Howes, C. (1988). Peer interaction of young children. Monographs of the Society for Research in Child Development, 53 (1, Serial No. 217).

Howes, C., Phillipsen, L., & Hamilton, C. (1993). Constructing social communication with peers: Domains and sequences. In J. Nadel & L. Camaioni (Eds.), New perspectives in early communicative development. London: Routledge.

Ladd, G. W., Price, J. M., & Hart, C. H. (1988). Predicting preschoolers' peer status from their playground behaviors. Child Development, 59, 986-992.

Maccoby, E. E. (1990). Gender and relationships: A developmental account. American Psychologist, 45, 513-520.

Parker J., & Asher, S. (1987). Peer relations and later personal adjustment: Are low-accepted children at risk? Psychological Bulletin, 102, 357-389.

Putallaz M., & Wasserman, A. (1989). Children's naturalistic entry behavior and sociometric status: A developmental perspective. Developmental Psychology 25, 297-305.

Rubin, K. H., Daniels-Bierness, T., & Hayvren, M. (1982). Social and social cognitive correlate of sociometric status in preschool and kindergarten children. Canadian Journal of Behavioral Science, 14, 338-349.

Sanderson, J., & Siegal, M. (1995). Loneliness and stable friendship in rejected and nonrejected preschoolers. Journal of Applied Developmental Psychology, 16, 555-567.

Urberg, K., & Kaplan, M. (1989). An observational study of race-, age-, and sex-heterogeneous interaction in preschoolers. Journal of Applied Developmental Psychology, 10, 299-311.

THE HISTORY OF THE CIVIL RIGHTS MOVEMENT IN PRINCE EDWARD COUNTY, VA (1951-1964)

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The years 1951 - 1964 were turbulent ones for the people in the small, Southside Virginia county of Prince Edward. Rather than integrate, Prince Edward County closed its public schools for four years. The dispute became part of the Brown vs. Board of Education decision. This study uses a series audio-taped interviews with local citizens detailing how they coped with the closing of the schools (e.g., loss of jobs, family displacement, tension between the Negro and white communities) and assesses the long range emotional and practical effects of the closingon those affected. Why the community still struggles with the abiding significance of race will also be discussed.

Prologue:

"I wish this integration situation in Prince Edward county could be laid to rest. Sometimes... I think people keep trying, even today, to dig it up and say you've got to know about it. That it happened. Yes, it's part of history, but as the expression goes, sometimes I feel like you are beating a dead horse" (Austin, 1995).

The *dead horse* Edith M. Austin spoke of is the history of civil rights in Prince Edward County. If it is true that horse has been flogged to death, someone needs to tell the horse, because that horse will not lie down.

Someone needs to tell the story of what happened in Prince Edward County because some cannot remember. Some do not want to remember, and some cannot remember to forget. But the story, a chronicle of a small Virginia county upon which the eyes of the world were once focused, needs to be told again and again. It is a harrowing account of the hours and the times, the fullness and the emptiness, the loss and discovery that are sewn into the fabric of peoples lives. The events in Prince Edward County, 1951 - 1964, were set in motion by two types of people: those determined to change the way they lived, and those who struggled to preserve the only way of life they have ever known. It is the story of our lives, then, and now.

Then

Prince Edward County is located 70 miles southwest of Richmond in the "rural underbelly of Virginia known as Southside" (Smith, 1965). Farmville, the major town in Prince Edward lies on the NE tip of the county on either side of US 460.

Forty-five years ago, life in this county changed forever through a series of improbable, extraordinary events. Farmville and Prince Edward became, alternately, a source of pride, scorn and the indelible benchmark of a changing order in the South.

In the late 1930's, like almost every other county in the South, Prince Edward was segregated: schools, churches, parks, clinics. Like almost every other Southern county, segregation meant separate and unequal. While tax rates for whites and blacks were the same, less money was appropriated for blacks in the county, and fewer public services were provided. No place in Prince Edward County were the racial discrepancies more apparent than in the county's educational system.

In the 1940's, education for a student in Prince Edward County was a priority, if he or she were white. In 1939, "the white Farmville high school had been rebuilt in part with Public Works Administration funds and insurance. It had a gymnasium, cafeteria, locker rooms, infirmary, and an auditorium with fixed seats" (Smith, 1965).

The same year the new white school was built, Prince Edward County broke ground for the new Negro high school, but the Moton High School had none of the facilities of the white high school. Moton High School's maximum student capacity was 175 pupils. When the 1945 - 1946 school term ended, Moton's enrollment topped 450 (Baker, 1996).

Two days after M. Boyd Jones, the new principal of Moton High School arrived in 1947, the county school superintendent, T.J. McIlwaine called. McIlwaine told Jones he was going to have to cut his $300 Moton science budget in half. Jones invited the superintendent to tour the school's one science classroom and showed McIlwaine Moton's complete science inventory: two test tubes and an alcohol lamp. "We have to service 250 biology students," Jones told the superintendent, "I don't know what to cut [;] you cut it" (Jones, 1995).

Eventually, local administrators formulated a response to the dangerous overcrowding of the Negro schools. The county hastily erected tar and plywood buildings on the back lot of Moton to accommodate the overflow of children. Hazel Davis, one of the Moton High School students, remembers the temporary buildings as tar-paper shacks: "'Everyone called them chicken coops. They were cold in winter and hot in the spring and fall'" (Baker, 1996).

On April 23, 1951, the Negro students of Moton High School walked out of class and refused to return for two weeks. The students hoped to call the community's attention to their school's inferior conditions and shabby facilities. The strike was led by 15-year-old Barbara Johns: " 'I was sick and tired of the inadequate buildings and facilities. I wished something could be done about it'" (Smith, 1965). From this feeling, the idea to walk-out was conceived.

After the strike ended, "the [students'] grievance had expanded from equal facilities to integration and the National Association for the Advancement of Colored People (NAACP) filed a law suit in federal court attacking the Virginia law requiring segregated schools" (Baker, 1996). In 1896, state laws enforcing segregation were ruled to be constitutional only if accommodations were equal as well as separate.

In 1952, a Federal District Court upheld Prince Edward's segregated education system, and ruled against the Moton plaintiffs' call for integration, but "found that the Negro schools were inferior to their white counterparts and ordered that the facilities be equalized" (Baker, 1996). Undaunted by the lower court decision, the NAACP immediately appealed the case to the U.S. Supreme Court. The Prince Edward County case, Davis vs. Prince Edward, was merged with similar court cases initiated in Kansas, South Carolina and Delaware. Eventually, these cases were consolidated to become Brown vs. The Board of Education of Topeka.

The legal suits, court action and the looming spectre of desegregation seemed to rouse the Prince Edward County Board of Supervisors to reconsider its tactics. Two months after the Moton High School strike, one month after the original lawsuit was filed, Prince Edward appropriated $850,000 for a new segregated school for Negroes. The new Moton High School, now Prince Edward County High School, was completed in 1953, but it was not a solution to the educational stalemate that divided the county. Negro educators looked upon the new school as a last-gasp gesture of die-hard Southern segregationists: "We didn't feel a sense of victory when the new R.R. Moton School was built. Not real victory, I guess we felt a sense of appeasement -- a sense of 'this will satisfy you now.' We were glad the children had an opportunity to go back to school, but it wasn't the answer" (Fisher, 1995).

By early 1954, "conditions in the county had changed drastically. Relations between whites and [Negroes] had become cool and resentful" (Hale-Smith, 1993).

On May 17, 1954, the nine white male justices of the nation's highest court ruled in Brown vs. Board of Education, that *"in the field of public education, the doctrine of 'separate but equal' has no place. Separate educational facilities are inherently unequal."* Furious Prince Edward County officials, along with those from several other counties in Virginia, quickly instituted a "massive resistance" plan against integration: County officials, led by Virginia's governor, Harry Byrd, and augmented with support from the state General Assembly, voted to deny funds and appropriations to any school district that followed the Supreme Court's order to desegregate (Heinemann, 1995).

Prince Edward administrators also took the extraordinary steps of establishing a private, publicly funded, segregated school for white children, and in mid-1959, closed all public schools to avoid integration. In early September 1959, when public schools were due to open, the newly-founded Prince Edward Academy opened its doors and welcomed the county's white children. Stunned Negroes watched public school buses carry the white children to and from school each day. The county's public schools were locked and chained and for the next five years there was no public school system in Prince Edward County.

When the school year came and went, and the county schools failed to reopen, Prince Edward County blacks struggled to find ways to cope. "A few classes for Negro children were held in church basements and homes" (Baker, 1996). These classes were taught by volunteers, displaced teachers and empathetic college students from the North. But these efforts faltered after a year or two because of a lack of money, personnel and supplies. "While a lucky few hundred students left the county to continue their schooling, the majority of the Negro students became part of a Lost Generation whose formal education ended abruptly, or never began" (Baker, 1996).

The Lost Generation

Driving west on Race Street in Farmville, the clean, well kept homes of the white neighborhood give way to worn, shabby houses and unkempt yards littered with trash. Middle-aged blacks sit on ancient front porches. Long, deep shadows have burrowed into the place in

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their faces where there used to be smile lines. Restless, agitated, they look like they are waiting for something. They are called the Lost Generation.

"It hurt every black person in Prince Edward County in some way or the other, to have your schools closed... just so that your little children couldn't go to school with little white children" (Eanes, S., 1995).

The closing of the schools in Prince Edward was devastating. No matter on which side of the conflict people stood, for five years, lives were interrupted. "Across the nation, school segregation and the belief that one race is superior to another left scars that can still be seen today. In Prince Edward, where there is a feeling everyone is a neighbor, the battle was a little more personal" (Ruff, 1995).

While other communities across the nation, trying to manage integration, erupted into violence and turmoil, Prince Edward did not. Charismatic leaders with cool heads prevailed on both sides to keep the issue a "gentleman's fight" (Wall, 1995). Though there was no bloodshed in Southside, there were casualties.

"You didn't really know which way to go. You didn't know how to offer support -- you didn't have much support to offer. I'm thinking of persons who were not able to send their children away to school. Those children were so large and so old, they had been stopped in the third grade and fourth grade. They went on to the eighth.... but they lost tremendous educational skills in between that time" (Fisher, 1995).

When the schools closed, a generation lost a future of possibilities. Years later, old hurts that should have healed long before are still raw: "I left school as a child, and I came back as a man. They put me in the eighth grade, but I never caught up. I was treated different. Teachers gave us less instruction and attention... we were so big. It still hurts today... My math is O.K., but I can't spell like I want to" (Eanes, W., 1995). Grief cannot be measured in time, but it has been 46 years, and for many former Prince Edward students like William Eanes, the tears keep coming: "It's a hard feeling to take... just when I finally graduated [from high school, at 21], I got a draft notice. I wonder, why did I have to serve a country that forced me to miss four years of school? It hurts" (Eanes, W., 1995).

Ethel Fisher was a Prince Edward County elementary school teacher at the time of the closing. Fisher, now retired, is an astute historian of the life and times of Prince Edward County. Fisher cautions against characterizing events in Prince Edward as a great fight in which one side was completely right and the other, almost completely wrong. The course of human events is infinitely more complicated: "I don't have a feeling that we alone, were affected, blacks, I mean. Whites were affected too- because no way in the world you can do that much damage to me, and not do any damage to yourself" (Fisher, 1995).

There was not universal support among whites in Prince Edward County for the closing of the schools. A number in the white community were opposed to the schools closing: "Some whites couldn't afford Prince Edward Academy. They struggled to pay the tuition, they lost their homes... they suffered too. They were trapped. And, of course, being white, they couldn't sympathize... fearing reprisals" (Fisher, 1995). Poor white families in Prince Edward County found themselves in the same situation as the county's blacks: shut out of school. "People forget, all those white people crowing the loudest about not integrating and organizing private schools were the ones who could afford it. Our family was not rich, we were farmers, and when my grandfather spoke out against the closing the schools, our whole family was blackballed. Even today, I have two grown uncles who cannot read" (Hines, 1996). One white woman recalls during the time the schools were closed, she was embarrassed to say she was from Prince Edward County: "Everybody believed we were all racists here" (Scarborough, 1995).

After the schools closed in 1959, there were children of both races who were never able to complete their education. Those students just about to enter high school suffered disproportionately. In Prince Edward County, those four years without school meant those students would assume adult responsibilities, a hitch in the armed forces, full-time jobs, and family commitments.

When the schools reopened in 1964, some returned; most did not. They were too far along in their lives to turn around and go back to ninth grade. Life can only be lived forward, not backwards. If there is any legacy of what happened in Prince Edward County, sadly, that is it. Ernestine Herndon, a displaced Prince Edward school teacher forced to relocate her family and find employment over 100 miles away when the schools closed, concludes: "We were called 'The Lost Generation.' And some blacks in Prince Edward County today, say our children are still affected by the schools' closing: The parents and grandparents of students today did not finish school, they did not go back to school. They lost out, dropped out, became discouraged... and they do not encourage their children and grandchildren today that education is very important" (Herndon, 1995).

Now

In 1995, an out-of-town newspaper reporter came to Farmville to prepare a story that marked the 40th anniversary of the Brown decision. Few people would talk to him, even fewer would go on record. "Many whites wanted all the attention to go away. Many blacks nursed an anguish that- for all the articles, discussions and documentaries, they felt was not completely understood" (Ruff, 1995).

Today, the Farmville Herald, which 40 years ago, under the stewardship of powerful editor and publisher, J. Barrye Wall, rallied against integration and government intervention, is relatively silent, almost docile now. Currently, the Herald covers education matters and school events from all local schools -- public and private. Publisher and editor-in-chief Steve Wall, grandson of J. Barrye Wall, regularly, almost reverently, reports efforts to save the old Moton High School and convert it into a museum.

Margaret E. Hale-Smith, a researcher from Michigan State University came to Prince Edward in 1993 to assess the effect the school closing had on the community. Hale-Smith's study concluded, " Prince Edward County continues to experience anxiety about African American children in the public school system; the Prince Edward Academy [now the Fuqua School] stills functions in the community and is a reminder of the school closings, and the division of races in the county is still very much a reality" (Hale-Smith, 1993).

Hale-Smith reported the overall consensus within the county is that the black community has forgiven what happened in 1959, but has yet to forget. Hale-Smith found many respondents would like to see "some kind of formal acknowledgment by the county, or town of Farmville, of the trauma they suffered as a result of the school closings" (Hale-Smith, 1993).

Today, the Prince Edward County public schools are customarily ranked among the best in the Commonwealth, among localities similar in size and location. Prince Edward students have won state-wide academic honors consistently in recent years. The county's teaching staff is approximately 50% white and 50% black, while the racial make-up of the student population generally falls into the 60% black and 40% white range. Approximately 20% of the county's white student population attends Fuqua School (Brookover et al., 1993).

Hale-Smith's research suggests that integration has not been completely extended into the elementary school level: "Teachers reported black children are not invited to white students' birthday parties. They also noted the existence of some white and black cliques; but on the whole, they claimed that race relations between black and white students are generally congenial" (Hale-Smith, 1993).

Current race relations between adults in Prince Edward County are better, or worse, than 40 years ago, depending upon who is asked, and who is asking. "One professional white man who was an active, committed segregationist 30 years ago, now claims that he has been converted from his segregationist views, but blacks and some whites who know him have a somewhat different perception of him. They noted that he interacts much more freely with some Afro-Americans than he did formerly, but he only relates to those Afro-Americans he views as nonthreatening or those he perceives as 'knowing their place.' Afro-Americans who challenge the traditional racial relationships and who do not accept a subservient role in that relationship are highly condemned by this 'former' rabid segregationist" (Brookover et al., 1993).

For some in Prince Edward County, 45 years after the fact, integration is still a new idea: "Another older white man, who is perceived as liberal in his attitude toward Afro-Americans, reported that he still has some difficulty accepting them in new relationships. For example, he reported that he finds it difficult to accept the fact that an Afro-American man who has worked for him several years now comes to the front rather than the back door to discuss his work from day to day" (Brookover et al., 1993).

From the black community, there is tacit acknowledgment of the past and tempered hope for the future. "I think sometimes the white people in this area were shocked -- they were so accustomed to blacks 'staying in their place.' Then, this line of demarcation has been crossed, and they got scared. All of this, the school closing, it came from fear" (Fisher, 1995).

Understandably, the movement in Prince Edward County to turn the old Moton High School into a civil rights museum is controversial. Within the community, the Moton School stirs powerful memories once thought dampened, vividly back to life. Some want to see the school gone, and some want to save it as a landmark: "There it comes again, the same old people. The emotions are still there. They want to erase the R.R. Moton School so it won't be there. Some ask why keep dealing with it? Why keep bringing it up... lets get rid of it. But it is a thing we will never get rid of. Its imprint is there. I would love for that school to stay there. Moton is a mark on our lives. Like the Holocaust, Jewish people will never 'get over' that. We need to have Moton as a landmark... to say 'this happened.' Don't deprive us of our past. Some of those things helped us plan a future" (Fisher, 1995).

Epilogue:

Some say what happened in Prince Edward County 45 years ago, could have happened anywhere. *But it only happened here.* Confronted with the prospect of desegregation and integration, Prince Edward County was the only county in the United States to close its schools for an extended (five years) period of time. "I often think other counties had the same feeling -- to close their schools, but they saw how ridiculous this county was, and they said, 'No, we are not going to do that'" (Fisher, 1995).

"All men are created equal," Jefferson wrote. From birth, we are all granted the same rights, all imbued with the same responsibilities, but 175 years after Jefferson's words were written, all men were not equal in Prince Edward County. In 1964, under intense pressure from the federal government, and burdened with a new Supreme Court Order, public schools, now desegregated, reopened in Prince Edward County. Jefferson's words, if not fully understood by everyone in Prince Edward, were, at last, heard. Said President Kennedy, "Something has to be done about Prince Edward County. There are only four places in the world where children are denied the right to attend school: North Vietnam, Cambodia, North Korea and Prince Edward County."

Anyone interested in the extraordinary processes of integration and desegration should know the story of Prince Edward County during the years 1951 - 1964. The history of civil rights in Prince Edward is the story of education, dignity, and the way hard facts of life marred life in a small Southside Virginia community.

Prince Edward County today is quiet; Farmville is a picturesque college town. The events of 1951 - 1964 seem so long ago. In fact, two generations have gone by. Today, both black and white people in Prince Edward struggle with " the abiding significance of race [in their county]. They cannot quite find the word for what they suspect is in the hearts of the other race. Not 'prejudice.' Not hatred,' not 'intolerance,' exactly. It is, they say, something hidden, and always there" (Morrow, 1989). For people like Ethel Fisher, and those who have lived through it, the matter of the schools closing, and the place it holds in their lives, stays with them: "I guess many of those feelings... anticipation, intimidation will always be a part of us. Some things you don't live down. Some things you absorb... you go on with your life and just keep moving. You have to keep moving." ☐

REFERENCES

Austin, E. (1995, April 28). Personal Interview.

Baker, D.P. (1996). Integration's victims: When Virginia slammed the school doors shut. The APF Reporter 17, (3), 45-50.

Brookover, W.B., Dudley, A., Green, R.L. (1993). Prince Edward County Virginia: A pretty good place to live. Journal of Negro Education 62, 162-170.

Brown v. Board of Education of Topeka (Brown I). 347 U.S. 483 (1954).

Brown v. Board of Education of Topeka (Brown II). 349 U.S. 294 (1955).

Eanes, S. (1995, March 15). Personal Interview.

Eanes, W. (1995, March 15). Personal Interview.

Fisher, E. (1995, April 7). Personal Interview.

Hale-Smith, M.E. (1993). The effect of early education disruption on the belief systems and educational practices ofadults: Another look at the Prince Edward County school closing. Journal of Negro Education 62, 171-189.

Heinemann, R. (1995, March 8). Massive Resistance. Lecture presented to Honors Civil Rights class at Longwood College, Farmville, Virginia.

Herndon, E. (1995, March 9). Personal Interview.

Hines, T. (1996, July 30). Personal Interview.

Jones, M.B. (1995, February 01). The student walkout. Lecture presented to Honors Civil Rights class at Longwood College, Farmville, Virginia.

Morrow, L. (1989, November 20). Prince Edward and the past. Time, p. 58.

Ruff, J. (1995, February 19). Course explores still-painful Prince Edward schools struggles. Richmond-Times Dispatch, sec.2,p.1.

Scarborough, S. (1995, March 29). From a child's perspective. Lecture presented to Honors Civil Rights class at Longwood College, Farmville, Virginia.

Smith, B. (1965) They closed their schools: Prince Edward County, Virginia 1951-1965. Chapel Hill, North Carolina; University of North Carolina Press.

Wall, S. (1995, April 12) Mr. J. Barrye Wall. Lecture presented to Honors Civil Rights class at Longwood College, Farmville, Virginia.

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QUALITATIVE RESEARCH ON THE TEACHING METHODOLOGY OF GENETICS 348: A HANDS ON APPROACH

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A qualitative analysis of the teaching methodology and the learning behaviors and attitudes of students was conducted on a laboratory intensive Genetics class at Hamline University. While in the laboratory, the students worked in groups of three or four, designed and carried out research projects, and then gave presentations. In addition, they were able to witness the importance of technology in genetics by actually practicing the "science" and through the use of computers to simulate projects. The presentation describes, the higher learning outcomes and greater depth of knowledge when the students are given the opportunity to practice the science. It shows that students don't just memorize the information, but are able to analyze and synthesize the information. In addition, the students are able to build a connection between lecture material and their laboratory research which also contributes to a greater depth of learning. There are also intrinsic rewards such as motivation, pride, willingness to learn and an awareness of self and others.

INTRODUCTION

The course was started at Drexel University in Philadelphia as the Enhanced Bioscience Education Program (EBE) and was created by Dr. Presley Martin. At Drexel the EBE program offered a holistic, hands-on approach to science and was series of 5 biology courses centered around cooperative group projects. When Dr. Martin left Drexel to teach at Hamline, he brought the core ideas of the EBE along. Due to time constraints, the program was modified for the Hamline course but was true to the philosophy behind Drexel's program.

The main reason behind a hands-on approach is that the students learn the genetics better. They are able to relate the lecture and lab material by actually doing the biology opposed to just reading or hearing about it. According to Dr. Martin, the students are also able to retain the information because they are experiencing the material as part of their projects. They also experience the trials and tribulations of experiments that don't work out, differences in opinions, and incorrect correlation's. Furthermore, the students are utilizing their biology knowledge and terminology in application to their projects and when giving presentations to their peers.

In addition to the biology concepts taught in the Genetics class, students were required to perform other skills not traditionally associated with a biology course. While in the cooperative groups, the students had to design and implement the projects, actively gather supportive resources, and communicate both written and orally. The computer was also a major tool used in the class and the students became familiar with different genetic programs. These skills, along with the project-based approach to presenting genetic information, served to enhance student learning and application of biology material.

METHODS

A variety of research methods were used to correlate student analysis, synthesis and intrinsic rewards of learning. The classroom lectures were observed two times a week for approximately three months. During this time periodic scanning of the room was conducted, behavior was categorized (i.e. listening without writing, writing, talking, sleeping) and each category was given a percentage. Individual conversations and interactions between the students and Professor Martin were also followed, highlighting questions and answers. Questionnaires were used to access various kinds of information. In order to gain response on the understanding and attitudes after lecture, a questionnaire would be given, this was done on three separate occasions. A pre-class (beginning of semester) questionnaire middle of the semester questionnaire and a post-class (end of semester) questionnaire were conducted to determine changes in students' learning styles and attitudes. Dr. Martin would periodically asked the students questions about the speed of the class and the level of information given. He was also used as an evaluative source on learning and attitudes in the classroom. Another research method was through information assessment in the form of quizzes and tests. In particular, midterm and final grades, Genetics construction kits (GCK) pre and post test scores, presentation grades and lecture quizzes were assessed.

Throughout the semester, one of two lab sessions per week were attended and observed. The Tuesday lab which ran four hours and contained four cooperative learning groups was more closely followed. These groups were observed during lecture, had their group presentations videotaped, and also were interviewed individually as well as in a group. In addition, the students were provided questionnaires during lab. However, students were given the choice if they wanted to answer them or not. These questions focused on student attitudes toward this class, if they would use the material again, and how they rated this class against comparable courses.

RESULTS

The results of a pre and post semester questionnaire, a questionnaire in the middle of the semester, personal interviews, video, and lab questionnaires show that students felt they were learning and retaining information. Test and quiz scores show students were able to utilize the knowledge learned in a lecture format analyze the information and apply it to realistic genetic projects and experiences. The students were able to listen to their peers' presentations and synthesize the information. They were then able to question, discuss and critically analyze the information opposed to taking it at face value.

Pre and Post Test results of Gene Map

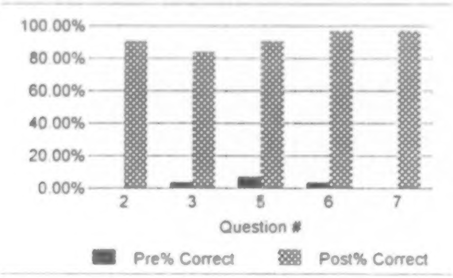

Figure 1 shows the results of a pre-test of Gene mapping prior to lecture and laboratory. The lab and lecture material closely related and the students completed the lab before the final test. The chart also shows the post-results of a similar gene mapping test.

The average score of this test was 92% opposed other test score averages of ~85%.

DISCUSSION

As with any evaluative piece, determining how much a student actually learned, opposed to how much is memorized is difficult. Learning is become capable in order to process, analyze and synthesize information. In addition, there is a discrepancy between copying a problem solving technique and actually understanding the function of the problem and utilizing it in a variety of ways. It is impossible to pinpoint a specific method of teaching that stimulates better learning. Rather effective teaching requires a culmination of intricate activities and interactions that generate an environment conducive to learning.

One of the first steps in providing the tools to learn in this class was through clear expectations. The students are given clear objectives and learning goals provided through unit outlines and pre-unit exams. The students indicated that the pre-unit exams were very helpful in identifying what they needed to know. There was no guessing or wondering about the important information.

The lectures were comparable to other college courses that utilized lectures. One student said this class is similar in lecture, had labs, but is different in computer use, more beneficial. The lecture portion of the class was mostly straight information delivery. Approximately eight people out of 30 felt they learned the most form lectures from the beginning of class to the end of class (Pre and Post Quiz). Although other students' learning patterns fluctuated from the beginning of the semester to the end, with many switching between learning the most on their own and learning through lab.

The questionnaire results showed that students said they learned the most from lecture, they most likely meant they understood the information, but did not learn the information. Student activity during lecture was generally passive, usually split between listening and note-taking. This lead to less learning of material and lower evaluation results.

An unexpected result of the pre and post lab questionnaire was the students choice to attend lab over lecture. Most students said they would rather attend a lab but felt they learned the most during lecture. However, in other questionnaires and interviews, the students said they were better able to understand lecture material in lab. The depth of knowledge in inquiry based education is greater when the students are able to analyze, synthesize and apply information when lab and lecture correlate. The students said they felt like they were learning, not memorizing. They would memorize in lecture and learn in lab.

Learning activities, hands-on labs, and projects in which the students were doing science contributed to a greater understanding and appreciation of the genetic information which was evident in the language, attitudes and assessment during lab and lecture classes. During lecture, learning activities allowed the students to analyze and utilize the lecture material. The students were given a scenario, question or problem to figure out. They would then have time to work on their own and then with the group to arrive at an answer. They would have to give an answer and explain their reasoning behind it. The students would analyze each other's answers and supporting data and either refute or agree. In such cases, the learning process was clearly visible. Even when students were incorrect, they were able to figure out why by synthesizing other's information and re-analyzing their own conclusions.

The labs were set up as a series of projects that the students designed and implemented while in a cooperative group situation. The groups were assigned by Professor Martin based on computer expertise. Each group had students with different computer experience. At the beginning of the semester, the groups were unable to commit to conclusions. They looked for specific right or wrong answers when there may have been neither. Later, they were able to discuss and explain problems with one another through small group and during presentations and were able to accept various answers for a problem based on the evidence each group presented.

Indications that learning was taking place was also shown through changes of opinion and discussion, much in the same way as lecture groups. Students were better able to clarify their own answers through discussion and even when wrong, able to see where they went wrong in their thinking process, go back and re-think a problem in order to get a better answer. Through questioning, an understanding of the material being presented could be directly linked to the hands-on projects they were working on. The ability to develop questions further indicates that their ability to synthesize the information is due to the actual doing in lab in contrast to the passive listening of the lecture.

The students said the lecture cleared up problems and concepts in lab (especially GCK) and the lab cleared up some problems in lecture (recombination and crossovers) and is a place to demonstrate that they know what they are doing (supports knowledge). Students often indicated this example in interviews and questions as a lab that really clarified and helped in the synthesis of information. From that knowledge, they were able to apply it in a variety of ways as shown through test scores, which were much higher for units that provided a strong link between lecture and lab than for other units. A specific project that correlated much better than the others was a series of problems called Genetics Construction Kits (GCK). Students attributed the difference in scores between the pre-test and post-test (Figure 1) to an inquiry based lab that corresponded well and had links provided to the lecture. The reverse was also true. The students had a more in-depth, or deeper understanding of the material because they applied and performed the information, rather than memorizing.

The presentations that the students gave were helpful in understanding and utilizing biological concepts and information. It was also a new experience for many of the students. At first, they were choppy, and the students looked to Professor Martin for reassurance. As time progressed, the presentations became much more fluent with more utilization of genetic terminology. The ability to speak like a scientist and use terminology was also evident through conversations between the students when discussing the projects and when casually speaking (i.e. making jokes). The students also gained confidence in their ability to speak in front of an audience about biology. In addition, the students used the computers in their presentations which was a new modem of communication for many. However by the end of the semester, the majority of students felt much more proficient at computer utilization and learned skills they could use again.

The end of the semester grades showed that students successfully learned genetic information. The lowest grades in the class were C's and the highest were A's. All the rest of the grades fell in between these grades. The grades indicate the students were able to synthesize and apply the information they learned.

Although this class was indicated as harder than other classes, the students enjoyed it. They had more opportunities to ask questions and ask for help (usually in lab) and there are more resources available: group members, classmates, a non-intimidating professor who explained the material well, and review sessions. One student said he didn't need to use a tutor as he did in other courses. Another student was able to apply the genetic knowledge to other classes such as psychology. The importance of genetics when researching many diseases was clear to yet another student through this course. The positive attitudes of the student's toward this class are apparent. From the questionnaire, a majority of students "significantly" liked this class over other comparable classes and would highly recommend this class to other students.

CONCLUSION

Learning processes such as analyzing, synthesizing and applying biological concepts and information as well as positive attitudes and rewarding experiences were obtained in a Genetics course which emphasized hands-on learning and cooperative groups. Major contributions to learning were the attitude and availability of the professor and the clear expectations and objectives. The students not only memorized information but were able to utilize it through application projects in which they felt they were doing science. They also gained skills in computers and communication. This class was notably liked more than other classes and would be highly recommended to others. Cooperative group structure during hands-on science versus individualized research in addition to the impact of computer technology are other areas of interest that should be researched within the context of teaching methodology.

SPATIAL DISTRIBUTION AND SOCIO-ECONOMIC PROFILE OF ASIAN INDIANS

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The United States has long since been known as the land of opportunity and for centuries immigrants from different parts of the world have migrated here for a chance to better their lives and start anew. This opportunity that drew many immigrants in the past has drawn numerous Asian Indians to the United States. The majority of Asian Indian immigration has occurred after the 1965 Immigration Act. Since then more then half a million Asian Indians have entered the United States in search for better income and education opportunities. The search has seemingly been paying off since most of these Asian Indian immigrants have become an important part of the United States social, economic, and political structure. Being one of the fastest growing ethnic groups in the United States to date, the Asian Indians have successfully become the one of societies most looked upon ethnic groups. With the massive increase in population of Asian Indians in the United States it is no question that this ethnic group is making it's presence noticed in the business market of today.

HISTORY OF ASIAN INDIAN IMMIGRATION

Although Asian Indian first arrived in the United States between 1899 and 1913, people still call their presence a recent phenomenon (Asian Central,1995). The number in which they came was not large by any meanings. Alarmed at the fewer then 7,000 Indians admitted into the United Sates between those years congress held special hearings on Indian immigration to stem what was called in that part of the century "the tides of turbans" (Mehra,1996). Most of these new migrants who came in the early stages were Sikhs from the Punjab region. They came to the United States and settled in the northwest region of the United States, where they found employment in lumber yards and the railroad building industry.

The majority of these migrants were men. The reason for this was that women were discouraged from immigrating in the country to prevent the "planting of roots" (Asian Central,1995). Americans only wanted to use the Asian immigrants for hard labor and then ship them back instead of letting them stay in the states and start a new life with their loved one. The Asian Indians were not considered as equals by Americans. One reason for this was the fact that they were not white. Instead Americans preferred European migrants and because of this the "Asian Exclusion League" was formed (Asian Central,1995).

There was much protest of Asian Indians in the United States, it caused riots in cities such as Washington and California. Hundreds of Asian Indians were forced out of the states and into Canada in 1907 (Mehra,1996). It was not until after 1965 that Asian Indians immigrated to the United States again. This was due to the amendments of the Immigration And Nationality Act, which made it possible for Asians to immigrate to the United States in large numbers once again. Of this large number of Asian Indians who migrated to the United States more then 1/3 live among ten different states: California, New York, New Jersey, Illinois, Texas, Florida, Pennsylvania, Maryland, Michigan, and Ohio (Mogeclonsky,1995). Traditionally Asian Indians flocked to the northeastern part of the United States and primarily the urban portion of New York and New Jersey, but California led all other states with almost 160,000 Asian Indians. Most of the Asian Indian population has lived in and around major Metropolitan areas. For example, in 1990 1.2 percent of the city of New York's population was of Asian Indian decent and 2.3 percent of Somerset-Hunterdon, New Jersey was of Asian Descent (Mogeclonsky,1995). In Wisconsin the Asian Indian population makes up 1.3 percent of the total population which is condensed in to two major cities Milwaukee and Madison (U.S. CENSUS,1990). This should come as no surprise since both Madison and Milwaukee are two of Wisconsin's major Metropolitan areas.

The Asian Indians migrated into three different waves since the middle of the twentieth century. The first wave of Asian Indian immigrants consisted of affluent Asian men from the 1960's. They came to the United States because of their qualifications. This is also what made it very easy for them to obtain green cards. Most are doctors, scientists, and other professionals who are now in their fifties and are at their peak earning potential (Mogeclonsky,1995). The women of the first wave usually do not work outside of the home and are usually, as compared to their husbands undereducated and speak little English. They carry with then no more then a high school diploma. The second wave of Asian Indians includes those whom came to the United States in the 1970's. The men in this group were highly educated professionals, but unlike the first many are married to highly educated women who work outside of the house (Mogeclonsky,1995). This wave understands the language spoken buy their parents, as well as speak fluent English. However they tend not to speak their native tongues themselves. The problem that is faced by this second wave is that there are such a small number of jobs allotted to them. Because of this the Asian Indians are not always able to find a job in their chosen field, therefore they are forced into taking a job that they are highly over qualified for. The third wave of Asian Indians consists of relatives of the earlier immigrants (Asian Central,1995). They are sponsored by established family members in this country. They are often less educated then the first two waves, which may explain the reason that they are the wave that is most likely running motels, convenient stores, and driving taxi cabs (Mogeclonsky,1995). In Wisconsin there can be found a mixture of all three waves of immigrants, but the majority are from the second and third waves. One reason for this is that children of the first generation immigrants who grew up in Canada migrated to Wisconsin in search for jobs and/or a college degree.

ECONOMIC AND SOCIAL PROFILE OF ASIAN INDIANS

The economic make up of the Asian Indian population is one that is not matched by many. The Asian Indians are having much success when it comes to there economic status in the United States. This status however did not come easy. The Asian Indians have a success story that seems to be masked by a reality of the situation, in that they are discriminated against. This discrimination is historical, it roots going back to the pre-1965 racist immigration laws that barred immigration from India, and the rest of Asia. Asian Indians, according to the 1996 Federal Glass Ceiling Commission's report, have been discriminated against in hiring practices, salaries, and advancement in the work place (Mehra,1996).

Nearly two in every three Indians over the age of 25 has a college degree, which is more than three times the national average (Mehra,1996). These Indians with their bachelors degrees typically earn $2,000 less than whites with comparable qualification and Indian women earn $6,000 less than white women (Mehra,1996). This all complements the fact that Asian Indians have the highest mismatched job rate of any ethnic group in the United States (Mehra,1996). The Asian Indians even though have these burdens upon them, have defied the odds and proven that they can become a very economically successful group, in part their success has come from the affirmative action programs that have been implemented. Asian Indians earn more than any other ethnic group in the United States except for the Japanese Americans (SUCCESS STORY,1996). On average an Asian Indian household makes 25% higher than the national average, which is around $44,700 a year as compared to the average United States household, whom earn around $31,200 a year according to the 1990 U.S. census. The Indian population throughout the United States is assuming positions of power.

Most of the Indian population are employed in professional fields such as medicine, engineering, entrepreneurial, and financial analysis careers. Of these professionals, 14 percent can be found in science, medicine and technological careers. To date there are more than 5,000 Asian Indians whom are faculty members at universities around the United States (SUCCESS STORY,1996). According to the Washington D.C. based center for immigration studies, Asian Indians are slightly over represented among managerial and sales-clerical workers and under represented among the blue collared workers (1990 census). In New York Asian Indians are over represented among taxi drivers. More than 40 percent of New York

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city's 40,000 licensed Yellow Cab Drivers are Asian Indians (Mogclonsky,1995) Most of these Indians see this job as just temporary until they save up enough money to start their own business.

Another example of a over representation by Asian Indians is in the motel/hotel and dry cleaning businesses, as well as a few deli's. The expansion seen by hotel and motel industry for example was generated by the Indians. To day the Asian Indians own between 20-25 percent of hotels and motels in the United States (Nichola,1996). In Wisconsin alone there over 150 hotels and motels owned by Asian Indians either living in Wisconsin or neighboring states. The Asian American Hotel Owners Association estimates that the Asian Indian population holds about 12,000 properties (Nichola,1996). The restaurant business estimates that 1/3 of all Baskin - Robbins are owned by Indians (Nichola,1996). This high number of Asian Indians in these fields are contributed by the fact that most Asians are geared towards the idea of being their own boss. One reason for this is that when they own the business they are less likely to be discriminated against. According to the 1996 Survey of minority-owned business Enterprises released by the census Bureau, the number of Asian Indian businesses has increased by 120 percent. This increase can be seen in the greater Milwaukee area of Wisconsin where a number of new Asian owned businesses have emerged, ranging from your local convenience store to a restaurant. In Appleton, Wisconsin an Asian Indian family has recently opened up a restaurant that serves authentic Indian food.

Financial Security is important to most Asian Indian. Saving money is a part of Indian culture, as well as saving for education and retirement. It is estimated that on average Asian Indians save 15 to 20 percent of their income; this is 5 percent higher then the national average (Mogeclonsky,1995). As the Asian Indian population continues to rise many banks and companies are starting to target them. The Asian Indian buying power is estimated to be around the 20 billion dollar mark, which makes them a healthy target for many companies (Asian Central,1995). Asian Indians are large advocates of well defined life and property insurance, and many buy their policies in cash and carry little disability insurance.

Asian Indians are very demanding when it comes to where they spend their money. They tend to look for a company that is involved or acknowledges their lives, and companies that are doing so are gaining many new customers in return. One examples of this is Metropolitan Life, which recently sponsored a Asian Indian religious festival , Navaratri. This festival attracted over 100,000 people (Mogeclonsky,1995). In Milwaukee, Wisconsin, a local bank (TCF) sponsored a retirement and college savings workshop. By making these contributions to the Asian Indian society paves the way for many business opportunities for the sponsors, as well as making it known that the Asian Indian population has gained a foothold in the United States market.

On a broader scale companies such as AT&T and Network television stations are also becoming aware of this market and are trying to gain their patronage by meeting their needs in an array of different ways (Haniffa,1995). AT&T realized that most Asian Indians have family ties in other countries which they keep in touch with on a regular basis and have launched a marketing campaign that has introduced a India web site, which helps Asian Indian net browsers connect to people and information around the corner and around the world, and a "true reach savings" program that helps them save money on calls to their family members across the globe (AT&T,1995). Alpha Star a planned direct-broadcast satellite service in the United States has recently signed a agreement with the Asian Television Network in an effort to try to gain a ethnic niche in programming. This station broadcasts 24 hours of programming that is in both English and several south Asian Languages which consists of everything from movies and news to sports and talk shows.

Political power is something that many Asian Indians are becoming very involved in. Asian Indians for the most part usually stay in concentrated areas which gives them a real good power to impact politics when it come time for a congressional election. (Though concentration of Asian Indians is not always needed to have Asian Indian influence.) In Wyoming the Asian Indian population is the smallest of any state in the United States , but it was the first state in the nation to elect an Asian Indian to its legislature (Mogeclonsky,1995). Throughout the United States many Indians are assuming positions of power. Among them are President Clinton's Administrator of the Department of Transportation and the Director of the National Institute of Standards and Technology. This great political participation of Asian Indians in America stems from a foundation that is based upon family.

This strong emphasis on family and community are cared over into many aspects of the Asian Indian lifestyle Out of all Asian Indians only 4 5 percent have households that consist of no husband and only 1 3 percent are headed by a unmarried household In a typical Asian Indian family the head of the household consist of usually the male The father dominated characteristic is one that has roots back to Asia (India) in which all major decisions were made by the ruling male This trend is easily seen when it comes time to making the final decision on such things as major ticket items: appliances. automobiles. homes (Mogeclonsky 1995) This decision role is also carried over into the realm of the dating world for young Asian Indians (Canvas 1996) It is the father who makes the decisions on who their child will be seeing This characteristic has changed with the younger generation of Asian Indians One factor in this is that now there is an educated mother who has her own career as well as the father where in the older generation it was usually only the father who was educated and had a career

The community importance factor is visible in other parts of their lives In the business world of Asian Indians many whom have businesses have started a community buying power program in which they buy in bulk for many restaurants or convenient stores By doing this they are able to cut the cost on the needed goods (MULTICHANNEL.1995) This is also seen in other decisions that a concentrated group of Indians make For example. when looking for a place to bank an Asian Indian will usually go were his community or family have been satisfied. showing trust in their choose (Mogelonsky 1995) In many Asian Indian households there are sometimes more then one family living there. this goes back to the idea of sponsoring relatives that has recently come over to the states

CONCLUSION

The social. economic. and political role of an Asian Indian in America has gone through many different changes Socially. their roots are planted in the United States These roots bring with them historical traditions such as strong family values and a common bond between other Asian Indians with similar backgrounds Economically. this group has transformed from a intensive migrant laborer working for next to nothing into the doctors and professors of the 1990's with a net family income almost 25 percent higher then the national average Along the way they are making businesses feel their estimated 20 billion dollars of buying power Politically. the Asian Indians have been moving into position at al levels of the spectrum and have been recently using their growing population in concentrated areas to impact local elections Until the 1980's they were categorized into the Asian Pacific Islander heading of the census Since then they have been classified as Asian Indians in the 1980 and 1990 census data It is apparent that as the Asian Indian population continues to rise the social. economical. political role of the Asian Indian in the United States will increase From the state and local level to the national level. Asian Indians are making their presence known

REFERENCES

"Alpha Star Signs Ethnic Services Asian T.V. Network." Multichannel News 27 Nov v1995

"Asian Indians." Journals of Asian Studies Online Available www family treemaker com/0000361 html

"AT&T Launches New India Horizons Web Site." AT&T news release Oct 30 1995 Available www.att.com/press/1095/951030 csa html

"A Brief History of Indian-American Immigration and Life." Asian Central 16 Oct 1996 Available www.asiacentral com/india_snap html

" The Canvas of Life." Little India Feb 1996

Haniffa. Aziz "Strategies Cover Broad Field." India Abroad 15 Dec 1995

"Indians Are Most Qualified of Asian Immigrants in U.S." Indian Express 30 Oct 1995

"Indians In USA: A Success Story." Indolink 12 Sept 1996 available www indolink com/analysis/indsinUS html

Mehra. Achal "Victims of Success." Little India Jan 1996

Mogelonsky, Marcia. "Asian-Indian Americans." American Demographics v17n8 (1995) 32-39

Nichola,Don "A Passage From India." Restaurants Business 95.5 (1996) 48-50

O'Hare, William P., Frey, William H., Fort, Dan. "Asians In The Suburbs." American Demographics May 1994 32-38

United States Census Bureau. 1990 United States Census.

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Intra-Asian Direct Investment and Indian Economic Liberalization

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INTRODUCTION

Defining the relationship between Intra-Asian investment and changing economic policy in India is vital to understanding of both regional and global trends. In the current global economy, rising labor costs and saturated domestic markets are forcing Asian countries with high levels of economic development to seek new labor supplies and new markets. India's population of 949.6 million provides both South Asia's largest labor force and its largest market. After nearly forty years of import substitution and high tariffs, India is focusing on export-oriented policies. At the same time, India is attracting capital, technology, and investments from both Western and Asian multinational corporations (MNCs) through economic liberalization. Pull factors for MNCs include India's domestic market base, expanding middle class, and large supply of skilled and unskilled labor. Asian MNCs also consider geographical and cultural factors in adapting processes and products to markets.

ECONOMIC POLICY AND FOREIGN DIRECT INVESTMENT

Economic development in India has not kept pace with development in other Asian economies. British colonial rule left India without an independent economy, and MNC foreign direct investment (FDI) focused on resource extraction, exporting post-colonial India's raw materials. The Indian government countered this practice with import substitution, and began to acquire assets discouraged by colonialism: capital equipment, entrepreneurship, technical knowledge, infrastructure, and skilled industrial labor. A foreign exchange crisis in the 1950s led India to re-think MNC investment. In the early 1960s, industries such as aluminum, electrical equipment, fertilizers, and pharmaceuticals, all of which had been restricted to the public sector, were opened to MNCs. Export processing zones (EPZs) were established at Kandla, with ownership and tax incentives for MNCs.

Fear of industrial stagnation brought policy reversals and import substitution was re-implemented. In 1970, patents were denied for chemical, drug, and food products to push Indian industries to develop substitutes. There were attempts to lure FDI by creating new EPZs, but growing limits on MNCs made India less attractive. The net result was creation of ownership advantage for India, following successful development of local resources. As Indian economic development internalized, MNCs lost competitive advantage to protected domestic industries. FDI stagnated under restrictions in the 1980s: actual average annual inflow of FDI was under $35 million, although FDI approvals averaged over $85 million (Zahid, 1994). At the same time, infrastructure obsolescence and substandard production limited the international market for Indian goods. The threat to foreign exchange led to exemptions from some restrictions: foreign equity in export-oriented firms increased, tariffs were cut, and imports of technical designs were permitted to stimulate technological development.

In the early 1990s, India's foreign debt increased, and the rupee was devalued. Structural adjustment policies dealt with the balance of payments crisis by stressing economic liberalization and austerity programs. Of all FDI approvals between 1991 and 1996, 60% were in priority areas for infrastructure modernization, such as communications, electronics, and power generation. FDI was allowed in services, imported consumer goods, and warehousing and FDI approvals jumped from $359 million in 1991 to $11.198 billion in 1995. Actual FDI inflows rose quickly from $154 million in 1991 to $1.958 billion in 1995, but were only 40% of approvals (Embassy of India, 1996). There are several reasons for this lag. Bureaucratic problems still remain at state and local levels. Constant shifts in economic policy failed to provide conditions for long term growth and stability. In April of 1996, investment reports cautioned that India was financially unsettled and politically unstable, and slowing in economic growth. Increased FDI was recommended, but short-term improvement was unlikely, since MNCs were concentrating on the domestic market, rather than on export production (Haniffa, 1996).

Past government policies tried to protect Indian economic interests from neo-colonialism by limiting foreign ownership. The flow of FDI was restricted, protecting inefficient state-run industries, and MNCs became reluctant to invest in limited joint ventures. Recent reforms are meant to reassure MNCs of increased control over their Indian assets.

ECONOMIC LIBERALIZATION AND FDI

Liberalization relies on attracting FDI, estimated at $2 billion for 1996, and expected to reach $10 billion by 2000 (Haniffa, 1996). Massive restrictions have been lifted, foreign brand names and trade marks are allowed, and EPZs have expanded the special status of manufacturers and exporters. FDI is allowed in sensitive areas like atomic energy, strategic metals and minerals, military equipment, and railroads. State-controlled industries like banking, communications, and highway construction have been opened. Project proposals in the electric power industry, where 100% foreign equity is allowed, totaled nearly $33 billion by 1995 (US Dept. of Commerce). At least $100 billion in other planned infrastructure development relies on FDI financing.

Once delayed indefinitely in federal bureaucracy, proposals are now being granted automatically in high priority industries. Proposals with foreign equity of up to 51% or foreign technology transfer receive automatic approval within two weeks of application. Foreign equity of up to 100% is accepted for completely export-oriented projects. Yet there are still obstacles to implementation of economic reforms. FDI approvals exceed inflow, indicating problems in the approval process. Privatization of state-owned firms, for example, is meant to provide a focus for FDI, but most of the quarter million state-run firms, which are chronically inefficient due to lack of competition, require government capital to operate. Deregulation stalls because remnant socialist-era legislation and powerful unions bar economic reforms, and buyers are discouraged by rules against layoffs of surplus labor.

Indian economic development is also affected by international trade blocs, which take India seriously as both competitor and collaborator. The Organization for Economic Cooperation and Development recently proposed including developing non-member countries like India. The agenda of such a group is essentially self-serving, and the benefits and risks of an association must be weighed against India's hard-won autonomy. Ultimately, the concerns of the trade blocs prove that India's potential economic power is already being recognized.

As a result, India is both sought as a trading partner and feared as a competitor, especially in Asian markets. India could emerge as an economic giant with the power to economically and politically destabilize the region. The influence of FDI on Indian policy will have a widespread regional effect, which will also affect world trade. Despite government emphasis on FDI, the World Bank states that it is unlikely to increase foreign exchange, or improve India's balance of payments position. FDI is important, but cannot offset India's massive debts and social problems. Attracting and keeping FDI may be increasingly difficult as there is intense competition among developing countries for available capital.

INTRA-ASIAN FDI

Although most FDI to India comes from US and European MNCs, the new international division of labor (NIDL) is bringing Asian MNCs as well. In the NIDL, countries with a higher level of economic development export labor-intensive production to less developed countries, and concentrate on capital-intensive activity. The NIDL relies on cheap labor, and Asian MNCs shift facilities from country to country, depending on production costs. Labor costs are low in India, especially in the informal sector, where employment is uncertain, labor is unorganized, and very low wages are accepted. Trade barriers in western industrialized countries (WICs) targeting specific countries can be avoided by exporting production. Japan, for example, shifted manufacturing to continental Asia because of lower labor and shipping costs, but also because WIC barriers discouraged Japanese exports. India's political infrastructure is more attractive than China's, having democratic government, independent judiciary, and private property rights. India also has an established banking system and stock exchange, while Chinese businesses prefer to bank overseas. Intra-Asian FDI takes advantage of India's strategic location near target markets as a base for regional transportation. Production in India can target the Middle East and Asia-Pacific regions through container ports. Asian MNCs which can also tailor regional production to regional tastes where ethnic groups have similar product preferences.

Japan, the major Asian investor in India, limited investments until recent reforms, yet maintained a strategic presence in India. Japanese firms took sub-normal profits for decades while keeping in contact with potentially lucrative Indian markets. Their perseverance placed them strategically to take immediate advantage of liberalization. The case of Maruti-Udyog Ltd., a Japanese-Indian vehicle manufacturer, shows this long-term focus and possible benefits for India. The Japanese MNC, Suzuki Motors, upgraded facilities and retrained local workers. Suzuki adapted quality control and management to local conditions, and emphasized gradual indigenization of production. At first, nearly complete vehicles were imported into India for assembly, until local firms could supply ancillary production (Joseph, 1990). The Maruti-Suzuki partnership employed 5,000 people to produce more than 130,000 vehicles, at a rate of 26 vehicles per employee. Mahindra, an Indian vehicle manufacturer, employed 12,000 workers in 1993, yet was able to produce only 82,000 vehicles, fewer than 7 vehicles per employee (Dahlburg, 1994).

Japan is only one of the Intra-Asian investors in India. In the 1990s, newly industrialized economies, such as Korea and Taiwan, have invested surpluses in developing Asian countries. Their FDI into India, however, has been limited. Much of India's competition comes from much smaller countries, such as Vietnam, which have aggressively pursued FDI. Like investors from other parts of the world, Asian MNCs avoid directing FDI to India's many inefficient industries.

FDI POLICY IMPLEMENTATION

Economies in Asia follow a cycle of sustained investment, trade, and growth: export-oriented development policies initially attract FDI, which encourages favorable policies, sustaining the cycle. In India, however, past policies focused obsessively on Indian control of MNCs, rather than on promoting FDI inflows, weakening the investment-trade-growth cycle. Policies have also interfered in the natural turnover within industries by reducing turnover among domestic firms, artificially protecting them from competition. The result is the nursing of "sick" industries and government purchase of grossly inefficient firms. The lack of "exit policy" for surplus labor makes firms retain workers that production capacity or product demand cannot support. Guaranteeing wages to workers who are unproductive due to oversupply of labor or lack of demand drains government resources. The system hurts business and government, but its greatest cost is to the workers who depend on it. The eventual collapse of the system will leave thousands of workers without wages, a dangerous social and political situation for India.

With MNCs already producing for export, Indian companies question the advantage of associating with MNCs, when the domestic market would be more lucrative. Quality standards set by importing countries for MNCs are not required of domestic producers, which lowers production costs and, along with the size of the domestic market, ensures profits based on quantity of goods sold, not necessarily on quality.

Indian infrastructure is not well developed for supporting FDI funded projects. Services are often be unavailable or incapable of supporting MNCs, as in the case of India's frequent power failures. The lack of consistent power can damage equipment, and is a major barrier to development of high technology industry, banking and communications. Although India is seeking technology transfer, India's poor protection of intellectual property rights discourages MNC investment in industries where process patents are common, and in the information industry, where India has the potential for world leadership. The government feels that although technology transfer is vital, it would conflict with domestic research and development (R&D). Evaluation of technology for transfer is impossible without in situ R&D. MNC affiliates did more R&D than local firms, yet liberalizing technology imports actually spurred local R&D to modify technology for local resources (Siddharthan, 1992).

The movement of FDI to lower technology sectors is an unintended side effect of tying FDI to technology transfer. Regulation of technology transfer from technically advanced industries causes MNCs to transfer older technology that is less valuable to Indian development. Without intellectual property protection, MNCs are reluctant to bring newer

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technology into India, stalling modernization. Problems with intellectual property protection can lead to protectionism as well, as MNCs risk being denied market access for "Made in India" products. The US labor force, for example, was unprepared for the NIDL, and lobbied for restrictions on Indian imports. Discouraging Indian export production could invite retaliatory legislation against US MNCs in India and stall progress on intellectual property rights. The tension between the need for FDI and the lack of intellectual property protection shows how policies are in direct conflict with India's economic situation.

FDI AND INDIAN SOCIETY

As MNCs move into host countries, they interact with other cultures. Expectations of the consumer market must be examined according to consumption patterns rather than income distributions. Lower middle class consumers do not have the same income as those in WICs, yet their relative purchasing power is high. With an annual income of $700 to $1400, India's lower middle class buys 75% of radios and toilet soaps, 60% of laundry detergents, and up to 50% of color TVs, soft drinks, and shampoos sold. (Jacob, 1992) Strategic FDI in target markets takes advantage of India's socioeconomic diversity and growing consumerism. Liberalization not only stimulates FDI, but encourages consumer spending, and increased consumerism is fueling a rise in consumer credit, as India's financial sector opens to FDI. Credit companies see the large number of consumers as potential credit card holders. However, as in WICs, use of consumer credit can lead to defaults, which would stall economic development. Use of credit also puts new emphasis on the outlawed custom of dowry, which is reportedly on the rise. Dowry has been the source of systematic economic abuse of women and their families, even contributing to the practice of female infanticide. Although the availability of consumer credit might help women gain independence, increasing consumerism makes this unlikely.

Other issues involving FDI include inadequate environmental protection, hazardous working conditions, and the low status of women. One problem that has been ignored, is the rapid rise of HIV/AIDS infection in India which will have an impact on economic growth. One of the priority sectors for FDI is the hotel and tourism industry, which will be one of the most affected by the HIV/AIDS crisis. Economic growth is fueling the crisis, since spread of the virus parallels truck transport of goods from manufacturing centers. Economic growth will slow as the working population becomes debilitated, shrinking both labor force and domestic market. HIV/AIDS will strain health resources and drain government money away from the capital improvements necessary for continued involvement in the world economy. (Ghosh, 1996)

These factors may discourage FDI unless the Indian government acknowledges the problems and begins to deal with them effectively. Investing countries seek healthy venues for FDI, and India's enormous potential market and large supply of cheap labor may not offset the possibility of a host country crippled with political or social upheavals.

CONCLUSION

Although India has adopted export-oriented, outward looking policies, implementation has not been smooth. There is a lack of long-term political stability and a lack of political will for positive change. FDI may increase the money supply, leading to inflation, yet appreciation of the rupee could make exports less competitive. MNCs are distrusted as promoters of neo-colonial enterprises. Inefficient state-owned firms, and entrenched bureaucracy have a vested interest in delaying privatization. Asian regional competition encourages efficiency while unions try to protect inefficient firms. Strong export markets are vital to both Indian industrial policy and MNC profit. Trade restrictions on "Made in India" goods can cause retaliation by the Indian government. Indian firms with strong domestic markets are less likely to seek partnerships with export-oriented MNCs, shrinking available venues for FDI. Large tax breaks for foreign MNCs discourage Indian MNCs, which redirect inward investment to other countries. MNCs may leave if tax incentives are removed in government attempts to intercept profits. There is fear that MNCs will homogenize Indian culture. India's inexperience with laissez-faire capitalism has given MNCs great economic power, although the government believes it has control because it can withdraw reforms. Growing consumerism will not permit a return to import substitution. India is hoping to cure social and economic ills by embracing supply-side economics. yet it is unlikely that any benefits will "trickle down" through India's stratified society. What has actually reached the working poor is consumerism.

Despite ideological disagreements. political instability. environmental protection issues and human rights concerns. economic liberalization in India will continue to expand. Given the rapid growth of technology and the emerging importance of Asian regional markets. India has no other option. Intra-Asian FDI plays a crucial role in India's economic growth. but the question is whether that growth can be controlled. These problems must be resolved. since FDI could direct India away from post-colonial policies and towards a pivotal role in the world economy. By 2010. there will be over 1 billion people in India. whose government must not only define goals. but implement them in the nation's best interest. A few short years will not provide enough transition time for an economy ready for change. but burdened with enormous political and social challenges.

REFERENCES

Dahlburg. J T. "National Agenda: India Opens Up The Road to Business." Los Angeles Times 10 May 1994.

Embassy of India. Foreign Direct Investment in India since the Economic Reforms. Washington DC 11 April 1996.

Ghosh. J. "Socio-Economic Factors and the Spread of Infectious Diseases: Case of India." Papers & Proceedings of the Applied Geography Conference 1996. Kansas City

Haniffa. A. "Markets: Report Advises Increase in Foreign Direct Investment." India Abroad 12 April 1996.

Jacob. Rahul. "India is Opening for Business." Fortune 126.11 (1992): 128-130.

Joseph. Abraham. "Japan's FDI in India's industrial development: A case study of Maruti Udyog Ltd." CTC Reporter 30 (1990): 25-26. 33.

Siddharthan. N S. "Transaction costs. technology transfer. and in-house R&D: A study of the Indian private corporate sector." Journal of Economic Behavior & Organization 18.2 (1992): 265-271).

US Department of Commerce. Economics and Statistics Administration. India Big Emerging Markets Home Page (stat-usa@doc.gov) 18 September 1995.

Zahid. Shahid N. "Intra-Regional Investment and Technology Transfer: A South Asian Perspective." Intra-Regional Investment and Technology Transfer in Asia 57-75.

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The Spatial Distribution of the Hispanic Population in the United States: An Analysis at Various Geographic Scales

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The Hispanic population in the United States is steadily increasing, but is it becoming more spatially concentrated? This study sought to answer that question by first mapping the Hispanic population at various geographic scales and then quantitatively measuring its degree of concentration.
The spatial distribution is shown by a series of choropleth maps which display the percentage of Hispanic population at the national, state, county, city and census tract block group scales. The degree of population concentration is measured by the use of location quotients at each geographic scale. The results of the study show the spatial concentration of Hispanics in the United States both geographically and quantitatively.

INTRODUCTION:

During the past 30 years, more people have legally and illegally emigrated to the United States from Mexico than from any other nation. Between 1960 and 1980, the Mexican population in the United States grew from 2.3 million to 8.7 million. By the year 2010, the Mexican population in the United States is projected to reach 40 million (Gutiérrez xvii). As a result, both interest and national concern have risen about the Mexican population in the United States.

The Mexican population trends are a direct result of the history between the United States and Mexico. There have been several periods of large-scale Mexican migration, which continue today with the increasing demand for rural and skilled workers. A 1991 nationwide survey of farm workers showed that 90 percent of the 73 percent foreign born workers in US crop production were Mexican. Mexicans currently comprise about four percent of the United States labor force.

The close ties the labor market has with Mexico do not show any hint of reducing demand for Mexican labor. In addition, the close proximity of the two countries provides easy access for those Mexicans pursuing a better standard of living in a country more developed than Mexico. Where are these migration trends? This study shows the areas of the United States that have higher spatial concentrations of Mexicans.

METHOD:

The 1990 Census of the General Population was the primary source used to study the Mexican settlement in the United States. Data were taken from the census information on the Hispanic population at the state, city, county and census tract level. The Hispanic population was divided into subsets, for example the Mexican, Cuban or Puerto Rican population at the state, city and census tract levels. However, at the county level, data was available only on the more general level of Hispanic population.

The study focuses on the spatial location of Mexicans in the United States. The first part is an analysis at the national level. First a table of the Mexican population and the total population for each of the 51 states was made. From this table, percentages of Mexicans in each state were calculated. Another quantitative analysis included calculating the spatial location quotient of Mexicans for each state. Below equation 1, using Texas data, gives a sample calculation of the location quotients calculated. To find the spatial location quotient, one must first take the Mexican population of the state (3,890,820) and divide it by the total Mexican population in all the states (13,495,938). Then divide this by the quotient of the total state population (16,986,510) divided by the total nation's population (250,709,873).

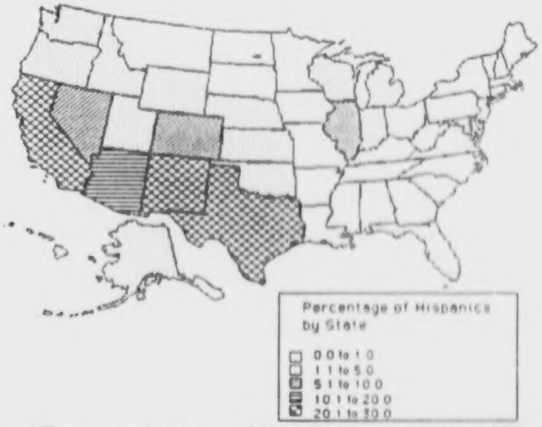
$$\frac{\left(\frac{3890820}{13495938}\right)}{\left(\frac{16986510}{250709873}\right)} = 4.26 \qquad (1)$$

The location quotient analyzes the degree of concentration of a population, indicating high or low population density. Table 1 lists the five states with the highest percentage of Mexicans and their location quotients. Map 1 is a choropleth map showing the distributions in the United States.

Table 1: Mexican Populations in Top Five States

States	Population	# of Mexicans	% of Mexicans	Location Quotient
Texas	16,986,510	3,890,820	23	4.26
New Mexico	515,069	328,836	22	11.9
California	29,760,021	6,118,996	20.5	3.82
Arizona	3,665,228	616,195	16.8	3.12
Colorado	3,294,394	282,478	8.5	1.59

Map 1: Mexican Population in the United States

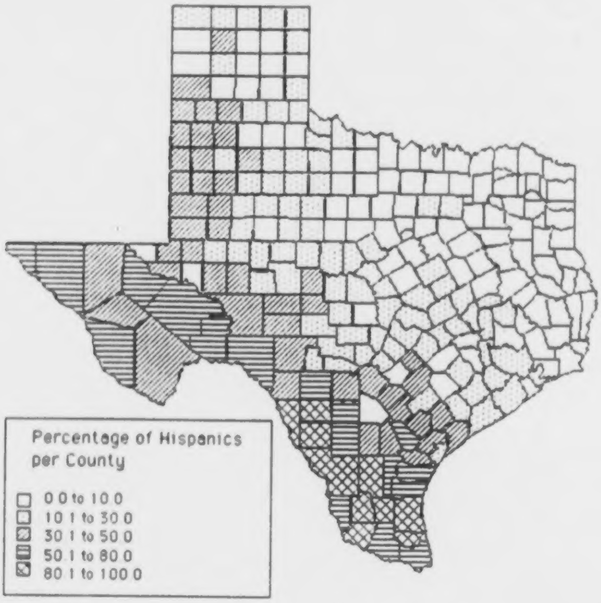


Because Texas was the state with the greatest percentage of Mexicans, the next study was on the spatial concentration of the Mexican population in Texas, by county. Again, calculations of both percentages and location quotients were made. A summary of the counties with the greatest percentages and location quotients is shown in Table 2. Map 2 shows the spatial concentration

Table 2: Hispanic Population in Top Five Counties

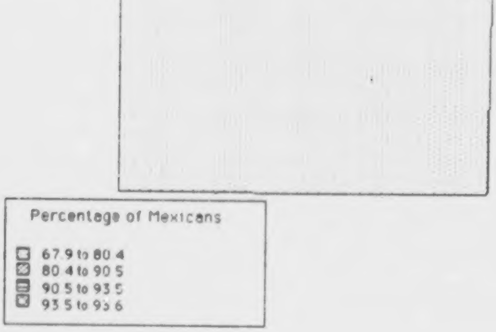
County	Population	# of Hispanics	% of Hispanics	Location Quotient
Jim Hogg	5,079	4,659	91.7	3.74
Brooks	8,187	7,338	89.6	3.65
Duval	12,721	11,267	88.6	3.61
Zavala	12,306	10,875	88.4	3.60
Starr	44,953	39,390	87.6	3.57

Map 2: Mexican Population in Texas


Percentage of Hispanics per County
0.0 to 10.0
10.1 to 30.0
30.1 to 50.0
50.1 to 80.0
80.1 to 100.0

Last, an analysis of the settlement pattern of Mexicans at the county and city level were made. The county with the greatest percentage of Hispanics, Jim Hogg county (Map 3), was mapped according to census tract blocks.

Map 3: Mexican Population in Jim Hogg County


Hebbronville
Percentage of Mexicans
67.9 to 80.4
80.4 to 90.5
90.5 to 93.5
93.5 to 95.6

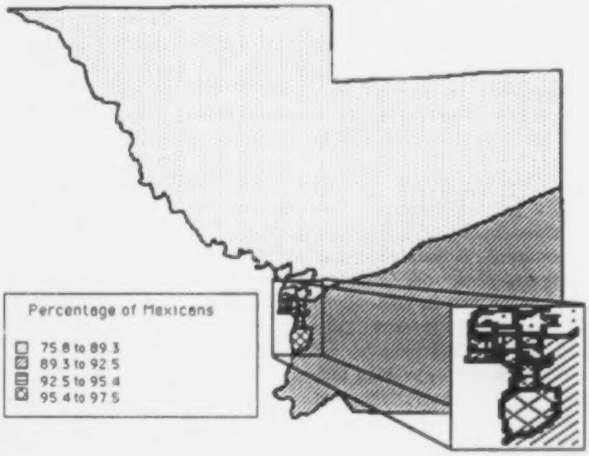
Next, using the 1990 census data each of Texas' cities with a population exceeding 50,000 persons was analyzed. Table 3 shows the five cities with the greatest percentages.

Table 3 Mexican Population in Top Five Cities in Texas

City	All persons	# Mexicans	% Mexicans	Location Quotient
Laredo	122,899	109,796	89.3	3.30
Brownsville	98,962	84,448	85.3	3.16
McAllen	84,021	61,206	72.8	2.69
El Paso	515,342	338,844	65.8	2.43
San Antonio	935,933	478,*409	51.1	1.89

Map 4 is Webb County. The enlarged area is of the census tract block groups for Laredo City, the city with the greatest spatial concentration of Mexicans. The city is magnified in order to show the individual census tracts.

Map 4: Mexican Population by Census Tract for Laredo, Texas



RESULTS:

As listed in Table 1, the Mexican population concentrates heavily in the Western region, including the states of New Mexico, California, Arizona and Colorado. However a large concentration was also found in Texas, a state in the Southern region. When analyzed by degree of concentration, the Western region has a very high location quotient, 2.29. On the location quotient scale, any number higher than 1.0 indicates a heavy population concentration.

The spatial concentration of Hispanics in the counties of Texas tends toward a higher concentration in the Southwestern portion of Texas than the Northeastern part of Texas. A regional analysis of Texas shows the Southwest has a high location quotient of 1.64 whereas the Northeast is .63.

A deeper analysis of the population density is done in the study of Jim Hogg County. Each census tract block group has high location quotients. Even though none reach 1.0, all are above .6. This again indicates high concentrations of the Mexican population. The greatest Mexican population density is near the town of Hebbronville (see Map 3)

The most specific level of analysis was the concentration of Mexicans within a city. The location quotient for Laredo indicated a very high density of Mexican population. Within the city, the census tract location quotients ranges differ very little, only by .24. The highest quotients were in census block group numbers 5 and 13, located in the downtown area (most likely the Central Business District). In general, the census tracts with the greatest location quotients and percentages are located either in downtown Laredo or in the southern part of the city.

CONCLUSION:

The spatial analysis of the Hispanic population in the United States shows similarities in all levels of geographic study. As stated in the results, the spatial location of Mexicans tends to be in the southwestern and western regions of the United States (Map 1). This trend continues through the national, state, county and city level. Texas shows high percentages of Mexicans in the Southwest region (Map 2). The city of Laredo demonstrates this as well, with percentages greatest at the location closest to the Mexican border. The trends shown by the spatial analyses and also the quantitative analyses are fairly uniform and expected.

Although the results are predictable, there are still sources of error in the study. The study was limited to the spatial analysis of Mexicans. Data in the 1990 Census listed Mexicans under the general heading of Hispanics. There is a level of uncertainty in the population data due to the census questionnaire. The Census used a self-identifying question in which people of Spanish/Hispanic origin classified themselves in one of the given categories: Mexican, Puerto Rican, Cuban or Other Spanish/Hispanic origin. Also, at the county scale of study, information on the Mexican population was not available. As a result the county scale analysis uses Hispanic population information. Second, the census information does not specify it is a census of the total population, legal and illegal immigrants. The assumption was that the census documented only legal residents, yet the status of the Mexican is very important to a simple study of spatial location.

Mexico is a border nation to the United States. Therefore, this study is significant by showing exactly where the immigration trends are occurring with the most frequency. It suggests that a greater pull factor than jobs is geographical proximity. It is obvious many Mexicans migrate and immigrate into the United States every year. This study shows that among the 51 states, Texas is the most preferred. In Texas, Jim Hogg is the preferred county of Mexican settlement. At the city scale, Laredo is favored over all Texas cities. The reasons for Mexican migration vary greatly, however predicting the spatial location is fairly easy once the general trends are known. Mexican groups are concentrated in locations closest to Mexico.

REFERENCES:

Bean, Frank D., and Marta Tienda. The Hispanic Population Of the United States. New York: Russell Sage Foundation, 1987.

Gutiérrez, David G., ed. Between Two Worlds: Mexican Immigrants in the United States. Delaware: Scholarly Resources Inc., 1996.

Hansen, Niles M. Location Preferences, Migration, and Regional Growth: A Study of the South and Southwest United States. New York: Praeger Publishers, 1973.

United States. U.S. Department of Commerce Economics and Statistics Administration BUREAU OF THE CENSUS. Statistical Abstract of the United States 1993. Washington: GPO 1993.

United States. Bureau of the Census. General Population Characteristics. Washington: GPO 1990.

United States. U.S. Department of Commerce Economics and Statistics Administration. BUREAU OF THE CENSUS. County and City Data Book 1994. Washington: GPO 1994.

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A Quantitative Study of Communication Apprehension and Self-Esteem

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This study investigates whether there is a correlation between self-esteem and communication apprehension. (CA). The forces is on the processing posits that individuals with high communication apprehension and individuals with low communication apprehension have in common. It is designed to explore the participant's reasoning for feeling and/or fear when communicating. The major findings in this study suggest that individuals with high levels of CA are less competent, and have lower academic success; individuals with low levels of CA are more competent in general, more communicatively competent, less anxious about communication, more composed, and more extroverted.

INTRODUCTION

The development of Communication Apprehension (CA) theory was the brainchild of McCroskey (1970). As the Chairperson of the International Division of the ICA, McCroskey with his colleagues did a study to find out how Communication Apprehension can affect individuals.

McCroskey (1970) defined Communication Apprehension (CA) as "a broadly based anxiety related to oral communication" (Infante, Rancer & Womack, 1993). This definition was expanded in future (subsequent) work to an individual's level of fear or anxiety associated with either real or anticipated communication with another person or persons (Infante, Racer & Womack, 1993). These over-reactions include trembling, difficult in swallowing, or temporary loss of memory (McCroskey, 1970), resulting from a physiologically over-reaction to an event.

Individuals with CA seem to possess some general characteristics. They tend to (1) be afraid of giving wrong answers and of receiving any type of evaluation; (2) focus on the correctness of the material; (3) feel that they do not have the ability to control themselves and the environment in which they are to speak; (4) be anxious about reading aloud; (5) feel emotionally unprepared to talk; (6) be unable to organize their thoughts and ideas; and (7) be unable to figure out rhetorical strategies for dealing with their audience (Berko, Wolvin & Wolvin, 1992, p. 95). Berko et al. (1992) estimate that eighty percent of the people in the United States confess to being shy as opposed to about seven percent of the people in the United States who have never felt shy. Berko's study also indicated that virtually one hundred percent of the people in the United States experience communication apprehension from time to time, and about ninety-five percent of the population reports having apprehension about communication with one person or group in their lives (Berko et. al., 1992).

There are several categories of CA: Traitlike CA, Context-Based CA, Audience-Based CA, and Situational CA. Traitlike CA is the stable degree of anxiety experienced by an individual across communication contexts, "such as" meetings, lectures, social and public speaking gatherings (Infante et. al., 1993). This type of CA is not such a debilitating condition that it would cause the speaker to communicate ineffectively. Traitlike CA has been the major focus of empirical research because it deals with a wide spectrum of personalities.

In Context-Based CA, time and context are the factors which influence the speaker's anxiety. This applies to individuals who may be comfortable speaking in certain settings, but not in others. For example, an individual may feel uncomfortable communicating to a person on an individual bases but not before a group. Another example is a graduate student who may be comfortable speaking before his classmates but experiences anxiety when speaking before a large seminar at his/her workplace.

Audience-Based CA is the fear experienced when communicating with certain types of people. Unlike Context-Based CA, the fear is experienced regardless of time and context (Infante, et. al., 1977). The presence of a particular audience member would cause anxiety in the speaker. An example could be a person who is confident speaking before large audiences, but when a pivotal figure (such as a parent) is present, the speaker could exhibit this type of CA.

Situational CA refers to the degree of fear encountered in communicating with a given person or persons in unique situations. This type of CA is caused by variables unique to a particular circumstance (Infante, et al., 1977). For example, an employee may rarely feel anxiety when called upon to speak in front of a large crowd and gives a superior performance.

RESEARCH METHODOLOGY

The research methodology employed for this research is quantitative. The theory that guides this study is the communication apprehension approach. This is tested on college students who both have high and low levels of CA. The hypothesis of this study is the following:

> H1: There are similarities and differences in self-esteem levels of both high CA students and low CA students.

This study is a micro level analysis in the sense that the unit of analysis is a convenient sample of 98 students at Bowie State University, University of Maryland at College Park, and Towson State University. The research design employed is a one group posttest only design. The basis of this design is a single post-treatment observation for the impact of communication apprehension. It can be diagrammatical stated as:

$$X\,O1 \quad [1]$$

where O1 is the observation or measure of communication apprehension and X is the level of communication apprehension itself.

The Survey Instrument employed for this study is McCroskey's Personal

Report of Communication Apprehension Questionnaire. This Instrument has 24 Statements dealing with communication Apprehension Issues (See Table !). The validity of this instrument hinged on thorough backgrounding, including contact with knowledgeable experts and intimate knowledge of existing research.· To ensure the reliability of the instrument, a sample of 10 of the students interviewed were again probed, and the same information was obtained as before.

DATA ANALYSIS

The data for this study were analyzed in one stage: univariate. The computer package that was used to compute the data for this study is called GB-STAT. The statistics used is the percentage, which is very useful for descriptive purposes. The results generated from the computer runs of the data for the univariate stage are summarized in Table 1.

As can be gleaned from Table 1, the Likert-Scale responses have been collapsed into three categories to facilitate ease in analyzing the data. This decision was based on the fact that an overwhelming majority of the responses for all the statements in the Personal Report Communication Apprehension instrument used were heavily skewed toward either strongly agree or strongly disagree. Also, it can be noted that the number of respondents who were undecided is relatively negligible.

Table 1 further shows that except for the first two statements ("I dislike participating in group discussions" and "Generally, I am comfortable while participating in group discussions") which have about four-fifths of the respondents agreeing and strongly agreeing with almost all of the rest of the respondents disagreeing and strongly disagreeing, the other twenty-two statements have about two-thirds of the respondents agreeing and strongly agreeing and almost all of the rest of the respondents disagreeing and strongly disagreeing. What is quite evident from the responses is that while about two-thirds of the respondents appear to have low self-esteem and communication apprehensive about getting involved in various communicative events (conversations, meetings, giving speeches) in the initial stages of these events, they tend to develop their self-confidence once the events progress. However, for about one-third of the respondents, their self-esteem and communication apprehension do not diminish even after they are already engaged in a communicative event. Therefore, the hypothesis posited in this study, H1: There are similarities and differences in self-esteem levels of both high CA students and low CA students, can be accepted.

What the results seem to indicate is that people with low self-esteem and communication apprehension seem to expect to be rejected by others. They also appear to think that they will perform poorly when being watched: sensitive to possible negative reaction. Characteristics like these make sense when one realizes that people with low self-esteem and communication apprehension are likely to believe that others won't like or respect them. Realistically or not, they imagine that others are constantly viewing them critically, and they accept these imagined or real criticisms as more proof that they are indeed unlikeable or unrespectable people. To use the well-known terminology of psychiatrist Eric Berne, they adopt an "I'm not OK--you're OK" orientation to life. Sometimes this low self-esteem and communication apprehension are manifested in hostility toward others, since the communicator takes the approach that the only way to look good is to put others down.

Table 1: Personal Report of Communication Apprehension (PRCA-24)

Statement	Agree and and Strongly Agree	Undecided	Disagree Strongly Disagree
1. I dislike participating in group discussions	79%	1%	20%
2. Generally, I am comfortable while participating in group discussions	84%	3%	13%
3. I am tense and nervous while participating in group discussions	66%	12%	22%
4. I like to get involved in group discussions	67%	11%	22%
5. Engaging in a group discussion with new people makes me tense and nervous	73%	6%	21%
6. I am calm and relaxed while participating in group discussions	66%	4%	30%
7. Generally, I am nervous when I have to participate in a meeting	66%	5%	29%
8. Usually, I calm and relaxed while participating in meetings	65%	3%	32%
9. I am very calm and relaxed when I am called upon to express an opinion at a meeting	68%	5%	27%
10. I am afraid to express myself at meetings	64%	7%	29%
11. Communicating at meetings usually makes me uncomfortable	71%	7%	22%
12. I am very relaxed when answering questions at a meeting	64%	10%	26%
13. While participating in a conversation with a new acquaintance, I feel very nervous	71%	9%	20%
14. I have no fear of speaking up in conversations	61%	5%	35%
15. Ordinarily, I am very tense and nervous in conversations	73%	5%	35%
16. Ordinarily, I am very calm and relaxed in conversations	64%	6%	30%
17. While conversing with a new acquaintance, I feel very relaxed	67%	5%	28%
18. I'm afraid to speak up in conversations	64%	8%	28%
19. I have no fear of giving a speech	60%	10%	30%
20. Certain parts of my body feel very tense and rigid while I am giving a speech	61%	12%	27%
21. I feel relaxed while giving a speech	65%	7%	28%
22. My thoughts become confused and jumbled when I am giving a speech	64%	10%	26%
23. I face the prospect of giving a speech with confidence	67%	3%	30%
24. While giving a speech, I get so nervous I forget facts I really know	62%	10%	28%

CONCLUSION

As the preceding discussion reveals, about two-thirds of the respondents appear to have low self-esteem and communication apprehension in the initial stages of communicative events; However, they tend to develop their self-confidence once the events progress. For the remaining one-third, their self-esteem and communication apprehension does not diminish even after they are already engaged in a communicative event.

The limitation of this study has to do with the fact that surveys, like the one employed for this study, usually ask people to describe their own behavior in relation to others. Consequently, self-reporting is grounded in self-perception. Accounts of behavior may be accounts of how people think they should behave. As such, their reported behavior sometimes is more "Should Be" Than "Is."

REFERENCES

Berko, Wolvin, and Wolvin, D. R. (1992). Communicating fifth edition. New York: Houghton Mifflin.

Infante, Rancer, Womack (1977). Communication Yearbook. p.150.

Infante, Racer and Womack (1993). Building communication theory second edition. Illinois: Waveland Press, Inc.

Levin and McCroskey, (1990). "Measuring trait communication apprehension: A test of rival measurement models of the PRCA-24." Speech monographs, Vol. 57.

McCroskey, J.C. (1970). "Measures of communication-bound anxiety." Speech monographsVol. 37, 269-277.

McCroskey, J.C. (1977). "Oral communication apprehension: A summary of recent theory and research." Human communication research, Vol. 4, 78-95.

Attraction Factors Involved in Internet Relationships

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The purpose of this study was to discover what major factors influence attraction in Computer-Mediated Communication. Reviewing past attraction research, a survey was devised including both traditional factors and the newly integrated cyberpersonal factors. The survey was intended to inform the researchers about attraction factors involved in internet relationships. These relationships included both the romantic and non-romantic. Subject anonymity was assured with the omission of the participant's return address when the survey was completed and returned. Approximately seventy-five internet users, both male and female, completed the survey asking about their involvement in computer-mediated relationships. Eight major factors were studied in the experiment: physical attraction, shared interest, proximity, moral structure, humor, intellect, age, and lack of touch. Using a block-sample study, the survey was analyzed and measured according to the intensity of the different factors involved. Conclusions were drawn regarding the primary factors involved in attraction in Computer-Mediated Relations and were compared to traditional Interpersonal attraction in relationships.

BACKGROUND

Since the dawn of computers, the information superhighway is rising at neck-breaking speed. Internet cyberspace is one of the fastest-growing forms of communication in the world. If one can talk to friends and business associates through his/her laptop computer, then why isn't it possible to meet one's soulmate? The days of wondering what to wear on a date are over. Now the only device one may find handy is the thesaurus for inventing witty advice and a can of Pepsi to keep you typing into the long hours of cyberspace--a world that keeps no clock. Eye-to-eye contact is lost, beauty is now in the hands of the typist rather than the eyes of the beholder. This research examines the differences between the primary elements of attraction in interpersonal and cyberpersonal contexts.

Attraction has always been a much debated subject among researchers. Attraction is based on several factors, one of which is physical attraction. Many studies have demonstrated that individuals view themselves as "more similar in interest and beliefs to physically attractive others than to unattractive others" (Marks & Miller, 1982; Marks, Miller & Maruyama, 1981). In a study completed by Miyake & Zucherman (1993), the physical and vocal attractiveness of the participants were measured and how view of self affected the interaction with others. The study showed that physical attractiveness appeared to be a more important factor than vocal attractiveness. Miyake & Zucherman also found that participants were aware of their physical attractiveness, and yet not aware of their vocal attractiveness. Another series of traditional interpersonal studies concluded that those in closer proximity to one another were more likely to be attracted to one another (Duncan, 1969; Levinger & Gunner, 1967; Little, 1965; Mehrabian, 1968). According to Byrne (1971), liking and similarity (attitudes, beliefs, likes/dislikes, etc.) are both strong influencers on attraction. Several researchers (Burleson et al., 1994; Burleson & Denton, 1992; Burleson et al., 1992) have proposed that "some types of similarity act not to validate another's cognition, but rather to enhance the quality of interactions and make them more enjoyable."

The traditional approach to interpersonal attraction tends to stress that proximity, physical attraction, similarity, personality, and touch are important factors involved in attraction. Similarity has always played a major role in personal attraction. (Adler and Towne, 1993). These attractive similarities include beliefs, attitudes, communication values, and likes/dislikes. Research has also suggested that similar personality traits have been attributed to greater personal attraction (Adler&Towne). According to Reid (1991), other factors of attraction exist in CMC. Other attraction factors might be fast typing, wit, and speed of response.

As noted above, being able to visually assess the individual has a large impact on how participants relate their own personality. In an article entitled "Computer-Mediated Communication," (CMC) Joseph Walter, states a similar idea. Since people are not aware of their partners' physical features in CMC, a "selective self-presentation" occurs. "This 'selective self-presentation' involves proof-reading your e-mail or newsletter before sending it out, while in face-to-face interaction people do not have that extra time to carefully select their words. Because of this difference in time, people increased their ability to censor themselves. This is mainly for asynchronous communication over the internet." Asynchronous communication is communication which does not occur simultaneously or concurrently, for example using electronic mail.

Physical attractiveness does not exist in Computer-Mediated Communication, except in video or photographs. Malcolm R. Parks, in his study on "Friends in Cyberspace", states that "no theory of relational development explicitly requires physical attractiveness as a necessary condition for development". In fact, Parks goes on to say that "while physical attraction is rewarding (e.g., Berscheid & Walster, 1978; Hatfield & Sprecher, 1986) it is only one of many rewards needed for a healthy relationship to start or continue." Chesebro and Bonsall (1989) admit that Computer-Mediated Communication is still lacking in aspects of communication compared with traditional interpersonal relations, but still support the validity of internet relationships as a whole.

One of the main reasons it seems people are attracted to others over the internet is the same reason face-to-face partners are attracted to each other. Elizabeth Reid (1991), asserts Internet Relay Chat (IRC) users share a "common language, a shared web of textual significance that substitutes for and yet is distinct from the networks of meaning of a wider community. It is this shared vocabulary and understanding that characterizes the networks as a unique and distinct culture" (Reid, p.39).

Humor and typing may also perform important roles in internet relationships. Reid (1991) asserts, "speed of response and wit are the stuff of popularity and community on Internet Relay Chat. A person who can succinctly and graphically portray themselves to the rest of the IRC usership will be most able to create a community within a virtual system."

Physical touch is very important way of communicating emotion between individuals. Although many researchers have stated that physical intimacy is very important to relationship development, cyberpersonal relationships are characterized by a lack of physical contact. Chesebro and Bonsall acknowledges this void of contact when they state: "they lack the physical intimacy of face-to-face friendships, but computer friends, in our view, will function as powerful psychological relationships at least equal in the importance to many face-to-face contacts" (1989). Face-to-Face communication involves dimensions of contact such as touch. It is noted that lack of these dimensions are overcompensated for in Computer Mediated Communication. "For instance, it has been noted that people use informal and expressive language and familiar slang to diminish the indifferent social relationship created by a computer connection" (Chesebro, 1989).

Proximity becomes another important factor when dealing with cyberpersonal relationships. Walther's (1992, 1993) information-processing perspective says that people in on-line settings may simply take longer to reduce their uncertainty about one another. The lack of proximity and of visual information might be overcome by arranging meetings or by exchanging photographs either electronically or by mail.

METHODOLOGY

In response to past interpersonal and Computer-Mediated Communication research completed attraction factors, a self-devised survey was constructed in order to determine what attraction factors were prevalent in Computer Mediated communication. The general survey consisted of 39 questions, including a working definition of a relationship and attraction. The survey has two parts; one is a demographics stage. Age, gender, and marital status were recorded in order to indicate trends within the statistical analysis. Twenty-five of the survey questions were included and answered on the basis of a seven point Likert scale. The scale indicated the intensity of the answers regarding the Internet relationship, this making up the second part of the survey. A comment section was also used for the participants to include their suggestions for improvement. The section allowed space for voicing concerns and questions about the research project at the conclusion of the three page survey. The survey was conducted over various Internet means including newsgroups, chatlines, and bulletin boards. A page was made for the World Wide Web to distribute the survey to a variety of internet users. The survey's address is http://pinncomp.com/attract/ and is still on-line. The Web page address was distributed to newsgroup, chatlines, and e-mail addresses. A total of 61 surveys were collected with the average age group of the participants being between 22 and 30. Thirty males and 31 females participated in the study. Because the participants were volunteers, a true random sample study was not possible. The survey was analyzed and measured using a Pearrson's Correlation Matrix and a block-sample study, according to the intensity of the different factors involved.

RESULTS

Much of our findings correlate with past research collected on attraction over internet relationships. Using the questions pertaining to the Likert scale, we computed the number of participants who felt particular characteristics are important in determining attraction factors. High factors were ascertained by determining the frequency of respondents who reported a 3 or less on the Likert scale questions of the survey.

The most significant finding was the importance of the partners being attracted to the other's intellect. A total of 53 respondents out of 61 rated this factor as significant. Question pairs determining intellect were included in the survey. These sets were compared using a Pearson correlation matrix in order to determine internal validity of the questions. The internal validity of the questions measuring intellect, was proven by the probability errors totaling less than ($p < .05$).

The second most important attraction factor for the survey participants was mutual interest attraction. For many internet participants, interaction takes place commonly among chatlines and interest-related newsgroups. As many as 51 participants rated mutual interest as important when meeting another over the computer. Pair validity was also determined with the p value. An interesting finding asserted that as shared interest between partners increased, so did physical attraction . ($r=.443$)

Participants also felt that an even intellectual level is extremely important in internet relations. Finally, the high scores of increased attraction basis included similar levels of commitment, and whether or not the internet partner makes the participant feel that the partner was supportive of life decisions. Fifty respondents out of 61 related a high association on the importance of the supportive level of their partner. These two attraction factors showed similar correlating positive trends. As the partner was perceived to be supportive of decisions, the physical attractiveness between the partners intensified.

Age trends show that there is a significant correlation ($r=.739$) between the age of the participant and the age of the partner. Face-to-face communication takes into consideration age as an attraction factor. Another interesting age correlation involves the significant impact the importance of age has on the importance of truth in a relationship with a correlation of ($r=.600$). Through the use of the Pearson Correlation Matrix, it was determined that Computer Mediated Communication shows a similar trend.

In contrast to previous research studies on physical attraction relating to traditional interpersonal approaches, the study indicated that physical attractiveness did not play a large role in assessing attraction factors. Less than half of the respondents (48%) replied that they were significantly physically attracted to his/her partner. Similarly, 70% of the respondents indicated that s/he is more interested in partner's personality than their physical appearance.

Another low factor rating was proximity. Asking them to rate the satisfaction of the relationship on a 1-10 scale (1 as least satisfactory, 10 as most satisfactory), it was found that those who were closer in distance were not necessarily more satisfied with their relationship, as hypothesized earlier. Fifty-seven percent (or 35/61) of the surveyors stated that they were more than satisfied with their relationship in general, giving the question a level number of 7 or above. See Figure 1 for tabulated results.

DISCUSSION

The findings of this survey relay many possibilities about factors that cause people to be attracted to one another in cyber-interactions. Because cyber-communication is so new to household technology, much information remains to be found. Some of the possible conclusions of our research only prove that more studies are imminent in the future.

Traditional interpersonal attraction factors, whether romantic or non, involve sometimes subtle verbal and nonverbal cues. For centuries, mankind has sought to pinpoint these cues in order for communication to improve between people. With the invention of technology-induced cyber and internet communication, these cues become more complex.

The results suggested that many of the factors in face-to-face and cyber communication are similar. the phases of meeting one another in the relationship process are different (namely, lack of physical contact). However, once initial contact is made, the attraction factors that are decision makers in the continuation or termination of the relationship are similar. The most important factors in both processes seem to be: shared interest, age, personality, and supportiveness of the partner in decision making. The only main deviations from traditional communication that play important roles are the factors of physical attractiveness and proximity. Latter factors may be determined after the first face to face contact is initiated.

Some possible source of error may include: truthfulness of participants in the study, lack of random sample due to the nature of volunteers participating in the study, and methods of error from the survey itself. Various participants went beyond the limited numbers in rating various factors in their relationship. Many possible errors were suggested after the survey was distributed. As this study is a continuing process, we feel that some of these error sources may be avoided in the future. Gender bias may be disproved surprisingly due to the natural balance of the male/female ratio (31 males, 30 females). Because the majority of our surveyors were at college-age level (18-24), age bias could be a factor in the attitudes attributed to the completion of our survey as well.

Reid's study suggested typing as well as Computer Mediated Communication skills play an important role in attraction over the internet. The survey responses that were collected in this study suggested differently. Typing and spelling rated in the lowest categories of interpersonal attraction. Given the conclusions of this research in comparison to research of the past, this "testing of new ground" offers many insights into possibilities for future research. These findings also give further knowledge of attraction factors involved in internet relationships.

Future studies may include: self-esteem related to frequent internet communicators, how important self-description is in furthering internet relationships, education and the importance it plays among relationships, and how quickly internet participants meet face-to-face after initiation. Other communication research may concentrate on the specific areas of internet attraction such as proximity or the factor of touch and satisfaction. Because the world is relying more and more on cyber-communication, it will be interesting to see where further knowledge and research lead us in this fast-paced technology.

REFERENCES

Adler, Ronald B. and Neil Towne (1993). Looking Out/Looking In. Harcourt Brace Jovanovich College Publishers.

Burleson, B.R., Adrianne W. Kunkel, and Jennifer D. Birch. (1994). Attraction (and Happiness, Too) Communication Quarterly. Vol 42 no. 3 (259-273).

Burleson, B.R. and W.H. Denton (1992). A New Look at Similarity and Attraction in

Marriage: Similarities in social-cognitive and communication skills as predictors of Attraction and Satisfaction. Communication Monographs. Vol 59 (268-287).

Byrne, D. (1971). The Attraction Paradigm. New York: Academic Press.

Chesebro, James W. and Donald G. Bonsall. (1989) Computer Mediated Communication : Human Relationships in a Computerized World. Tuscaloosa: The University of Alabama Press.

Marks, G. and N. Miller (1982). Target Attractiveness as a Mediator of Assumed Attitude Similarity. Personality and Social Psychology Bulletin. Vol 8 (728-735).

Marks, G. N. Miller and G. Maruyama. (1981). Effect of Targets' Physical Attractiveness on Assumptions of Similarity. Journal of Personality and Social Psychology. Vol 41 (198-206).

Miyake and Zucherman (1993). Beyond Personality Impressions: Effects of Physical and Vocal Attractiveness on False Consensus, Social Comparison, Affiliation, and Assumed and Perceived Similarity. Journal of Personality. Vol 61:3 (411-437).

Murstein, Bernard I. (1971). Theories of Attraction and Love. New York:Springer Publishing Company, Inc.

Parks, Malcolm R and Kary Floyd. Making Friends in Cyberspace http//:www.attraction 1996.

Reid, E. (1991). Electropolis: Communication and Community on Internet Relay Chat. Department of History, University of Melbourne, Australia.

Stafford, Cheryl. Interpersonal Communication and The Internet: The Cyberspace World of Net. Relationships. http//:www.attraction 1996.

Walther, Joseph B. (1996). Impersonal, Interpersonal, and Hyperpersonal Interaction. Computer-Mediated Communication. Vol 23:1 (3-43).

Walther, Joseph B. (1993). Anticipated On-going Interaction vrs. Channel Effects on Relational Communication in Computer Mediated Interaction Western Journal of Communication. Vol 57:4 (381).

Figure 1: Percentage of Importance Stated by Participants

Intellect:	87%
Mutual Interest:	84%
Supportiveness:	82%
Personality:	70%
Physical Attraction:	48%

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Wartime Benevolence: A Portrait of Northern Philanthropy During the Civil War

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When the French observer and critic of American democracy Alexis de Tocqueville traveled the United States in the 1830's, he was struck by the American brilliance for voluntary societies, particularly in the Northern states.[1] What made America's voluntarism unique was its organizational nature. Before the outbreak of the Civil War, American society was largely characterized by an elevated degree of citizen involvement in national matters. Americans were steadfastly concerned with issues such as women's rights, slavery, poverty and health care. The same type of meticulous, even fanatical attention was given to the issues of the Civil War.

Most northern citizens who did not serve in the military believed they should improve the war effort in some way other than battlefield heroics. Ties of family and friendship to Union soldiers may have provided a substantial portion of the citizenry's motivation to participate in benevolent associations. The Union army, after all, consisted of the husbands, brothers, sons, uncles, nephews, and cousins of the homefront's citizens. Moreover, those who were involved with voluntary organizations during the Civil War derived a great dignity and honor from their efforts of benevolence. It was usually women, the wives, mothers, sisters, cousins, and aunts of their beloved men in blue, that participated in such benevolent societies. It was not unusual for women of all countries to voluntarily assist those suffering because of war. What made the American women different is that they organized relief.[2] To be sure, the first few weeks of their patriotic activity reflected more of a zealous fanaticism than a practical plan. But what eventually emerged was a diverse collection of passionately efficient benevolent organizations. The multi tiered voluntaristic structure that evolved was testament to the ability of groups and individuals to negotiate the complex and harsh demands of a war.

The attack on Fort Sumter on April 12, 1861 spelled war between the states. President Abraham Lincoln initially summoned 75,000 troops to thwart the uprising. The health and welfare of this fast gathering host of Northern troops had aroused much anxiety. Small groups of women in various cities formed societies to supply nurses, to purchase clothing, medicines, and comforts for the sick and wounded. The first soldiers' aid society appeared at Bridgeport, Connecticut. Similar organizations soon surfaced in towns such as Charleston, Massachusetts and Cleveland, Ohio, forming what would become a large and thriving network of aid societies.

Reverend Dr. Henry Whitney Bellows, minister of the All Souls Church Unitarian in New York, was especially interested in relieving soldiers in camp and field. Without direction and a clear idea of common goals, Bellows noted that the devoted women of the northern homefront might have wasted their energy and produced more harm than good from their zeal. Bellows was interested in giving these women's enthusiasm a much needed focus. Bellows and a well-known physician, Dr. Elisha Harris, met accidentally in a New York street and discussed the general question of military sanitation and health. They talked and discussed the issue with others. Bellows subsequently sent out a call for a general meeting at Cooper Institute to deal with the work of relief in the army. After several conferences, Bellows drafted a constitution of what became the Women's Central Association of Relief. Bellows met no opposition in calling the Association to order as nearly one hundred of New York's most influential women signed his initial address.[3]

Relief to Union soldiers was surely needed at this time. Never before had the issue of mass hygiene confronted America with such urgency. Essential to good health was nutritious food, fresh air, clean water, proper clothing, and adequate shelter. Upon entering the army, most soldiers rarely received any of these things. More often than not, the soldiers' rations were poorly cooked and served without cleanliness. And almost never did they have the luxury of sleeping in a warm, uncrowded tent on dry land. For Bellows, the answer to the American sanitation problem would be found within a large sanitary commission that would pick up the slack of the stumbling Medical Bureau.

The initial objective of the United States Sanitary Commission was to aid struggling soldiers until such time the Medical Bureau could handle the task on its own. But at no point was the Medical Bureau equipped to perform this task properly. The Sanitary Commission that responded to these problems was to exist in a form that did not supplant other governmental agencies. Sanitary Commission administrators made a concerted effort to keep it subordinate to army rules and regulations. Acting surgeon general R.C. Wood advised that, "This commission is not intended to interfere with, but to strengthen the present organization."[4] Although this was their intent, relations between the Sanitary Commission and Medical Bureau were turbulent at best. Throughout the course of the war, the Sanitary Commission would express very little patience with the inadequate fashion by which the Medical Bureau operated hospitals, transportation, lines of communication and the handling of supplies.

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[1] Matthew J. Gallman, *The North Fights the Civil War: The Homefront* (Chicago: Ivan R. Dee, 1994), 109.

[2] Susan J. Ellis and Kathern H. Noyes, *By the People: A History of Americans as Volunteers* (Philadelphia: Energize, 1978), 95.

[3] Allen Nevins and Milton Halsey Thomas, eds., *The Diary of George Templeton Strong* (New York: Octagon Books, 1974), 3: 150.

[4] *War of Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* (Washington, D.C.: Government Printing Office, 1880-1901), ser 3, vol 1, 225.

USSC inspectors, who were usually medically qualified in some way, assessed the quality of many things in and around the battlefield. These inspections covered things such as rations and water, camp cooking, ventilation of tents and quarters, drainage of the camp, administration of the hospital, quality of the tents and the materials used for flooring them, soldiers' clothing, and the personal cleanliness of the men.[5] What the USSC's inspectors found was not good. During late 1861, the USSC inspected over 200 regiments in the Union Army and found that 58 percent of them had no thorough system of inspection of their recruits on enlistment. With such a loose system, droves of weak and unable men entered the army. Furthermore, men with more defined maladies such as hernia, varicose veins, tuberculosis, and syphilis were allowed to march into war.[6] Most of these weak, substandard soldiers would break down during the war, subjecting the already overcrowded hospital system to further strains.

To remedy these ailments of the Union Army the USSC quickly mobilized its many volunteer workers who ran its 7,000 local auxiliaries. These auxiliaries collected water and clothing and organized sanitary fairs to raise money for the Commission. The Sanitary Commission's next step was to dispense these goods. The Commission did so by building depots for the distribution of clothing, food, and medicine to the army. USSC inspectors who were sent to regimental camps provided instruction and advice on matters such as water, cooking, and drainage. The USSC further supplied soldiers with vegetables that were usually absent in the basic army ration. The Commission also collected emergency inventories of bandages and medicine which were rushed to battlefield hospitals as they were needed. The Commission even chartered ships to evacuate the wounded and provided ambulance services to replace the army's insufficient system of patient transportation.[7]

The methods the USSC used to raise funds for the purchase of their supplies and their distribution are largely reflective of the organizational nature of the USSC. Funds were collected by the many dedicated women of the North. These loyal, female patriots organized more than ten thousand "aid societies" over the course of the war. Funds were constantly and consistently raised during every year of the war. Branches of the USSC were established as quickly as possible in Boston, New York, Philadelphia, Cincinnati, Chicago, and other cities. In these cities, sub-depots of sanitary stores were kept up, receiving the endless contributions of the soldiers' aid societies. The items sent to these sub-depots were assorted, repacked, and stamped with the seal of the Commission. The boxes of supplies were then put into storage, subject to the requisitions of the central distributing depots at Washington and Louisville. From these two cities, supplies of every kind were dispensed to Union troops who desperately needed them. The reception and care of these hospital supplies followed a very strict and meticulous system. This system was configured in such a way that it was easy to trace packages sent to hospitals back to their original contributors. The USSC took vouchers from every person that received the supplies at every stage of their progress until their ultimate destination was reached. The efficiency of this system was so great that only a small fraction of the supplies was lost or mishandled.[8]

The soldiers' aid societies were illustrative of how women made voluntary activities a staple of their wartime lives. The Sanitary Commission was, in fact, the main avenue by which women participated in the war. In any given week, an unmarried woman might spend an evening at a soldiers' aid society meeting, an afternoon reading to soldiers at a nearby hospital, and several more evenings visiting the wives of men who had enlisted in the Union Army.[9] While others were less involved, most of the North's citizenry were always prepared to give assistance after a major battle or during a crucial fund-raising event.

The USSC was, by far, the most outstanding and effective of all benevolent volunteer organizations. Under the direction of Henry Whitney Bellows as its president and Frederick Law Olmsted as general secretary, the USSC raised millions of dollars and channeled the voluntary efforts of hundreds of small groups into the distribution of great quantities of food, medicine, clothing, and innumerable hospital services. Although some soldiers complained about the USSC's partiality to army officers, the Commission cannot be faulted.[10] The USSC's achievements and acts of goodwill more than outweighed its faults. The Sanitary Commission most certainly spared many Union soldiers much suffering.

Rivaling the USSC and sometimes competing with it was the Western Sanitary Commission. The WSC played a central role in assisting troops and refugees in the Mississippi Valley and the Western theater of the Civil War. Before the war's end, the WSC received and spent more than $770,000 which it raised nationwide. The WSC also donated and distributed supplies worth in excess of $3,500,000. It would also render services that far surpassed its original intentions and received high praise from commanders, generals, army medical directors, and thousands of soldiers and refugees who benefited from its services.[11]

The scenario in the West was the same as in the east. The army Medical Bureau had made few preparations to handle the large number of casualties resulting from major battles. Early in the war, those wounded in battles were cared for in local makeshift hospitals. The nearest decent hospital facilities were located in St. Louis, New Orleans, and a few other major cities. Wounded troops were sometimes transported over 100 miles in army wagons and ambulances to the nearest railheads. From these railheads, they would be transported in railcars to the nearest city that possessed adequate hospital facilities. Once the war began, these hospitals quickly became crowded and overexerted.

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[5] Mary Ashton Livermore, *My Story of the War* (New York: Arno Press, 1972), 130.

[6] Bell Irvin Wiley, *The Life of Billy Yank: The Common Union Soldier* (Baton Rouge and London: Louisiana State University Press, 1978), 125.

[7] James McPherson, *Ordeal by Fire: The Civil War and Reconstruction* (New York: Random House, 1982), 387.

[8] Livermore, *My Story of the War*, 133-34.

[9] Gallman, *The North Fights the Civil War*, 115.

[10] Wiley, *The Life of Billy Yank*, 150.

[11] William E. Parrish, "The Western Sanitary Commission," *Civil War History* 1 (March 1990): 18.

Stepping up to organize relief efforts in the Mississippi Valley region was the Reverend William Greenleaf Eliot, pastor of the Unitarian Church of the Messiah in St. Louis. In some sense, Eliot was the professional rival of Henry Bellows as Eliot was equally fond of power. Some people, including Bellows, may have been misled by his frail physique and nervous manner. But Eliot was forceful, often ill mannered and had many compunctions about the seemingly neglected sanitary conditions of the western theater.[12] Anticipating the inevitable difficulties of the war, Eliot organized the St. Louis Provident Society to coordinate various charities in St. Louis. In August of 1861, Eliot began to investigate the military hospital situation. Eliot, like so many others, was not pleased with what he found. Eliot subsequently approached Jessie Benton Fremont, wife of the departmental commander, with a plan to help solve this problem. Before Fremont was contacted by Eliot, she had already asked Dorothea Dix, army superintendent of women nurses, to make an inspection tour of the area. When Dix arrived, Eliot showed his plan to her, winning her support. General John Charles Fremont then quickly issued a general order, which used Eliot's wording verbatim, thereby establishing a headquarters for the Western Sanitary Commission in St. Louis.[13]

Within its first two months, the WSC adequately supplied many Mississippi River Valley locations with hospital buildings, nurses, food, clean water and other important aids. The Western Sanitary Commission was seemingly on a very successful path. But all did not go well for the WSC. Its better-known counterpart in the east, the United States Sanitary Commission, soon threatened the WSC's independent existence. Western sectionalism was already an established fact and it may have been no less mischievous than Southern sectionalism. USSC centers in Chicago and Philadelphia were concerned because the Commission had thus far held no session at the west.[14]

Henry Bellows of the USSC believed that for the sake of efficiency, all Union sanitary work should be coordinated through his agency. The USSC was shocked when Fremont bypassed one of its representatives in St. Louis to establish the Western Sanitary Commission. USSC Commissioner George Templeton Strong blamed Dorothea Dix, asserting that she was repaying the USSC for failing to acknowledge and give full attention to all her suggestions. Strong complained:

> General Fremont seems to have set up a local Sanitary Commission of his own in St. Louis, to act under the direction of Miss Dix...She is disgusted with us, because we do not leave everything else and rush off the instant she tells us of something that needs attention.[15]

Strong certainly saw Dorothea Dix as a bit of a nuisance in the USSC. He often told of one instance when the USSC was in Washington. Dix approached Strong and other USSC officials in breathless excitement to say that a cow in the Smithsonian was dying of sunstroke, and took it very ill that they did not adjourn instantly to look after the case.[16]

The USSC and WSC finally came to a compromise in October when Eliot met with members of the USSC in Washington. Their resolution provided that the WSC would cooperate with the USSC in every way practical, while assuring its eastern counterpart that it would limit its operations to the Trans-Mississippi theater.[17] This episode between the USSC and the WSC proved that even the most well-meaning of organizations were not immune to such faults as jealousies and competitions. As noble and heroic as the idea of a unified voluntary movement seems, the whole phenomenon was, at times, less than unified. But collisions between large agencies such as the Medical Bureau, USSC, and WSC were inevitable. Eliot would often observe that the most hateful of all jealousies and controversies were those among philanthropic or charitable associations.[18] Pure harmonious cooperation between large agencies would be of absurdly high expectations. Considering the relative effectiveness of voluntarism, however, the ordeal between the Western and Eastern agencies did not seem to cripple the movement very much.

Offering more than material relief to the troops was the United States Christian Commission. The Christian Commission was organized later in 1861 by YMCA officials who more or less followed the example of the USSC. The Christian Commission offered more of a spiritual relief to soldiers. The Christian Commission explained to Jefferson Davis, president of the Confederacy, that

> It is a voluntary agency-Christian, not political, evangelical, not denominational-and sends earnest Christian men as delegates to minister in person to the spiritual and physical relief and benefit of the army and navy and furnishes good reading matter for distribution by its delegates.[19]

Although the Sanitary and Christian Commissions played the most important role in directing voluntary aid, numerous unaffiliated groups collected money and distributed goods by their own representatives.[20] The refreshment saloons of Philadelphia are the best example of this decentralized voluntarism. Refreshment saloons were established for transient soldiers passing through the Philadelphia community. At these places, men could rest, eat a good meal, drink, and receive proper medical care, all services having been donated by citizens in the area.[21]

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[12] Nevins and Thomas, *The Diary of George Templeton Strong*, 3: 189.

[13] Pamela Herr and Mary Lee Spence, eds., *The Letters of Jessie Benton Fremont* (Chicago: University of Illinois Press, 1993), 244-45.

[14] Nevins and Thomas, *The Diary of George Templeton Strong*, 3: 375.

[15] Ibid., 182.

[16] Ibid.

[17] Parrish, "The Western Sanitary Commission," 22-23.

[18] Nivens and Thomas, *The Diary of George Templeton Strong*, vol 3, 188-90.

[19] *Official Records*, ser 2, vol 7, 1262.

[20] Hamlett Robert Bremner, *The Public Good: Philanthropy and Welfare in the Civil War Era* (New York, Random House, 1980), 65-9.

The Cooper Shop Refreshment Saloon began in May 1861 when the women of Southwark observed the trainloads of troops who gathered in Philadelphia to await transportation south. The women responded by immediately forming a committee which began to distribute coffee and refreshments to these hungry troops. The efforts of these women soon attracted the attention of others who began a drive in the city to collect provisions. The examples set by these people were soon emulated as the citizenry of Philadelphia turned out in throngs with donations. Butchers, milk men, and storekeepers all generously responded with offerings from their respective guilds. The Cooper Shop Refreshment Saloon grew quickly and could soon feed 1,000 soldiers in only one hour.[22]

The refreshment saloons of Philadelphia were not mere rudimentary, makeshift distributing centers of barely edible food. They were, in fact, high quality preparers of good, nutritious meals. Compared to the standards of half rations and undercooked food that soldiers had become accustomed to, the meals prepared by the refreshment saloons were an elegant feast. Private Wilbur Fisk described his stop at the Cooper Shop Refreshment Saloon in Philadelphia:

> At the Cooper Shop Volunteer Refreshment Saloon we found a glorious supper prepared expressly for us. Bread of an excellent quality, butter and cheese, pickles, hot coffee, and all that a hungry soldier need ask. It was not soldiers' living at all, it was good enough for a first class hotel. This is the first place of the kind that has been opened since the war broke out, and I doubt if anymore modern, can surpass it.[23]

Soldiers like Fisk often remarked that Americans should take pride in these kinds of philanthropic accomplishments. Considering the fact that the Union was embedded in a long and relentless war, such accomplishments were truly remarkable.

Still more local, decentralized groups formed to assist other victims of the war. In many of the North's cities and towns, private groups and city officials worked alongside of each other to secure funds to dispense to the families of volunteers themselves. Quakers, who were particularly upset by any action that may improve the war effort, sometimes became notorious for knitting soldiers' gloves without trigger fingers.[24] But they soon found avenues through which they could offer assistance without compromising their pacifist principles. A great number of Quakers participated in fund raisers to assist the droves of contraband, or runaway slaves, that fled North. Northern free blacks were also active in voluntary activities by assisting contrabands, sending aid to enclaves of Southern freed people, and preparing basic necessity packages for local black regiments. Spontaneous organizations for collecting special donations were also formed. In one of the most peculiar instances of benevolence, Philadelphians raised money to donate to Manchester, England's impoverished factory workers when they learned that the Civil War had crippled the British textile industry. Such localized efforts cannot be discounted as they were perfect supplements to the larger national organizations.

Not the least of the effects that voluntarism had was its impact on medical history. The voluntary movement that occurred during the Civil War could be considered the forerunner of the American Red Cross. One of the era's most influential volunteers was Clara Barton. Encouragement from other volunteers and the things she saw during the Civil War precipitated her obsession with forming the American Red Cross. After dealing with an initially unenthusiastic Washington, the Red Cross in America was functioning. The history of the American Red Cross need not be repeated here. It suffices to say that the innovations and benefits of the Red Cross of America in handling disasters, particularly the cataclysms of epidemics, cyclones, hurricanes, and overseas famines, are incalculable. It makes one wonder what other kinds of pioneering organizations could have been formed in the United States had voluntarism produced more Clara Bartons.

The voluntary movement also produced enormous strides of progress in the area of American hospitals. At the beginning of the war, medical facilities were entirely insufficient. The Union's emergency medical system was comprised of only a handful of career surgeons, a few men from the ranks serving as orderlies and nurses, no ambulance service, and, of course, no proper hospitals to treat the droves of sick and wounded troops. The efforts of the North's volunteers, however, precipitated change. The Sanitary Commission pressured the government into building higher quality, pavilion-type hospitals based on those developed during the Crimean War. Subsequent construction of more hospitals saw an increasing quality in the buildings and their facilities. These hospitals were so well equipped and of such good quality that future hospitals of World War One were based on their designs. The Civil War experience and the examples put forth by voluntary agencies such as the Sanitary Commission helped crystallize a consensus about the specific elements that constituted a good hospital.[25] In doing so, voluntarism of the Civil War period helped motivate those who sought to make the new, big, efficient, well-equipped hospital a reality. If these hospitals could be made to work effectively under the harsh demands of war, they could surely be made even more efficacious in peacetime. Because of Civil War voluntarism, the last three decades of the nineteenth century have the distinction of clearly marking the beginning of an era which brought more changes to medicine and medical practice than any other time in history.

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[21] Ellis and Noyes, *By the People*, 96.

[22] Matthew J. Gallman, *Mastering Wartime: A Social History of Philadelphia During the Civil War* (Cambridge: Cambridge University Press, 1990), 129.

[23] Emil and Ruth Rosenblatt, eds., *Anti-Rebel: The Civil War Letters of Wilbur Fisk, 1861-1865* (Lawrence, Kansas: University Press of Kansas, 1992), 152.

[24] Gallman, *The North Fights the Civil War*, 113.

[25] Charles E. Rosenburg, *The Care of Strangers: Rise of America's Hospital System* (New York: Basic Books, 1987), 98.

Moreover, voluntarism was a critical factor in the North's victory. Judge J.A.P. Campbell was correct in his assessment of the South when he said, "Sacrifices and prayers and efforts were, all combined, insufficient to bring final victory to our standard."[36] Insufficiency would certainly describe the organized relief and medical work of the South. Although local soldiers' aid and hospital societies developed in the South, the Confederacy never possessed a counterpart to the Sanitary or Christian Commissions. The Confederacy's thin line of societies doubtless provided many valuable services, but Confederate troops, as a whole, did not fare as well in medical care as did their Union enemies. The percentage of Confederate troops who perished from disease was double that of Union troops. The medical corps of the Confederacy were never able to provide sick and wounded soldiers with the proper amount of food and supplies. Had the North failed to produce voluntary organizations such as the Sanitary Commission, the odds against the Confederacy may have been a little more even.

Finally, the common experiences of Northern volunteers underlined the Civil War's role as a nationalizing, centralizing force. Nearly every facet of the war effort depended on the successful integration of diverse voluntary efforts. Through an intricate web of established associational ties, patriotism was appealed to, making this integration successful. This institutional complexity had the effect of giving volunteers the freedom to do as little or as much as they chose.[37] There were men and women who volunteered to go strait into the battlefield as agents for national or local groups. Some volunteers kept their anonymity while others, such as Clara Baron, became national heroes. The heroic sacrifices of the North's women were even documented in several books, such as Clara Barton's *Angels of the Battlefield*, that were published after the war. The array of organizations that were formed served to open the doors for future organized philanthropic activities. The leaders of the voluntary movement and the volunteers themselves formed a dynasty of benevolence in America in which everyone could take civic pride. Private Wilbur Fisk once remarked that "Americans may well be proud of their nation when the common people show a spirit like this, through a long relentless war."[38]

PRIMARY SOURCES

Billings, John Shaw. *Hospital Plans*. London: J.B. Lippincott Co., 1895. This writing was one of Billings' many works on what a suitable military hospital should be. This particular work was located at the University of North Carolina at Chapel Hill.

Duncan, Russell, ed., *Blue-Eyed Child of Fortune: The Civil War Letters of Colonel Robert Gould Shaw*. Athens: University of Georgia Press, 1992.

Herr, Pamela and Mary Lee Spence, eds. *The Letters of Jessie Benton Fremont*. Chicago: University of Illinois Press, 1993.

Livermore, Mary Ashton. *My Story of the War*. New York: Arno Press, 1972.

Nivens, Allen and Milton Halsey Thomas, eds., *The Diary of George Templeton Strong*. New York: Octagon Books, 1974.

Rosenblatt, Emil and Ruth, eds. *The Civil War Letters of Wilbur Fisk, 1861-1865*. Lawrence, Kansas: University Press of Kansas, 1992.

Southern Historical Society Papers. 52 vols. Richmond, VA: Broadfoot Publishing Company, Morningside Bookshop, 1990.

Tilley, Nannie M., ed. *Federals on the Frontier: The Diary of Benjamin F. McIntyre, 1862-1864*. Austin: University of Texas Press, 1963.

War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies. 128 vols. Washington: Government Printing Office, 1880-1901.

SECONDARY SOURCES

Bremner, Robert Hamlett. *The Public Good: Philanthropy and Welfare in the Civil War Era*. New York: Random House, 1980.

Ellis, Susan J. and Kathern H. Noyes. *By the People: A History of Americans as Volunteers*. Philadelphia: Energize, 1978.

Gallman, Matthew J. *Mastering Wartime: A Social History of Philadelphia During the Civil War*. Cambridge: Cambridge University Press, 1990.

---. *The North Fights the Civil War: The Homefront*. Chicago: Ivan R. Dee, Inc., 1994.

Maxwell, William Quentin. *Lincoln's Fifth Wheel: The Political History of the United States Sanitary Commission*. New York, London, Toronto: Longmans, Greene and Co., 1956.

McPherson, James. *Ordeal by Fire: The Civil War and Reconstruction*. New York: Random House, 1982.

Parrish, William E. "The Western Sanitary Commission." *Civil War History*, 1 (March 1990): 17-32.

Rosenburg, Charles E. *The Care of Strangers: The Rise of America's Hospital System*. New York: Basic Books, 1987.

Wiley, Bell Irvin. *The Life of Billy Yank: The Common Union Soldier*. Baton Rouge and London: Louisiana State University Press, 1978.

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[36] *Southern Historical Society Papers* (Richmond, Virginia: Broadfoot Publishing Company, Morningside Bookshop, 1990), vol 16, 235.

[37] Gallman, *The North Fights the Civil War*, 114.

[38] Rosenblatt, *The Letters of Wilbur Fisk*, 341.

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Media and the construction of identity: Young women's use of "Friends"

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Research focusing on the psychological implications of media uses and gratifications has focused on how general and specific audiences consume popular culture. One potential use for this research is to explore how specific audiences use mass mediated messages for identity formation.

This study focuses on how female college students consume the popular NBC television show "Friends." Students (N=80) were given a questionnaire based on Radway's (1984) reader response questionnaire and the uses and gratifications instrument. In addition, ten additional students participated in a focus group interview on the subject of how and why they watch the show.

These findings suggest that college women are sophisticated viewers that have multiple uses for "Friends" including testing the conversational competence of their significant others.

INTRODUCTION

Mass communication theorists have long argued that media affects the formation of individual identities. Real (1989) states that "personal experience combines with media experience as we construct individual lives under the directing influence of powerful institutions" (15). At the minimum, television viewers have felt a strong bond with characters on shows and the actors that portrayed such characters. Taken to the extreme, some viewers have over-identified with television characters and failed to see the division between fiction and reality.

How television affects individual identity continues to be a question for researchers. Real (1989) suggests that viewers often use television characters as role models, claiming that viewers "find elements of our validity and connectedness in the media" (26). Other research (Novak, 1977; Kidd, 1975; Lull, 1980) also supports this claim that media portraits often provide a comparison base for individuals assessing their self-image, often resulting in what Cathcart and Gumpert (1986) refer to as the "significant other."

More broadly, television affects the public character. Real (1989) argues that television creates a set of symbols that represent the national experience. If this is true, then television in the last half of the last decade of the twentieth century symbolizes a culture far removed from the experience of average Americans. Politicians such as former Vice President Dan Quayle attack television shows for promoting liberal causes.

The popular NBC sitcom "Friends" exemplifies the claim that many conservative critics of television make about prime time viewing. The show, a favorite among men and women of college age, revolves around the lives of six young adults and their various sexual exploits. Columnist George Will (1996) even suggests that the show's humor is too graphic for the 8 p. m. time slot and could even result in a conservative backlash in politics: "When parents cannot watch early evening television with their children without wincing, their distress will take on political coloration, and the winner of the nation's premier political office is apt to be he who best exemplifies credible disgust with what distresses them" (A16).

Although researchers disagree on the nature of the affect the media has on shaping identity, it is clear that identity can be affected on many different levels. An individual's identity can be shaped by his or her interaction with a character on a particular show, while the identity of a group, such as a generation of college students, can be shaped by the whole theme of a show like M*A*S*H. Also, identity can be shaped on a national level by programming symbolizing the general attitudes of that time.

REVIEW OF LITERATURE

Viewing Behavior

In trying to understand how and why people watch television generally and any program specifically, two distinct theoretical positions are represented by the research. The first position is that people's motives for watching television programs and uses for the particular programs are unique. Given new developments in media technology, it could be argued that viewing choices are so great in number that group viewing patterns are impossible to discern. Brunette and Wills (1989) take the extreme position that there is no normal viewing experience. They suggest that the media text must be considered in light of postmodern's radicalized notion of context. Television viewing then, becomes a purely individualized experience that cannot be shared by anyone else.

This position cuts against the standard social science belief in patterned viewing experiences. The "Uses and Gratifications" theoretical model posits that individuals have a limited number of needs that are fulfilled by consuming mediated messages, including television programs. Rosengren and Windahl (1986) discuss four "functional alternatives" or "uses" for television viewing: change, compensation, escape, and vicarious experience. Viewers hoping to transform an attitude or behavior might identify with particular characters or themes of a television program. Using a television show for escape purposes would mean the viewer watches to postpone dealing with a day-to-day problems or simply to relax after a tough day. Compensation occurs when the viewer uses a television show to make up for something, such as romantic relationship, missing from their lives. Vicarious experience carries this compensation one step further, allowing the viewer to actually live their lives through those of the characters. For example, Cathcart (1986) cites cases where viewers watch soaps to experience things, such as wild love affairs, that they will never experience in real life. These uses depend on a number of factors, including degree of involvement with a particular mediated message and amount of media consumption. To put this in lay terms, how someone uses a mediated message depends on how much the person identifies with the message and how often he or she is exposed to the message.

Common sense and empirical observation suggests that group viewing patterns emerge. This is particularly true with young audiences. In the last twenty years college men and women have routinely gathered in groups to watch popular television programs such as "M*A*S*H," "Newhart," "Cheers" and daytime soap operas. The significance of this fact is not only that many individuals prefer watching the same programs with groups of people, but that these programs functioned as a means of fulfilling group maintenance and identity needs for individuals. The idea that media rituals can perform even therapeutically for individuals has been explored by researchers such as Payne (1989).

Uses of Television

For years, theorists have argued that television provides connections for people lost in a contemporary society that is fragmented and without strong traditional institutions such as family and church. Television is particularly powerful because it shows life that is often in sharp contrast to the reality of everyday life. Social commentator Philip Slater (1976) argues that television shows featuring characters enjoying life poses an impossible standard for real people who feel further distanced from their dreams. This contrast is further explored by psychologists such as Rollo May (1991) who contend that, for many, television viewing is an attempt to revive a depressed life.

Scholars such as Hart (1994) contend that television fills an emotional void in modern life by delivering intimacy at all hours of the day, while others such as Merelman (1984) argue that the intimate disclosure we are used to seeing on television has become the norm for everyday living. This view that television shapes social interaction is extended by several scholars who suggest that television replaces social interaction or makes social interaction less desirable than consuming television images. Cathcart and Gumpert (1986) argue that para-social interactions are less threatening than real interactions and that the communication patterns engaged in by television characters create an ideal that real communication interactions cannot match. Thus, television viewing functions as a substitute for interpersonal interaction. Cathcart and Gumpert argue that these para-social interactions both comfort and distress the viewer. These relationships are comforting because they are "always predictable, never unpleasant, always sympathetic, never threatening." On the other hand, these para-social relationships are stressors because they allow for unreal expectations to inhibit actual interpersonal interactions. Building on this idea, Miller (1986) states that viewing media messages enables people to predict the success or failure of interpersonal messages. Thus, some viewers construct "scripts" for their interpersonal relationships based on fictional accounts on television and in film.

Media and Identity Formation

The belief that mediated messages affect individual identity formation and maintenance is pervasive. Media theorist Michael Real (1986) argues succinctly that media "penetrate daily life, creating an environment where identities are formed" (15). Within this viewpoint, there are theorists who suggest that television performs a valuable social function in helping viewers learn about the world around them. Cathcart (1986) argues that television shows, like soap operas, expand interpersonal relationships by coaching viewers about appropriate responses to be used in interpersonal relationships. Caughey (1986) mildly supports this position by stating that some television characters can be used as a mentor or guide, but strongly warns that viewers "may compensate with artificial companions" (p. 233).

Carbaugh (1996) argues that identity is a more complex issue. He suggests that a television viewer may learn two sets of appropriate behaviors from consuming media messages. First, a viewer may appropriate a set of behaviors for his or her personal identity. Second, a viewer may learn ways of acting in public, thus creating a social identity. This distinction between the two possible identities is particularly important for viewers that consume media messages in group settings.

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METHOD

Two groups of college students participated in the study. The first group (N=80) responded to a questionnaire on viewing behaviors and attitudes. The second (N=10) participated in a focus group interview on the subject of watching "Friends." Participants in both groups were predominantly white, 18-22 year old female college students at a small all-women's college. The average age was 19. Participation in the study was voluntary and only those students that had seen the show were selected for participation in the questionnaire and focus group segments of the study.

The questionnaire employed in the study combined questions regarding the participants television viewing history and types of shows they prefer to watch with specific questions about the television show "Friends." The questionnaire was constructed using Radway's (1984) survey given to readers of romance novels and standard questions used by researchers employing the "uses and gratifications" theoretical position. This theoretical and methodological position was used because of its audience-centered approach that helps understand why people use media to explain viewers' motives for media exposure and perceived personal outcomes for that exposure (Perse, 1996). The questionnaire was distributed to all students at the college (N=435) with the instructions to respond only if familiar with "Friends." Eighty students responded.

From the eighty students that responded to the initial questionnaire, ten students were randomly selected to participate in a focus group interview. These participants were asked to watch an episode of "Friends." During the viewing, participants were allowed to interact with one another and comment freely on what they viewed. After viewing the episode, a series of questions was asked of the group about this episode specifically and the program generally. The schedule of questions was prepared ahead of the interview and the participant responses were taped, transcribed, and analyzed by the researcher.

This approach of combining survey and ethnographic research fulfills Radway's (1984) observation that a complex methodological approach is necessary for understanding the complexity of mass culture's impact on social life. By asking participants to recall how they view a popular show like "Friends" and also observing them watching and talking about the show, we can gain an understanding of how popular culture influences personal and social identity formation.

RESULTS

To the non-fan, "Friends" appears to be typical escapist entertainment television without much relevance or potential impact on an audience member's life. To the fan, however, "Friends" is a more complex message with important effects on the lives and identities of college age women in the 1990s. Watching "Friends" is a media ritual for many college age women, one that performs important group and individual identity functions.

The idea that a television show performs group functions is not a new one. In fact, each generation of college students has one television program that it adopts as its own. "The Bob Newhart Show," "M*A*S*H," "Cheers," and "The Simpsons" are examples of television shows that were extremely popular with college students. The popularity of these shows extends beyond the quality of the scripts or acting and exists because of the topics covered in the programs and the interpersonal relationships portrayed in each program. "M*A*S*H," for example was popular with college audiences in the late 1970s and early 1980s because it portrayed people rebelling against authority, a theme common in programs popular with college audiences. "Cheers" remained a college student favorite for years because of its unique characters, but also because it focused on the changing nature of interpersonal relationships and the tribulations faced by the characters engaged in the relationships. Not only are these shows important to their respective college audiences, but they were shows that college students watched grouped together around dormitory or apartment television sets. Watching these programs and participating in the watching of these programs with small or large groups of friends were weekly rituals, a classroom for learning about popular culture and a time to enact the important socialization rituals associated with being a college student. Few college students of the "Cheers" generation, for example, could resist shouting "Norm" along with the Cheers' regulars as George Wendt's character entered the bar during each episode.

"Friends," a sitcom about the lives and relationships of six people in their mid-twenties, functions in a similar manner for a segment of college students in the mid-1990s as M*A*S*H and "Cheers" did for previous generations. In the population studied, 43.8 percent of those surveyed listed "Friends" as their favorite television show, with over 80 percent ranking "Friends" among their top three favorite shows to watch. "ER," a medical drama, came in a distant second as the participant's favorite show, capturing only 10 percent of the audience's preference. Over half of the participants also answered that they began watching the show after a friend recommended it to them, offering one explanation of how the show became so popular with the 18-24 age group.

More important than why they began watching "Friends," is how participants currently watch the show. Over 57 percent of those surveyed watch the show with large groups of people, with a total of 85 percent watching with at least one other person. A large number, 77.5 percent, reported that they watch the show with a group of close friends. There are many reasons why "Friends" is so popular among groups of college students, including: the show's Thursday night slot, the age range and lifestyle portrayed, the focus on relationships and interpersonal communication, and identification with the characters. With Thursday night being one of the most popular nights to go out, the "Friends" time slot is a typical time for college students to get together. Focus group participants confirmed this idea when they reported gathering together specifically for the purpose of watching "Friends" on Thursday nights as a prelude to other social events. Thus, in this case "Friends" serves as a catalyst for other interpersonal activities.

From the discussion, the viewers painted a vivid picture of the typical viewing experience: Several viewers pile into one room with a large television set, perhaps with a large pizza on the way, and sing in unison the theme song, "I'll be There for You," as they wait for the show to begin. All is quiet during the show except for spontaneous outbursts of laughter. During the commercials, chatter about things such as what Monica is wearing, the way Ross looked at Rachel, and various lines of dialogue. While observing the participants view the taped episode, it was quite clear that viewers had their particular favorite character, whose lines were directly repeated or commented upon. This reveals that the act of watching "Friends" is an active process that is just as important as the show itself. The rituals that take place before, during, and after the program are an integral part of the show's popularity and influence.

One obvious purpose for the show is to provide entertainment for those watching the show. Both during an episode and immediately following each episode of "Friends," subjects reported using dialogue from the show for entertainment purposes. Many reported quoting funny lines from the evening's program to other friends who had also watched the program. Another stated specifically that she watched "Friends" because of its entertainment value. She explains, 'It gives you some down time in your day to relieve stress. Laughter is a way of relieving stress." Using "Friends" for entertainment purposes, one of Rosengren and Windhal's 'uses and gratifications,' the viewers retreat from the pressures of everyday life by laughing at the trials of show's fictional characters.

Beyond functioning for group maintenance and entertainment purposes, "Friends" also functions on an individual level. For example, many college women reported using the show as a basis for social comparison. Both the survey participants and the focus group interviewees revealed that viewers compare the interpersonal relationships on the show, romantic and platonic, to their own relationships. Of those participating in the survey, 45 percent rated discussions about relationships as the most fundamental element of "Friends." One viewer describes why these relationships are so important to the show when she compares "Friends" to other shows featuring groups of twenty somethings living together: It ["Friends"] has appeal to people especially in our age category, because there aren't many shows. . .that relate to people our age about issues like dating, friendships, roommates and those things. . . It is something you can relate to; you don't have to feel alone." The survey revealed that most viewers agreed that the relationships on the show are at least somewhat realistic and over 60 percent of the viewers agreed that the characters of "Friends" are somewhat similar to people they know in real life.

During the focus group, discussions about specific episodes allowed the participants to describe exactly how the comparison between the relationships on the show and their own take place as well as describe the feelings that result from this comparison. In a discussion about an episode where two of the main characters, Ross and Rachel, kiss at the end of the show, one viewer told how this reminded her of her own relationship with her boyfriend: "I guess when I watch something like that it makes me think of my own personal life. I think of times my boyfriend and I fell in love. It just gives me that feeling that you had in your life that maybe you don't have anymore." In this case, the viewer allows Ross's romantic actions to compensate for the lack of romance in her own relationship. Several participants reported using the characters and their dialogue as ways of negatively evaluating their own relationships. One participant wished that "her boyfriend could talk about his feelings like Ross," while another lamented that her signficant other "was not nearly as witty as Chandler." Although all participants recognized the fictional nature of the show, their discussion confirmed Miller's (1986) claim that viewers predict behavior from what they see or hear.

Another facet of the way "Friends" affects the identity of individual viewers are the characteristics or traits that viewers admire in the characters on the show. The questionnaire and the focus group illustrated an interesting parallel. The survey revealed that college-aged women most admired the female characters' sense of humor, their intelligence and their independence. In the male characters, the viewers liked to see a sense of humor, intelligence and a good body. This supports DeFluer and Dennis's (1996) idea that viewers model the behavior of characters they watch on television. DeFleur and Dennis argue that the viewers are identify with the characters, believe that she is like them or wishes that she was like them, and then reproduces one of the characters actions in an interpersonal setting. Strong support for this notion was found in the survey results, as 91 percent of those participating felt that the female characters reactions and feelings were at least somewhat similar to their own.

DISCUSSION

Television critics who dismiss "Friends" as unrealistic or as an assault on family values have valid arguments if one examines the NBC sitcom's role as a barometer of our culture at large. "Friends" is not a landmark television program, along the lines of "All in the Family" or "M*A*S*H." However, those who dismiss "Friends" as a metaphor for its generation and discuss how it legitimizes its fans' lack of direction miss the importance of the show completely. "Friends" does more than reflect the most recent hairstyle or clothing trend—it reflects, even shapes the way college students form and maintain interpersonal relationships.

Studying how viewers consume television shows such as "Friends" provides insight into the complex way television shapes identity, both private and social. Television viewing, particularly

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with college-aged audiences, is both a public and private affair. These viewers create a set of behaviors for each type of viewing, possibly creating two sets of identities. As Carbaugh argues (1996), social identities are created to identify with a larger group.

This study, through its use of survey and ethnographic research, demonstrates the complex ways in which people consume media messages. A complex mehodology using a combination of survey and ethnographic techniques should be employed to give a richer understanding of why people consume and use the messages they do. Future research should continue examining the relationship between particular audiences and the popular culture messages they consume.

REFERENCES

Brunette, P. & Wills, D. (1989). *Screen/Play: Derrida and film theory*. Princeton: Princeton University Press.

Carbaugh, D. (1996). *Situating selves: The communication of social identities in American scenes*. Albany: State University of New York Press.

Cathcart, R. & Gumpert, G. (1986). "Mediated interpersonal communication: Toward a new typology" in Cathcart & Gumpert. *Inter/Media*. Beverly Hills, CA: Sage.

Caughey, J. L.(1986). "Social relations with media figures," in Cathcart & Gumpert. *Inter/Media*. Beverly Hills, CA: Sage.

DeFleur, M.L. & Dennis, E. E. (1996). *Understanding mass communication*. Boston: Houghton Mifflin.

Hart, R. P. (1994). *Seducing America: How television charms the modern voter*. New York: Oxford University Press.

Kidd, V. (1980). "Happily ever after and other relationship styles: Advice on interpersonal relations in popular magazines," *Quarterly Journal of Speech*, 61.

Lull, J. (1980). "The social uses of television," *Human Communication Research*, 6.

May, R. (1991). *The cry for myth*. New York: W. W. Norton.

Merelman, R. (1984). *Making something of ourselves: On culture and politics in the United States*. Berkeley: University of California Press.

Miller, G. (1986). "A neglected connection: Mass media exposure and interpersonal communication competency," in Cathcart, R. and Gumpert, G., *Inter/Media*. Beverly Hills, CA: Sage.

Novak, M. (1977). "Television shapes the soul" in Sellars, L. L. and Rivers, W. C. eds. *Mass Media Issues*. New York: Prentice Hall.

Payne, D. (1989). "*The Wizard of Oz*: Therapeutic rhetoric in a contemporary media ritual," *Quarterly Journal of Speech*, 75.

Perse, E. M. (1996). "Gratifications sought and obtained scales" in Rubin, R. B., Palmgren, P., and Sypher, H., *Communication research measures: A sourcebook*. New York: Guilford Press.

Real, M. (1989). *Supermedia*. Newbury Park, CA: Sage.

Rosengren, K. E. & Windahl, S. (1986). "Mass media consumption as a functional alternative," in Cathcart & Gumpert. *Inter/Media*. Beverly Hills, CA: Sage.

Slater, P. (1976). *The pursuit of loneliness*. Boston: Beacon.

Will, G. (1996). "'Friends' America doesn't need at 8 p. m." *The News and Observer*, February 27, A16.

Dress and Nonverbal Communication

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Humans everywhere dress their bodies with garments, ornamentation, or body modification While dress may not always be essential for survival, it is a cultural necessity for individuals to announce status, rank, power, identity This practice lets us inform others who we are, and in turn make assessments about others In recent years, social scientists have begun to study both the meaning and relevance of dress in a systematic and scientific way This study investigates thirty students' accounts of their experiences connecting the meaning and relevance of dress as they relate to the nonverbal communication concepts proposed by Gregory P Stone, and compares those accounts which support his hypothesis and those which seem to refute it

BACKGROUND

Gregory P Stone was both a social scientist and pioneer in the study of dress He was interested in dress as an aid in establishing an individual's identity, and as part of a nonverbal communication system In his 1963 article, "Appearance and the Self," Stone proposed that each individual presents a "program" of dress to others, which is assessed or "reviewed" by them If what the individual intended to portray in his or her dress matches the review, Stone claimed that the self was "validated;" if the intention was not matched by the review, the self was "challenged " Stone also implied in the latter case, that individuals would change their programs in order to become validated and, therefore, socially accepted

This research project uses the framework from Stone's 1963 article, and is supported by data collected by Joanne B Eicher in 1995 Eicher teaches theory based on Stone's research and commented that his theory has been widely discussed but not extensively tested through research She realized that a question on a midterm exam asking students to write an essay illustrating Stone's theory from a life experience could be used to test these concepts All thirty students signed consent forms giving permission to use their answers in this study

Because dress is a powerful means of communication and makes many statements about an individual, I have included definitions of both dress and communication before discussing how dress "contributes to the acquisition of identities and the development of a sense of self" (Eicher and Roach-Higgins, 1993 13) Questions to consider include How does dress help construct identity? What happens when role expectations are not matched by clothing choices? Who influences dress—family members, peer groups, social or cultural institutions?

Eicher and Roach-Higgins provide a comprehensive definition of dress that "identifies both direct body changes and items added to the body" (1993 15) Dressing the body occurs when human beings modify or supplement their bodies not only with articles of clothing, accessories, jewelry, but also with changes in hair, skin, nails, muscular or skeletal system, teeth, breath While "the visual stimuli of dress" (1993 17) may be the most obvious, odor, taste, sound, and touch are other sensory stimuli that help in establishing an individual's identity

Current definitions of communication agree that ideas must be shared in some way before communication can exist, and "should be thought of as a process, not simply as a transfer of meaning from one mind to another" (Ross, 1986 8) This involves both common experience and mutual influence "Whether we know it or not, we communicate hoping to influence others to respond as we want them to" (1986 8)

Communication requires a series of events, and two or more participants First, the sender conveys a message by sorting through a vast store of data to select and refine the specific intent of the message It is then encoded and translated into signs and symbols that we commonly think of as language How the message is coded, the method for its transmittal, and the skill with which it is transmitted influence the meaning it will have for the receiver The receiver decodes the signal by sorting, selecting, and extracting meanings until the sender's message has been reproduced in the receiver's mind. If the receiver's version is similar to the sender's ideas, communication is achieved, if it is dissimilar, not much communication will occur. The meaning of the message also depends on the knowledge and experience of the receiver. Ross says, "The value of knowing your listener and the value of audience analysis now become evident" (1986 9)

Language helps us communicate about who we are and what we want others to know about us. Ross suggests that only about 35% of communication is verbal, others may claim even less. Tone of voice, gestures, facial expression, and body movement convey meaning as well. Dress makes statements about one's occupation, age, gender, social class, special affiliations, religion, geographic region. Both language and dress are dependent upon "each person's subjective interpretations" (Roach-Higgins and Eicher, 1995 11) of meaning, knowledge, experience, feelings, and previous training "within a particular cultural context" (1995 11)

In discussing self presentation through appearance, Efrat Tseelon says, "perhaps it is not really the type of audience that influences the way one feels about one's self and appearance, but the kind of atmosphere induced by that audience whether supportive or disapproving, whether creating a feeling of visibility or invisibility ..." (1992 507). The translation a person uses "when applying learned meanings of dress within specific social situations" (Roach-Higgins and Eicher, 1995 11) is also important.

Roach-Higgins, Eicher, and Johnson discuss two functions of dress first, dress can alter body processes, and second, dress can be a medium for communication. "Designating a type of dress as protective clothing illustrates that some examples of dress communicate that they are likely to have positive effects on body processes" (1995 11). An astronaut's space suit as protective clothing and a portable environment is such an example. If identifying a type of dress by aesthetic qualities, it "belongs with the discussion of social function of dress as a means of communicating individual and social standards" (1995 11). Geisha dress, for example, communicates cultural and social standards through aesthetic properties. Both garments are encoded in signs and symbols that are transmitted visually. As in language, the viewer/receiver attempts to decode the meaning, and will be more or less successful depending on the range of that individual's experience and knowledge.

RESEARCH DATA—STUDENT'S RESPONSES

Methodology. The data for this paper came from a midterm examination in a class of 30 students, comprised of 27 undergraduates and three master's level graduate students. The examination was not designed with a research goal in mind, it was after the exams were graded and recorded that the instructor realized students' answers could provide a test of Stone's concepts. Students had been asked to write an essay responding to the following

> "The self according to Stone's theory of program and review may be validated or challenged. Illustrate program, review, validation, and challenge from your own life experience in regard to dress."

The students openly shared successes, challenges, triumphs, and defeats. Their answers were very creative, encompassing clothing examples ranging from occupational situations to social occasions to aesthetic expression to solemn and ceremonial events. While no demographic data were collected, the class is intended for juniors, seniors, and graduate students. Enrollment included traditional students and some mature, returning students. Most students had a major in clothing design or retail merchandising, although other disciplines were represented.

Findings. While almost a third of the students mentioned more that one example of program, review, validation, and challenge, this study examines only information from the first-mentioned example. Another third described one program with more than one review. Those examples were included in the study. Twenty-eight students described programs of themselves, two described programs of others. Table 1 shows the distribution of responses.

Table 1 Responses From the Sample of Thirty Students

Program, Review, Validation, Challenge	*No*	*%*	*Total*
Describes one program/one review	20	66 7	
Describes one program/multiple reviews	10	33 3	100
Mentions validation (program and review coinciding)	22	73 3	
Does not mention validation	8	26 7	100
Mentions challenge (program and review conflicting)	19	63 3	
Does not mention challenge	11	36 7	100

Table 2 shows responses from the eleven students who mentioned program change.

Table 2 Responses About Program Change From Sample of Students

Mentions Program Change	*No*	*%*	*Total*
Reviewer changed response	1	9.1	
Individual changed program	10	90.9	100

All students described examples of validation or challenge, and most (27) described their feelings about being validated, challenged, or how they felt after changing programs. Table 3 shows the distribution of responses from the sample of those students who described their feelings in response to review. Since some students received more than one review for one program, the total number of responses is greater than the number of students responding about feelings.

Table 3 Feelings About Review From Sample of Students

Feelings: Validation, Challenge, Change	+	%	–	%	±	%	*Total*
Describes feelings about validation	19	100.0	0	0.0	0	0.0	19
Describes feelings about challenge	1	7.1	12	85.8	1	7.1	14
Describes feelings after program change	6	75.0	2	25.0	0	0.0	8

Key: (+) positive feelings; (–) negative feelings; (±) neutral feelings

In their responses, students elaborated on feelings about validation, challenge, and changes made because of challenges to their programs. The responses reflected a broad range of social and cultural contexts, and many fit in more than one category. Table 4 illustrates the context of the program and review examples.

Table 4 Context of Program and Review

Social contexts	*No*	*Total*
Work	8	
Family	7	
School	6	
Special associations	4	
Friends and others	3	
Leisure	3	
Religion	3	
Special occasions	1	35
Cultural Contexts	*No*	*Total*
Aesthetic standard	5	
Aesthetic expression	3	
Rituals	2	
Health and illness	1	11
Individual Development	*No*	*Total*
Dress and role enactment	2	
Socialization for social role	1	3
Time and Place	*No*	*Total*
Fashion	1	1

The majority of students described experiences in which a program was either validated and the student felt affirmed, or challenged and the student felt socially unaccepted, both of which support Stone's hypothesis. Experiences involving one program with multiple reviews were more complex. All students depicting this situation described both validation and challenge. In his doctoral dissertation, Stone discussed how "interruptions of identity are facilitated by changes of dress" (1959:164). By the same token, if one can't present a change of dress, then the individual's identity (program) would be challenged, also supporting Stone's hypothesis.

One student described a day in which both validation and challenge occurred. She wore the same clothes for school, work, a meeting, and an evening event. Her plain black pants suit, black boots, no jewelry, basic makeup, and neatly brushed hair were validated at school. Since she sold jewelry at work she was expected to wear some; some customers challenged her program. After a meeting to secure sponsors for a project, she observed, "At least I knew it wasn't my legs they were giving the money to, it was my ideas." Later that night she met friends to see a punk band. "My program was really challenged. The people there thought I was... an older sister of a band member or a music critic or a producer of some sort." Different degrees of validation and challenge exist when presenting one program and participating in diverse activities.

Sometimes challenge was seen as a validation. A theater major found that hair helped portray or sabotage stage roles. When playing an 80-year-old, her makeup and hair were elaborate and complex. Not only did she receive good press reviews, her own sister didn't recognize her. Later, playing another older role, she was told to use glamour makeup accompanied by a contemporary costume and hairstyle. The reviews were brutal. "A major part of the criticism directed at me was related to my costume. My dress program, directed by others was severely and correctly challenged." Before this experience, she had described herself as "a restrained theatrical minimalist," believing "that costume in the theater, and everyday life had little meaning in identity. I was wrong...." The student had challenged her own review and was validated in the process.

In family issues, students were validated when family values coincided. When values conflicted, aesthetic expression or an aesthetic standard was always the arena for challenge. One student received an invitation to a cousin's Bar Mitzvah, specifying casual dress. Her mother said she could wear nice jeans and a blouse. The student added a blazer. "I walked in and immediately felt challenged....Everyone was dressed-up, including my mother who had told me I could wear jeans." This example is intriguing because the student did check the dress code with her mother so her clothing would be socially accepted. Stone considered the roles that socialization and appropriate dress play by comparing them to games, uniforms, and the apparent representation of the self. In the above instance, all but the student were wearing the appropriate "uniform."

In other examples students expressed less concern about family acceptance and more about peer acceptance. One student decided to get a tattoo as a way of expressing individuality. Although the student's friends (and even strangers) seemed to admire it, the student's mother had a very negative reaction. "She was embarrassed and wouldn't tell any of my relatives about it. She even sent me articles on laser surgery to remove tattoos. However, ... my mom has finally begun to validate and... accept it." In this instance, the reviewer (mother), not the student, changed her earlier review. Stone did not discuss this possibility.

In his article, "Becoming and Being Tattooed," Sanders suggested that individuals with tattoos validate each other. Tattoos may be "defined by others as a stigmatizing mark....Given the negative reaction that tattooees encounter with some frequency when casual associations or strangers become aware of their body decorations, most are selective about to whom they reveal their tattoos" (1988:418-9).

A variation on peer acceptance came from an identical twin who described herself as "sort of yuppie looking with trendy clothing, hair, cosmetics, and an athletic body." Her twin sister, however, had shaved her head, wore "grunge" clothing, a nose ring, and was overweight. "Our programs are very different and so are our reviews." The student was usually validated; her sister was frequently challenged. "She is always snickered at and stared at." Perhaps it didn't occur to the student that no one was forcing her twin to dress as she did. Like the tattooee, the "radical" twin and her friends may have reviewed "yuppies" as "narrow and convention-bound" (Sanders, 1988:419). The student also mentioned that she and her sister shared similar values, but she didn't mention if they were moral, religious, or other values. Social values, however, seemed to differ and were expressed through both social roles and cultural standards of aesthetic choice. It would be revealing to know how her sister and "radical" friends were reviewing the student. In this example, it appeared that one individual intentionally chose a message that would be reviewed negatively. Stone did not discuss this possibility either.

Weight was another aesthetic standard that two students explored. One student lost 40 pounds and felt good about her appearance,but she was unable to keep the weight off. She began feeling terrible about herself. Even when people complimented her, she said, "I felt like people were telling me this to be nice." Since the reviews did not coincide with her program, she felt challenged. In fact, the student challenged her reviewers, assuming they were insincere.

Clothing is a tangible and powerful sign of identity. Rubin, Scmilovitz, and Weiss noted that after losing weight, buying and wearing regular-sized clothing is "a mechanism for the removal of a stigma" (1993 10). Fat people "are subject to several unpleasant stigmas" (1993 3). They bear a medical stigma—obesity is a health hazard, a religious stigma—"'overindulgence' is a sin," an aesthetic stigma—"'fat' is considered ugly," and a moral stigma—they are "unable to control themselves" (1993 3).

The other student included stigma in describing her weight change. She specifically mentioned being seen as having no self-control. She also mentioned the challenge of meeting an aesthetic standard, and the role of clothing in defining her identity both before and after her weight loss. After losing 80 pounds, her style of dress changed dramatically. She described wearing clothes that were more feminine and body-contouring. She knew was being treated differently because she was meeting society's expectations. She said, "We do somewhat rely on others for our identity."

CONCLUSIONS

An individual assumes many roles and therefore, a number of identities. Data about those identities can be transmitted and processed visually. As Stone hypothesized, individuals form ideas about how other people will respond to their dress based on experience. If a person's predictions are correct, the nonverbal identity of the sender coincides with that of the receiver. If the sender's message differs from the receiver's meaning, interaction is difficult or perhaps impossible. This study examines only a small sample using one of Stone's concepts. Most examples support his hypothesis, however, he did not discuss the possibility of a reviewer changing a review, or that in some instances, a sender intentionally chooses a message that will be reviewed negatively. This project has sparked my interest in pursuing a more expansive and detailed investigation of these concepts.

In the last example, the student linked identity, gender, nonverbal communication, and clothing. Students were not identified by gender nor asked to specify gender in this study, and gender was not part of the original analysis. Even so, gender queries surfaced. What part does gender play in dress and nonverbal communication? How is gender defined? What constitutes gendered dress? Is it important to know another's gender?

Stone proposed that both language and vocabulary are gender specific, and every social transaction must be divided into two distinct and important components: appearance and discourse. Before meaningful communication can occur, appropriate language must be selected, therefore, participants need to identify each other. That requires knowing another's gender—usually a silent activity, established by appearance.

REFERENCES

Barnes, Ruth, and Eicher, Joanne B. (Eds.) (1993 pp. 8-26). *Dress and Gender*. Oxford: Berg Publishers, Inc.

Eicher, and Roach-Higgins, Mary Ellen (1993). "Definition and Classification of Dress: Implications for Analysis of Gender Roles." *Dress and Gender*. Oxford: Berg Publishers, Inc.

Roach-Higgins, Mary Ellen, Eicher, Joanne B, Johnson, Kim K P. (eds.) (1995). *Dress and dentity*. New York: Fairchild Publications.

Ross, Raymond S (1986). *Speech Communication: Fundamentals and Practice*. Englewood Cliffs, NJ: Prentice-Hall.

Rubin, Nissan, Shmilovitz, Carmella, Weiss, Meira (1993). "From Fat to Thin: Informal Rites Affirming Identity Change." Symbolic Interaction 16, 1 (pp. 1-17).

Sanders, Clinton R. (1988). "Becoming and Being Tattooed." Journal of Contemporary Ethnography 16, 4 (pp. 395-432).

Stone, G P. (1959). "Clothing and Social Relations: A Study of Appearance in the Context of Community Life." Doctoral dissertation, University of Chicago, 1959.

________ (1962). "Appearance and the Self." *From Human Behavior and the Social Processes: An Interactionist Approach*, Arnold M. Rose, ed. (New York: Houghton Mifflin Company, 1962), reprinted by permission of the publisher in *Dress and Identity*.

Tseelon, Efrat (1992). "Self Presentation through Appearance: A Manipulative vs. A Dramaturgical Approach." Symbolic Interaction 15, 4 (pp. 501-513).

Confronting Learning Disabilities:

A Proactive Approach for Parents

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An often used solution for problems in special education is prescribed medication. The option readily chosen by the apathetic parent is ritalin. This approach raises the question: what is fostering the cognitive development of the child, medication or parental involvement? The fact that one in seven school age children is eligible for special education requires that this question must be addressed. Contrary to many doctors' preference of ritalin as a panacea, a proactive approach for learning disabilities is parental involvement. Home schooling and other methods of active participation should be accepted as viable alternatives to medication. Recent cases of young students have shown significant improvement in learning through individual instruction. For example, one student diagnosed as learning disabled advanced by one school grade under his mother's active interest. For these reasons, and others yet to be explained, resolution for learning disabilities requires parental engagement.

INTRODUCTION

The term "special education" has a new meaning. There was a time when "special" referred to students with severe retardation or physical disabilities. Medical and educational professionals, however, are advancing their understanding of learning disabilities. Therefore, the term "special" now includes a much broader spectrum of children. Many types of disorders, such as "hyperactivity, autism, retardation, emotional disturbance as well as physical handicaps would be considered special need" (Ilg 180). What is unclear are the types of treatment that should be used for these children. An example of a commonly diagnosed learning disability is attention deficit disorder. Until recently, the most common method of treatment for this disorder was to prescribe medication, such as ritalin. This medication has been deemed a panacea for A.D.D. by many doctors, teachers and parents. However, there is not one solution to this problem and no two children will respond in the same way to the same treatment. So, what is the most effective way to treat a learning disability? This paper seeks to demonstrate that the sooner a problem is diagnosed, the better the chances for a quick resolution. And, treatment for learning disabilities should encompass many proactive strategies, such as parental involvement, tutoring, special education and counseling. The methodology used to evidence this theory is observation of children with learning disabilities coupled with research from books that address proactive approaches such as They Can But They Wont: Helping Students Overcome Work Inhibition and The Learning Mystique.

Unfortunately, learning disabilities occur more frequently than most people assume. According to Loraine Stern, author of "When a Child Has Trouble Learning", "More than 15% of school children are learning disabled, and they make up about half of the children who are eligible for special education" (86). That statistic translates to about one in seven school age children, which makes learning disabilities a primary concern for Americans today. However, some parents may not seek a diagnosis for their child due to the stigmatism often associated with learning disabilities which may hinder early detection.

"TINA" AND "BRAD"

In 10 year old Tina's case, when her parents realized that their daughter had problems paying attention in school, they immediately decided to consult a physician. The doctor diagnosed Tina as having A.D.D. and suggested that she take ritalin which is a medication used to "stimulate neurotransmitters in the brain, like dopamine, to help the brain work better" (Kennedy 51). Tina's parents took this advice, but they did not stop there. In addition to medication, Tina's parents enlisted the help of a tutor for assistance in the subjects where she proved to be weakest. Another aspect of Tina's treatment is parental involvement. Her parents pay close attention to their daughter's achievements and her minor setbacks. If there is the slightest concern over any problems reoccurring, these parents promptly find a remedy. They also incorporate a little "T.L.C." into their program. Tina knows that she is loved and this type of support is crucial for progress. Tina is improving her grades. In fact, her performance reached a satisfactory level within months because she responded so well to individual treatment. The course of action that Tina's parents are taking is working. But, would it work for other students or is there another way?

To answer these questions, the case of a six year old, named "Brad," can be analyzed. When this child attended kindergarten, his parents were receiving complaints about his inability to follow directions. He was also having problems with vowel and consonant sounds. At the end of the year, Brad's parents were informed that their son would probably be considered for special education. They, however, felt that part of the problem could be attributed to teacher failure. One observation Brad's mother made was that his teacher did not give positive reinforcement and, in fact, most of the feedback could be deemed quite negative. In a few instances, Brad made comments to his mother about how "dumb" he was, and said he did not want to go back to school. So, instead of enrolling him in special education, Brad's parents decided they would try personal attention for their son in the form of home schooling. This may sound quite drastic since home schooling is a considerably less conventional method than those used in the first case. However, this family made it a feasible alternative because Brad needed help. To ensure that their son's needs were being met, they enlisted the aid of their local school district's curriculum and coupled that with support from other home school families at their church. The program is working well. Brad's mother, who does the teaching, found that he responds extremely well to personal instruction. Brad now knows all of his vowel and consonant sounds. In fact, he is reading basic words. He is also following directions to the letter. In addition, Brad is learning about the world around him by taking weekly field trips with other home school families. Moreover, his mother incorporates religion into the lesson to ensure a strong moral foundation for her son. As in Tina's situation, there is an abundance of love. Brad is receiving much-needed support on a daily basis. Consequently, because of his mother's active interest Brad advanced one grade.

TYPES OF TREATMENT

The most common methods used when treating learning disabilities are medication, tutoring, special education and counseling; any combination of these can prove to be effective. Home schooling is also an alternative to be considered, especially for a student with A.D.D. who will have less distractions at home. However, as with treatment for any ailment, there are definite advantages and drawbacks to each type of treatment and when considering help for a child, these must be weighed.

For instance, when parents ask themselves the question, to medicate or not to medicate, the risks should not outweigh the advantages. Medication is a viable option for treating learning disabilities, and ritalin is one example of medication often recommended by doctors for the treatment of A.D.D. The fact that it can be obtained by attending a few doctor's visits is a plus for the argument of using this type of treatment.

There are, perhaps, much stronger arguments for the other side. First, some parents might think that they can stop searching for solutions because their child is being treated medically. However, "it is erroneous to believe that you can take a pill and have all your ills disappear"(Routburg 73). Also, a poor combination of medicines can be dangerous. Another factor to consider is the possibility that the medication might be forgotten occasionally which will affect the student's learning. Therefore, if medication is not an option, parents must explore other alternatives.

One seldom used option in treating learning problems is home schooling. Frequently, a child needs extra special attention that can not be obtained in public school. The formerly-noted case of Brad is a prime example. In this case, Brad's parents took the perspective that responsibilities which should lie in the hands of the school system were not being carried out. There seemed to be no positive reinforcement. This theory is corroborated in Gerald Coles' The Learning Mystique, wherein he quoted a study that found "teachers gave students little reinforcement of any kind, whether in the form of specific task related knowledge and praise or general support and encouragement" (92). If this is so, then the possibility of a student receiving no reinforcement may be ruled out by home schooling. However, parents must engage in a program that focuses on positive support and encourages their child. A problem with home schooling is that so many families today are double-income. What must be addressed is whether or not the parents are both working out of necessity or as a means to acquire material wealth. In Brad's case, his family is by no means comfortable. They are, in fact, barely making it. But, when it came time to make a choice, Brad's education came first.

Similarly, tutoring can be useful for those students who need extra attention to learn. In the case of a student who is capable of grasping a certain subject but needs a little extra time, tutoring could be the best option. The problem is that this special service may not always be available or practical. Many parents simply can not afford to pay someone to tutor their child. However, one way to acquire this service at no charge is by enlisting the help of other students at the child's school. According to Jerome H. Bruns, author of They Can But They Wont: Helping Students Overcome Work Inhibition, "students enjoy helping each other...in high school, members of the National Honors Society, Key Club, or other service organizations may be ready and willing to give tutorial assistance" (107). By recruiting a little extra help, parents may be giving their child the chance to contend with a tough system. However, there are still more options and added help can be attained in school.

Special education has been around in the public school system for many years now. It is, however, quite different than the "special" classrooms of the past. "Special education today is founded on the conviction that if certain principles are contentiously applied all children who have disabilities will be able to learn regardless of the nature or severity of their disability" (Shore 10). Because of the advancements in defining the word "special", this option is available to many students who would not have been considered for special education before. Since public education is free, the obstacle of practicality is removed. But, while this type of help can give that extra push that some students need, for some parents there are a few apprehensions. The first is the possibility of their child being stigmatized by the term "special". Another is the concern that their child may not be able to advance because his class is working at slower pace. Nevertheless, when contemplating this option the primary consideration should be what is best for the child. Counseling can also be a useful tool to assist a child with learning disabilities. Sometimes, emotional distress is a dominant factor in a child's inability to learn. Financial considerations, however, are one of the main barriers when pursuing this option. Many people will avoid enlisting a counselor because they do not think they can afford it. If this is the case, school psychologists are often available; "however, they are less flexible in terms of time than individuals in private practice" (Brusko 92). Another less widely known form of counseling is group support such as the Foundation for Children With Learning Disabilities and the Resource for Children With Special Needs Inc. (Levine 246). If the funds are available, private counseling is probably the best approach. When looking for a therapist, the parents have to do their homework. "If you and the therapist can not work harmoniously your child may lose as a consequence" (Routburg 81). The responsibility of finding a good therapist rests on the parents who must educate themselves about what is available. Nevertheless, a parent's obligation to his or her child is far greater than simply enlisting the help of others.

Parents owe their children personal support and love while going through what can be a exceedingly tumultuous experience for a child with learning problems. According to Marlene Brusko, author of Living With Your Teenager, "children need to be constantly reminded that they are loved" (57). Everyone requires a little tenderness, and for a child this need is even greater. If the student is making progress, he should be told. Positive reinforcement is crucial if the child is expected to achieve. Similarly, if the child is not doing well, the parent must encourage him to do better. Without parental support, a child stands little chance of progressing normally.

CONCLUSION

One way to determine which plan of attack to use when confronting learning disabilities would be to compare them with other ailments. For example, if a child were diagnosed with a disease that is potentially fatal, the parents would want to seek every option for him. The same should hold true when parents address their child's learning disability. Since no child will respond the same way as his or her equally "special" counterpart, different approaches must be taken with each individual. The most important realization a parent can make in regard to a child's learning disability is that there are no absolutes. The entire gamut of therapies, such as parental involvement, tutoring, special education and counseling, must be explored. In the cases that are cited here, Tina and Brad respond extremely well to a combination of proactive treatments: one to medication, tutoring and parental involvement, the other to home schooling and positive reinforcement from his parents. Also, the authors formerly quoted strengthen the argument for the use of proactive treatments. Regardless of what form of treatment is used, finding a remedy is crucial since children are our single most important natural resource.

REFERENCES

Bruns, Jerome H. (1989). They Can But They Don't: helping students overcome work inhibition. New York: Harper and Row.

Brusko, Marlene (1986). Living With Your Teenager. New York: Ballantine Books.

Coles, Gerald (1987). The Learning Mystique: a critical look at learning disabilities. New York: Pantheon Books.

Ilg, Frances L. M.D., Aims, Louise Bates Ph.D. and Baker, Sidney M. M.D. (1992). Child Behavior. New York: Harper Perennial.

Levine, Katherine Gordy (1991). When Good Kids Do Bad Things. New York: Norton and Company.

Routburg, Marcia (1986). On Becoming a Special Parent: a mini support group in a book. Chicago: Parent/Professional Publications.

Shore, Kenneth Psy.D. (1986). The Special Education Handbook. New York: Warner Books.

Stern, Loraine (1995). "When a child has trouble learning." Woman's Day. August 8, v58, n13, p.86.

Turecki, Stanley M.D. and Tonner, Leslie (1986). The Difficult Child. New York: Bantum Books.

(*) Individual, non-published case studies of "Tina" and "Brad"; two children who have been diagnosed with learning problems.

Public Perceptions of Television Versus Newspaper Credibility: A Local Study

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Research in the media has shown that public perceptions of credibility differ for newspapers and television. Previous studies have suggested that survey respondents tend to rate television as more credible than newspapers in their ability to provide news coverage, mainly because of television's ability to provide live, on-the-spot coverage of breaking events and because of the idea that "seeing is believing" in media content.

This project describes a public opinion study measuring perceptions of media credibility in Buncombe County, N.C. Respondents were questioned on their level of trust of both media in situations of local and national importance, as well as the medium they found most trustworthy overall. Results of the research could be used by local media as an indicator of public sentiment and as a tool for targeting possible audiences.

INTRODUCTION

Newspapers and television are the two media that provide the most information about current local and national news events. The two are in constant competition for the same audience. The public's perception of these two media has been the subject of countless research studies over the years. Though the two operate in different venues (print and electronic media), the information they provide is almost identical in content. This project explores Buncombe County, North Carolina residents' perceptions of, and willingness to trust, both of these media in specific situations. It provides an overview of previous research and a description of the research conducted. The main goal of this study is to determine which medium Buncombe County residents turn to for information about what's going on in the world today, from a local and national perspective.

MEASURING THE CREDIBILITY OF TELEVISION VERSUS NEWSPAPERS: PREVIOUS STUDIES

The idea of measuring credibility of television and newspapers is not a new one for media researchers. One of the most frequently cited studies measuring credibility of television versus newspapers was performed by Gaziano and McGrath (1986). The study sought to describe the measurement of credibility in previous research and report the results of a national survey which treated credibility as a multi-dimensional concept. The study asked respondents to rate the daily newspaper with which they were most familiar. Television newscasts were rated in a similar fashion. A 12-item scale was devised based on the responses and defined as "credibility." The results of the study found that 61 percent of respondents scored high on credibility for both media, but that respondents were more likely to believe television than to believe newspapers, mainly for the reason that "seeing is believing." Newspapers were rated as more trustworthy than television when respondents were asked which local media they trusted more when faced with a situation in their local area that was controversial or hard to understand. However, one half of respondents chose local TV news for local news in general. For national news, over half of respondents chose television news. Gaziano and McGrath found that the credibility of television news increases as the focus moves from local to state to national to international news. Overall, 64 percent of respondent chose television over newspapers when asked which medium they would pick if they could choose only one source for all their information.

In a study by Newhagen and Nass, the different criteria people use to evaluate newspaper and television news were examined. This study looked at the problem of defining a source as a person or an organization and found that television viewers base credibility of the medium on the personalities of on-camera newscasters, while newspaper readers base credibility judgments on the newspaper as an organizational unit rather than the set of individuals who create it. The study also showed that as the circulation size of a newspaper decreases, it is more likely to be seen as a collection of individuals than as an institution, and the personal dimension of credibility emerged.

A Gallup Poll report from 1995 found that 33 percent of respondents said they trust television news "quite a lot," while only 25 percent said they trust newspapers "quite a lot." A 1995 report by the Freedom Forum Media Studies Center at Columbia University found that television news' major strength lies in providing up-to-the-minute breaking news, while newspapers excel in providing information that is timely but more comprehensive. A similar study by the Times Mirror Center for People and the Press found that 74 percent of respondents "primarily" turn to television for local news, while only 20.9 percent pick up a newspaper.

HYPOTHESES

Based on previous research, the following hypotheses are presented:

H1: That Buncombe County residents will turn to television over newspapers for information about breaking news of local and national importance.

H2: That Buncombe County residents will choose television over newspapers as the medium from wich they get most of their information about what's going on in the world today.

H3: That residents will choose television over newspapers in situations of conflicting or different reports of the same story.

It is believed that the ease with which media consumers can access information through television news will be a driving factor in public perception. It is also believed that the increased amount of attention and involvement in the act of reading a newspaper will also affect public perceptions.

METHODS

Six questions were purchased from the Buncombe Poll in the fall of 1995. The questions are as follows:

1. Where do you get most of your news about what's going on in the world today--from newspapers or television?
2. How much do you trust newspaper coverage of an important local event, such as a city council election? Do you trust it completely, trust it somewhat, trust it a little, distrust it somewhat, or completely distrust it?
3. How much do you trust television coverage of the same event? Do you trust it completely, trust it somewhat, trust it a little, distrust it somewhat, or completely distrust it?
4. How much do you trust newspaper coverage of an important national event, such as the impeachment of a U.S. president? Do you trust it completely, trust it somewhat, trust it a little, distrust it somewhat, or completely distrust it?
5. How much do you trust television coverage of the same national event? Do you trust it completely, trust it somewhat, trust it a little, distrust it somewhat, or completely distrust it?
6. If you got conflicting or different reports of the same news story from television and the newspapers, which of the two would you be most likely to believe, television or newspapers?

Demographic information on age, gender, political affiliation, and income was compiled using questions asked annually on the poll. The poll was conducted October 27 through November 4, 1995. Three hundred eighty-six completed surveys were used for analysis. Sampling error was +/- 4.5 percent, and completion rate was 59 percent. Surveys were coded and the data analyzed using the SYSTAT program of statistical analysis. The first part of analysis involved a cross-tabulation of the six questions to obtain percentages of residents responding to each answer category. Results of the cross tabulations are listed in Table 1.

For the demographic profiles, question number six ("if you got conflicting or different reports of the same news story from television and the newspapers, which of the two would you be most likely to believe, television or newspapers?") was used to test against questions on age, gender, income, and political affiliation. In order to do this, a new variable was created to produce a dichotomous variable. Also, demographic questions on race, gender, and voter registration were dichotomized. An Analysis of Variance (ANOVA) was performed on the demographic variables (results on Table 2). A separate ANOVA was run on the two best models to test for significance (Table 3). Finally, a cross tabulation was performed for each demographic variable for comparison against the new conflict variable (Table 4).

Table One: Cross Tabs for Survey Questions

Question	Percentage Favoring TV	Percentage Favoring Newspapers
Where do you get most of your information about what's going on in the world today?	57.3%	24.4%
If you got conflicting or different reports of the same news story, which could you trust?	45.7%	28.9%

How much do you trust	Complete Trust	Trust Somewhat	Trust a Little	Distrust Somewhat	Complete Distrust
TV Coverage of an important local event?	7.4%	47.4%	22.2%	11.6%	4.9%
Newspaper coverage of the same event?	5.9%	46.2%	20.2%	14.1%	6.7%
Television coverage of an important national event?	11.9%	51.9%	17.5%	8.1%	4.4%
Newspaper coverage of the same event?	10.6%	47.4%	18.5%	11.4%	4%

Table Two: Analysis of Variance (ANOVA) test
for demographic variables

Variable	p value
Education	0.090
Age	0.852
Voter Registration (dichotomous)	0.983
Race (dichotomous)	0.621
Gender (dichotomous)	0.053
Income	0.946

Table Three: ANOVA after removal of non-significant variables

Variable	p value
Education	0.001
Gender (dichotomous)	0.080

Significance for tables- p is less than or equal to 0.05

· Table Four: Cross-Tabulations for Demographic Variables

Gender

	Female	Male
Trust Television	64.8%	54.9%
Trust Newspapers	35.2%	45.1%

p value = 0.090

Race

	White	Non-White
Trust Television	59.8%	67.9%
Trust Newspapers	40.2%	32.1%

p value = 0.405

Voter Registration

	Republican	Democrat
Trust Television	54.2%	57.9%
Trust Newspapers	45.7%	42.1%

p value = 0.632

Education

	4 Yr. College or more	Some College or 2-year degree	High School gradate/GED
Trust Television	72%	59.2%	48.8%
Trust Newspaper	28%	40.8%	51.2%

p value = 0.003

RESULTS

As Table 1 shows, television emerged as the medium chosen most often in the six questions on television and newspaper use, with 57.3% of respondents choosing television as the medium from which they get most of their news about world events. A majority of respondents also chose television as the most trustworthy in situations of conflicting or different reports. For the questions on media coverage of local and national events, a majority of respondents said they trusted both media "somewhat" in all situations. However, a greater percentage of respondents said they trusted television coverage of local and national events over newspaper coverage, and fewer respondents completely distrusted television coverage than newspaper coverage.

The inital ANOVA did not produce significant variables. Clearly, age, voter registration, and income were not factors in predicting trust in newspapers or television. The two variables whose p values were closest to being significant were removed from the set and run separately, to test if the "best model" would yield significant results. After the second ANOVA was performed, it was concluded that education level was the only significant variable in predicting perceptions of media credibility.

The cross tabulations for the demographic variables were used as a test (to prove that the other variables were not significant) and as a way to see how education affects perceptions of credibility. As Table 4 shows, the original conclusion that gender, race, and voter registration were not significant was proven correct. Also, the impact of education on perceptions of credibility was shown in a rather surprising manner. A majority of respondents with a four-year college degree or more were shown to trust television over newspapers, as were respondents with some college education or a two-year degree. However, the majority of respondents with a high school education or general equivalency diploma (GED) tended to trust newspapers over television. It is interesting to note that the greatest difference in percentages (72% and 28%) occurred in higher-educated respondents, with the percentage differences dropping substantially for respondents with some college education (59.2% and 40.8%) and high school graduates (48.8% and 51.2%)

DISCUSSION

The findings in this study were, in some respects, surprising and predictable in others. Respondents' choice of television over newspapers was in accord with previous studies. However, the results of the demographic profiles was not as predicted. The failure of the majority of variables to predict trust is easier to understand than the results of the education variable. Prior studies had suggested that respondents with higher levels of education would be more print-oriented and would therefore choose newspapers as more credible. However, the exact opposite was determined. It is the lower education brackett that favored newspapers. Reasons behind this can only be speculated about. Perhaps respondents with a high school diploma or GED now choose to read partisan newspapers, or those considered out of the "mainstream press." Or, perhaps a higher level of education denotes a greater level of cynicism towards the local daily newspaper. Certainly the reasoning behind the findings are an avenue for further research.

While the findings of this study echo results from previous research, they are unique in their limited geographical scope. While other studies have described research conducted on an undefined geographical area, this research concerns itself only with Buncombe County, N.C. Hopefully, the smaller size of the area being surveyed can give a better indication of the true feelings of the region.

REFERENCES

Gaziano, Cecile and McGrath, Kristen, "Measuring the Concept of Credibility," Journalism Quarterly, Vol. 63, Autumn 1986. pg. 451-462.

McAneny, Leslie and Moore, David W., "American Confidence in Public Institutions Rises," The Gallup Poll Monthly, May, 1995. pg. 11-13.

Newhagen, John and Nass, Clifford, "Differential Criteria for Evaluating Credibility of Newspapers and TV News," Journalism Quarterly, Vol 66, Summer 1989. pg. 277-284.

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The Evidentiary Impact of the Likelihood Ratio and Assessment of Diagnosticity

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People often fail to make probabilistic inferences according to the rules of probability. This paper is concerned with people's ability to assess the strength of evidence and whether their assessments follow normative standards as given by Bayes' Theorem. An experiment was conducted to test the hypothesis that people violate the normative standard by placing excessive emphasis on the numerator of the Bayesian likelihood ratio rather than on the completed likelihood ratio. The results of the experiment generally supported this hypothesis.

BACKGROUND

It is often suggested that people have trouble understanding probabilities and using probabilistic information to form and revise their beliefs. Prior research has shown that people do not correctly adjust their prior beliefs in the face of new evidence as required by the rules of classical probability theory. Much research has focused on people's insensitivity to background probabilities or base rates relative to information that seems to be more directly relevant to the case under consideration. For example, studies have shown that people are likely to think that a target person is an engineer when provided with a description that is similar to a stereotype of an engineer even when they are also told that only a small percentage of the general population are engineers.

A related line of research has demonstrated that people fail to consider the probability of evidence given the alternative hypothesis, P(E|-H). However, probabilistic theory tells us that the value of new evidence is given by the ratio of P(E|H) to P(E|-H). A problem arises if people either know only one of these components or attach too much weight to one of them.

The Normative Model

Bayes' theorem provides a method for updating probabilistic beliefs when considering new evidence. For the phenomenon investigated in this paper, the appropriate normative model is the odds form of Bayes' theorem:

$$\frac{P(H|E)}{P(-H|E)} = \frac{P(H)}{P(-H)} \times \frac{P(E|H)}{P(E|-H)} \qquad (1)$$

P(H) to P(-H) refer to the probabilities that a hypothesis H is true and false respectively, prior to the presentation of evidence. These probabilities are commonly referred to as priors and their ratio is the *prior odds*. P(E|H) and P(E|-H) refer to the diagnostic value of the evidence E if hypothesis H is true and false respectively. The ratio of these two likelihoods is called the *likelihood ratio* and defines the probative value, or strength, of the evidence. Finally P(H|E) and P(-H|E) are the probabilities that the hypothesis H is true and false in light of the evidence E. The ratio of these two quantities, called the *posterior odds*, is computed by multiplying the prior odds by the likelihood ratio.

P(E|H) and P(E|-H) were previously defined as the probabilities of the evidence given hypothesis H and -H respectively. Notice that these two probabilities are the inverses of the posterior probabilities, P(H|E) and P(-H|E). For example, if you want to know the probability that it will rain given that the weather forecast indicates rain, P(Rain|Rain Forecast), then P(E|H) and P(E|-H) would refer to the P(Rain Forecast|Rain) and P(Rain Forecast|-Rain) respectively. The ratio of the former to the latter would represent the diagnostic value or evidence strength.

Bayes' Theorem as a Practical Application

Bayes' Theorem can be applied in a wide array of practical situations, as exemplified in Saks and Koehler's (1991) Bayes & AIDS problem.

One in every 250 Americans has the HIV virus that causes AIDS. The initial test that is used to detect the virus is known to be 97.7% accurate in the sense that 97.7% of those who actually have HIV will test positive for the disease, and only 2.3% of those who have HIV will erroneously test negative. It is also known that the false positive error rate of the test, or the rate at which the test will erroneously indicate that one who does not have HIV will test positive, is 7.4%. What is the probability that a person who tests positive for HIV actually has the HIV virus?

Most people believe that the answer to this problem is 97.7%, the accuracy rate. Bayesian analysis shows that the probability is much smaller. When we use Equation 1 to solve for P(HIV|Positive Test), we obtain:

$$\frac{P(\text{HIV}|\text{Positive Test})}{P(\text{No HIV}|\text{Positive Test})} = \frac{P(\text{HIV})}{P(\text{No HIV})} \times \frac{P(\text{Positive Test}|\text{HIV})}{P(\text{Positive Test}|\text{No HIV})}$$

$$\frac{P(\text{HIV}|\text{Positive Test})}{P(\text{No HIV}|\text{Positive Test})} = \frac{.004}{.996} \times \frac{.977}{.074} = \frac{.003908}{.073704}$$

$$P(\text{HIV}|\text{Positive Test}) = (.003908)/(.003908+.073704) = .05$$

A Bayesian analysis shows that the probability that a person who tests positive on the first test for HIV actually has the HIV virus is only 5%. At first, people are often bewildered by the Bayesian analysis and are skeptical about the answer that it provides. However, Figure 1 provides a more intuitive approach to understanding the accuracy of Bayesian analysis and its response to the Bayes & AIDS example. Notice that only 40 of 10,000 Americans have AIDS, whereas 9,960 do not. The implication of this imbalance is that even a very accurate test (such as the 97.7% accurate AIDS test) will yield a fairly large number of false positives (737) relative to the number of true positives (39). Hence, a large majority of positive test results will be false rather than true positives, and the chance that one has AIDS given that he or she tests positive will be small (39/776 = 5%).

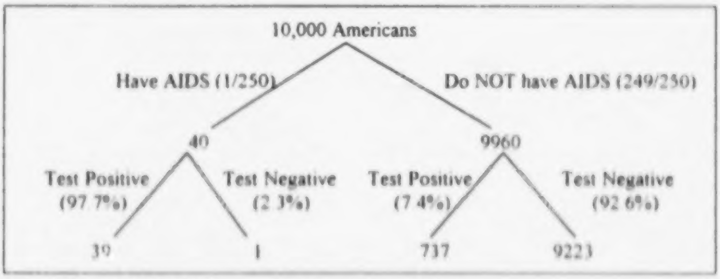

Figure 1. 'Bayes & AIDS' Diagram Yielding Bayesian Response

THE LIKELIHOOD RATIO

According to Bayes Theorem, the diagnostic value, or evidentiary impact, of new evidence is captured by the likelihood ratio, P(E|H)/P(E|-H). A likelihood ratio greater than 1 increases the chance that H is true whereas a likelihood ratio less than one increases the chance that -H is true.

In the Bayes & AIDS example, the likelihood ratio is the probability of a positive test given HIV divided by the probability of a positive test given no HIV, (.977/.074) = 13.2. Because the likelihood ratio is greater than 1 in this example, the evidence increases the chance that a person who tests positive for AIDS has AIDS relative to the prior odds of 1 out of 250. Importantly, when the likelihood ratio is used to assess the strength of the new evidence, both the numerator, P(E|H), and denominator, P(E|-H), must be taken into account as a proportion. A large numerator, P(E|H), is not necessarily indicative of high diagnosticity just as a small denominator, P(E|-H), is not necessarily indicative of high diagnosticity.

A Case of High P(E|H) and Low Probative Value

A common fallacy that people make is associating a large P(E|H) with high diagnosticity and high P(H|E) However, if the denominator of the likelihood ratio, which represents the probability of the evidence given the alternative hypothesis, is large as well, then the evidentiary impact of the new evidence may be minimal The reason that a high P(E|H), high P(E|-H) ratio can lead to low evidentiary impact is that the probability of the evidence E will be high regardless of whether hypothesis H or -H is used

A Case of Low P(E|H) and High Probative Value

Similar to the fallacy described above, there is a tendency for people to associate low P(E|H) with low diagnosticity If however P(E|-H) is less than P(E|H), the likelihood ratio can become quite large and probative Consider this example from Lyon and Koehler (1996)

The probability that a child contracts a venereal disease (VD) from sexual abuse, P(VD|Abuse), is only around 5% Does this mean that a venereal disease is not probative of abuse? Absolutely not Focus must also be placed on the denominator of the likelihood ratio which represents the probability that a child contracts a venereal disease given no sexual abuse This probability P(VD|-Abuse) is nearly zero, but we will assume a probability of 000001% for application sake The likelihood ratio is thus 05/ 00000001 = 5,000,000 Thus, here we have an example in which P(E|H) is low (05), and yet the completed likelihood ratio, P(E|H)/P(E|-H), is quite high (5,000,000) As this example shows, if people judge the strength of evidence based solely on P(E|H), they may assume that the evidence is weak when in fact, a likelihood ratio analysis reveals it to be quite strong

EXPERIMENT

Obviously, people do not usually conduct explicit Bayesian computations when reasoning about problems such as the AIDS problem But when the various terms of the prior odds and likelihood ratios are manipulated in an experimental setting, it is possible to see to which terms people's intuitive judgments are more or less responsible As indicated earlier, some research shows that people's intuitive judgments are not very sensitive to changes in the prior odds or base rates The present research shifts the focus to the likelihood ratio and considers whether people's intuitive judgment about the strength of incoming evidence will also violate Bayesian standards Specifically, people may be overly sensitive to P(E|H) and insufficiently sensitive to P(E|-H)

Overview and Method

This experiment tested the hypothesis that people are overly sensitive to P(E|H), the numerator of the likelihood ratio when making judgment about strength of probabilistic evidence As seen in the examples above, assessing diagnosticity based solely on the numerator of the likelihood ratio P(E|H) can lead to situations in which weak evidence is regarded to be strong and strong evidence is regarded to be weak

Subjects and Procedure

The participants in this experiment were 140 students in various marketing classes at the University of Texas at Austin They received extra credit toward their course grades for their participation This study was run over a two day period Subjects were run individually in groups of around 30 students Subjects were given two other unrelated experiments along with this experiment The experimental session lasted about 30 minutes

Materials

A single page (See Figure 2) on which the instructions, background, and questions were printed served as the materials for this study Subjects read about a virus among African tribesmen and were asked to identify the probability that a researcher contracted the virus in light of certain probabilistic information There were three versions of the study Version A, Version B, and Version C

As seen in Table 1, Version A contained a relatively high LR numerator and denominator (7, 5), and Version C contained a relatively low LR numerator and denominator (3, 005) Version B contained moderate values of the LR numerator and denominator (5, 05) The last column in Table 1 shows the strength of the evidence as given by the LR Notice that Version A contains the weakest evidence of the three despite having the largest P(E|H) value Version C contains the strongest evidence despite having the smallest P(E|H) If as predicted, people tend to judge the strength of evidence by focusing attention on P(E|H) rather than on

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$P(E|H) P(E|-H)$, then the assessed evidence strength will follow the pattern Version A>Version B>Version C instead of the normative, or statistically correct, pattern Version C>VersionB>Version A

In order to ascertain the evidence strength that the subjects assessed, some algebraic manipulation had to be conducted The experiment did not directly ask for the evidence strength for the reason that subjects might confuse evidence strength with the posterior probability Instead, the experiment asked for the subjects' prior odds and posterior probabilities With those two pieces of information, subjects "implicit" LRs could be determined using the equation

$$LR = P(E|H)/P(E|-H) = (P(H|E)/P(-H|E)) * (P(-H)/P(H)) \qquad (2)$$

Instructions Please read the information and answer the corresponding questions in sequential order There are no right or wrong answers

Part I

Dr Howard Johnson, professor of anthropology at Minnesota University, received a large government grant to conduct research on the effect of various environmental and dietary changes on the red-spotted lizard In order to conduct his research, Dr Johnson decided to make a one month journey to the Mozambique jungle in Africa, where the lizard was originally discovered

Weeks after Dr Johnson's departure, his wife read about a rare virus that was found to have killed some tribesmen in South Africa -- 8,000 miles from Mozambique jungle Because the virus was spreading at such a low rate and the Mozambique jungle was far from South Africa, most experts believed that there was only a very small chance that the virus would spread to Mozambique within the next year On the other hand, all experts acknowledged that little is known about the virus and that it should not be taken lightly

Question 1 Given the information above, what would you say is the probability that Dr Johnson will contract the virus? _______%

Part II

Dr Johnson's wife decided to conduct some investigation on her own What were the symptoms of the virus? If her husband showed the proper symptoms, would that necessarily mean he contracted the virus? So the wife put her "Investigator" hat on and got to work

After some investigation, Dr Johnson's wife learned that the primary symptom of the virus was a serious rash Available data revealed that 70% of the South African tribesmen who had the virus had a serious rash However, 50% of the tribesmen who did not contract the virus also had signs of a serious rash

After Dr Johnson returned from his trip, his wife noticed that he had a serious rash

Question 2 Given that Dr Johnson had a serious rash, what would you say is the probability that he contracted the virus? _______% A

Figure 2 Experiment, Version A

Table 1 P(E|H), P(E|-H), and Likelihood Ratios of Versions A, B, and C

Version	P(E|H)	P(E|-H)	Likelihood Ratio (i e , Evidence Strength) P(E|H)/P(E|-H)
A	7	5	1 4
B	5	05	10
C	3	005	60

The normative evidence strength, as measured by the LR, is A<B<C

Results

As predicted, subjects assessed the strength of the evidence in the three versions in the pattern Version A>Version B>Version C This pattern was identical to the pattern of P(E|H) values However, this pattern was precisely the opposite of the pattern given by the likelihood ratios This supports the prediction that people's judgments about the strength of evidence are influenced more by P(E|H) values (i.e., LR numerators) than by P(E|H)/P(E|-H) (i.e., LRs). Figure 3 shows that the average assigned evidentiary strength values for Version A, B, and C respectively were 26.14, 8.59, and 4.78 whereas the normative evidentiary strength values are 1.4, 10, and 60 respectively. Note that as the evidentiary strength values rise, subjects assign declining evidentiary strength values because of their focus on the declining LR numerator.

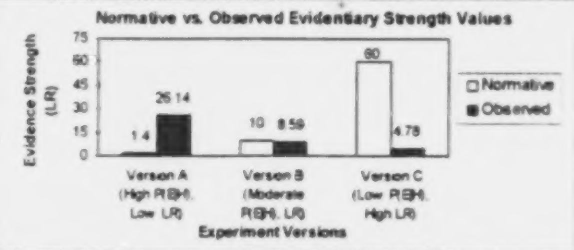

Figure 3. Confirmation of Over Sensitivity to LR Numerator

A t-test comparing the means of Version A and Version B revealed that these means were significantly different, $t(88) = 2.235$, $p<.02$ ($M_{Version A} = 26.14$, $M_{Version B} = 8.59$), while the t-test comparing the means of Version B and Version C did not reach significance, $t(88) = 1.415$, $p<.2$ ($M_{Version B} = 8.59$, $M_{Version C} = 4.78$). Though the comparison between Version B and Version C did not reach significance, the data in Figure 3 show that the assessed evidentiary strength values in Version B and Version C are in the direction that the hypothesis suggests. Perhaps with more data, significance between these two means can be reached as well.

CONCLUSION

The results of this experiment support the hypothesis that people focus on P(E|H) values when assessing the strength of evidence, rather than on the LR, P(E|H)/P(E|-H). When large P(E|H) values were combined with large P(E|-H) values, the strength of the evidence was low. However, subjects in this study judged the strength to be high, reflecting a focus on P(E|H) at the expense of P(E|-H). Likewise, when P(E|H) values were low and combined with low P(E|-H) values, the strength of the evidence was high. Subjects judged the strength to be low, reflecting a similar focus on P(E|H) at the expense of P(E|-H).

Though Bayesian analysis is counter-intuitive to many individuals, fallacies such as inattention to base rates, inattention to P(E|-H), and excessive attention to P(E|H) can lead to astonishing statistical implications and poor judgment and decision-making.

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REFERENCES

Doherty, M.E., Mynatt, C.R., Schiavo, M., & Tweney, R.D., 1979. Pseudodiagnosticity. Acta Psychologica, 43, 111-121.

Doherty, M.E., & Mynatt, C.R., 1990. Inattention to P(H) and to P(D|-H): A Converging Operation. Acta Psychologica, 75, 1-11.

Koehler, J. and Saks, M., 1991. What DNA "Fingerprinting" Can Teach the Law About the Rest of Forensic Science. Cardozo Law Review 13, 361-372.

Koehler, Jonathan J., 1992. Probabilities in the Courtroom: An Evaluation of the Objections and Policies. Handbook of psychology and law, 167-184.

Koehler, Jonathan J., 1993. The Influence of Prior Beliefs on Scientific Judgments of Evidence Quality. Organizational Behavior and Human Decision Processes, 56, 28-55.

Lyon, T. and Koehler, J., 1996. The Relevance Ratio: Evaluating the Probative Value of Expert Testimony In Child Sexual Abuse Cases. Cornell Law Review, 1-49.

Root-Bernstein, Robert S., 1990. Misleading Reliability. The Sciences, 30, 6-8.

Wagenaar, Willem A., 1988. The Proper Seat: A Bayesian Discussion of the Position of Expert Witnesses. Law and Human Behavior, 12, 499-507.

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Proceedings — NCUR XI (1997)

Solitary Confinement
A Study of Prisoners' Access to the News Media

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BACKGROUND

In 1994, there were more than one million prisoners in United States' correctional facilities (Statistical p.219). It is a collection of people comparable to the population of several small countries including Gabon, Swaziland and Oman. Of that number, more than 90 percent were inmates at state institutions, while the remaining 80,000 served their sentences in federal prisons (Statistical p.219).

In late 1995, the California Department of Corrections enacted an emergency ban on face-to-face interviews with prisoners by anyone other than family, clergy or the inmates' attorneys. The media's glamorization of prisoners and prison life, as well as the inherent safety compromises of such reports, were given by the CDC as the reasons for the ban (News p.12). Following more than a year of administrative wrangling and public hearings, the ban remains in effect. Some California lawmakers are now moving to enact legislation to prevent the permanent adoption of the proposed CDC regulations (Lawrence).

In Pennsylvania, the story has been much the same. Effective on November 11, 1996, all face-to-face interviews with prisoners were banned. In addition, all recording devices, including cameras and tape recorders, were prohibited (Commonwealth).

In both states, prisoners must now write or call collect to contact the media. In order to meet journalists face-to-face, inmates must place them on their personal visitation list -- a painfully slow bureaucratic process. Yet, journalists in Pennsylvania should rejoice because they can continue to enjoy the luxury of bringing a pencil and paper to their meetings with inmates (Commonwealth). In California, reporters can bring nothing (News p.13). They must write their stories completely from memory.

CASES

Contrary to what many Americans believe, prisoners have rights. They do not lose all of their rights when they commit a crime or serve their sentence. "A prisoner retains all the rights of an ordinary citizen except those expressly, or by necessary implication, taken from him by law" (Coffin v. Reichard, 143 F.2nd 443, 444-445). In case after case, courts have recognized that prisoners retain constitutional protections despite their confinement (Cooper v. Pate, 378 U.S. 546, Brown v. Peyton, 437 F.2nd 1230, Bell v. Wolfish, 441 U.S. 520, Turner v. Safely, 482 U.S. 84). One of their protections is embodied in the First Amendment right to free speech.

In 1974, the Supreme Court heard arguments for several cases that went a long way in shaping prisoners' First Amendment rights, as they pertain to inmates' access to the news media. In the first of these cases, Procunier v. Martinez, 416 U.S. 396, the Supreme Court established a strict scrutiny test designed to insulate inmates' rights from unwarranted government intrusion. However, the initial fortified protection of prisoners' rights provided by this ruling would be confounded and eventually rendered nearly meaningless. The confusion following Martinez began with Pell v. Procunier, 417 U.S. 817, and was finally resolved, to the dismay and protest of journalists, in Thornburgh v. Abbott, 490 U.S. 401.

In Martinez, several prison inmates brought a class action against Procunier, then director of the California Department of Corrections. Among other grievances outlined in their complaint, the prisoners challenged the censorship of prisoner mail by the CDC. The correspondence of these inmates with other inmates and with the outside world, other than their attorneys and public office holders, was subject to prison censoring. Moreover, prison rules defined letter writing by prisoners as "a privilege, not a right . . ." and discouraged written letters which "unduly complain" or "magnify grievances." In addition, prison rule flatly prohibited writings that were politically, racially or religiously inflammatory, as well as letters received by the inmates which "pertained to criminal activity, are lewd, obscene or defamatory, contain foreign matter, or are otherwise inappropriate" (416 U.S. 396-400.) Protecting the prisoners' First Amendment rights, the District Court found for the prisoners and enjoined further censorship. The Supreme Court affirmed the District Court's decision.

Justice Powell, writing for the Court, began by asserting that the Court should avoid acting as prison administrators. However, Powell justified the Court's review of the case. "When a prison regulation or practice offends a fundamental constitutional guarantee, federal courts will discharge their duty to protect constitutional rights" (Id., at 405-06). This is an important point which clearly defines the Court's role as a judicial arbiter and protector of the people's fundamental rights from unwarranted governmental intrusion.

In his opinion, Powell defined the issue before the Court as one centering on the appropriate standard of review for censoring prisoner mail. In defining the issue before the Court, Powell admitted that the courts had been less than consistent in their decisions on the appropriate "standard for testing the constitutionality of prisoner mail censorship ... Our task is to formulate a standard of review for prisoner mail censorship that will be responsive to these concerns" (Id., at 407).

In doing so, the Court began by recognizing that it was not just the rights of prisoners that were being invaded, but also those with whom they were corresponding. In effect, censorship of prisoner mail restricted the First and Fourteenth Amendment rights of the persons outside of the prisons who received the inmates' letters (Id., at 409). The rights of these individuals, the Court said, must be weighed against the interests of the government. As a penal institution, the Court recognized several governmental interests, including "... the preservation of internal order and discipline, the maintenance of institutional security against escape or unauthorized entry, and the rehabilitation of the prisoners" (Id., at 412).

By balancing these interests against each other, the Court developed a test. "First, the regulation or practice in question must further an important or substantial governmental interest unrelated to the suppression of expression." The interests the Court previously defined were security, order and rehabilitation. And, "second, the limitation of First Amendment freedoms must be no greater than is necessary or essential to the protection of the particular governmental interests involved" (Id., at 413.) Thus, by using this test to affirm the Appellate Court's decision, the Supreme Court determined that the government failed to demonstrate the need to censor prisoner mail to preserve security, order or rehabilitation. In short, the prison regulations were too broad.

The Court decided another closely related case just months after the Martinez ruling. In Pell v. Procunier, 417 U.S. 817, several journalists and inmates again brought suit against the CDC for a ban on face-to-face interviews with prisoners. Justice Stewart, writing for the Court, began where Martinez had left off -- by balancing the institution's penological interests against the inmates' rights (Id., at 822). The Court went on to determine that because Martinez protected letters written by prisoners to journalists, a ban on prison interviews did not interrupt the flow of information. "Thus, it is clear that the medium of written correspondence affords inmates an open and substantially unimpeded channel for communication with persons outside the prison, including representatives of the news media" (Id., at 824). Moreover, the Court asserted that the press had no greater right to conduct interviews with inmates than did the public (Id., at 831).

Thus, the majority opinion in Pell was a setback for journalists, prisoners and the public. Still, there was some solace in the dissenting opinion of Justice Douglas, who was joined by Justices Brennan and Marshall. In the dissent, Douglas began by challenging the Court's treatment of prisoners' rights. "Prisoners are still 'persons' entitled to all constitutional rights unless their liberty has been constitutionally curtailed by procedures that satisfy all the requirements of due process ..." (Id., at 837). He further criticized the decision in light of the necessary role of the press to act as the eyes and ears of the public, especially where the government is concerned. Douglas quoted from his dissent in Branzburg v. Hayes, "The press has a preferred position in our constitutional scheme ... to bring fulfillment to the public's right to know. The right to know is crucial to the governing powers of the people" (408 U.S. 665, 721). Therefore, the press has a responsibility to provide information to the people. As Douglas states, certainly crime and the country's penal institutions, which are supported by public tax dollars, are of interest to the people (817 U.S. 840). In essence, Douglas stated that restricting the flow of information from prisoners curtails the power of the people.

The Court's decision was criticized further in Powell's dissenting opinion in a case decided on the same day as Pell. Saxbe v. Washington Post Co., 417 U.S. 843, was a case similar in fact to Pell, which is the reason Powell applied his dissent to both Saxbe and Pell.

Saxbe was a case brought specifically by the media, which challenged regulations that prohibited inmate interviews at federal medium and maximum security prisons. The Court again avoided nailing down a standard of review for prisoners' rights by deciding the case based on the principle that the media have no greater right of access to prisons than the public.

Powell, joined by Brennan and Marshall, found that the Court's decision allowing a ban on media interviews with prisoners "impermissibly burdens First Amendment freedoms" (Id., at 850). Powell began by recognizing the importance of face-to-face interviews with inmates. Personal contacts with inmate sources facilitates a reporter's evaluation an inmate's credibility. Powell added that alternatives to interviews were not comparable. ". . . [C]orrespondence is decidedly inferior to face-to-face discussions as a means of obtaining reliable information about prison conditions and inmate grievances" (Id., at 855).

Perhaps more important to journalists, Powell criticized the Court for essentially allowing any governmental restriction on press access to information. In Branzburg, Powell argued that while the Court held that there was no First Amendment right to gather news, the Court also recognized that the government cannot broadly restrict the media from obtaining newsworthy information (Id., at 859).

Similar to Douglas' dissent in Pell, Powell asserted that the public has a genuine interest in the conditions and operations of prisons. "What is at stake here is the societal function of the First Amendment in preserving free public discussion of governmental affairs" (Id., at 862). In other words, Powell stated that a Core Value of the Constitution was at stake in this case -- the right of the public to openly and freely criticize the government.

Powell went on to define the press as "agents of the public at large" (Id., at 863). Thus, the press facilitates the exchange of ideas, especially in areas not easily accessible to the public. "For good reasons, unrestrained public access is not permitted. The people must therefore depend on the press for information concerning public institutions" (Id., at 864).

In further distancing himself from the Court, Powell stated that restrictions on First Amendment rights must be "applied in light of the special characteristics of the . . . environment" (Id., quoting from Tinker v. Des Moines School District, 393 U.S. 503). It was the same position that the Court had considered in deciding Martinez. Thus, Powell was relying on the strict scrutiny test established by Martinez. Yet, according to the Supreme Court, the lower courts had applied the wrong standard to this case.

To this point in case history, the Court's decisions in Martinez, Pell and Saxbe had guaranteed little more than confusion on the part of prisoners, journalists and prison administrators alike. Though it was understood that journalists, like the public, did not have a right to interview specific inmates, it remained unclear under which, if any, circumstances inmates had access to the media. The decisions in Turner v. Safely, 482 U.S. 78, and Thornburgh v. Abbott, 490 U.S. 401, would clear up the confusion, but also declaw the strict scrutiny standard established in Martinez to protect prisoners' First Amendment rights.

In 1987, Turner took the bite out of the strict scrutiny standard by developing a "reasonably related" standard. Specifically, the Court permitted prison regulations that infringe on prisoners' constitutional rights so long as those rules are reasonably related to the penological interests of the institution, which Martinez had identified as security, order and rehabilitation (482 U.S. 78). In this case, the Court's decision meant that a Missouri prison could prohibit inmate-to-inmate correspondence based on a four-part test. For a regulation to be reasonably related to a governmental interest: 1) the rule must be rationally connected with the interest; 2) there must be an evaluation of other alternatives; 3) the regulation must have an insignificant effect on the prison environment; and 4) "the absences of ready alternatives is evidence of the reasonableness of a prison regulation" (Id., at 89-90).

The decision in Turner was applied to Abbott in 1989. The prisoners in Abbott challenged the constitutionality of prison regulations that censored incoming publications. Again, the Court held that such regulations were "reasonably related to legitimate penological interests" (490 U.S. 404). The Court further explained that the cases following Martinez, including Pell and Saxbe, specifically dealt with prisoners' rights, and that in those cases, a reasonableness standard applied (Id., at 409). The split five-to-four Court went on to say that Martinez tied the hands of prison administrators in a way that jeopardized safety and security at prisons. Moreover, the Court stated that Martinez was decided in favor of the inmates because outgoing mail posed on threat to the prison's security, order or rehabilitative goals (Id., at 411).

In short, the Court explained that the reasonably related standard applied to prisoners' incoming correspondence and contacts, which included media interviews. The least restrictive means test of Martinez now only applied to prisoners' outgoing mail, or an inmate's access to the media. Thus, in 1974 what seemed to be a strict standard thoughtfully designed to protect prisoners' rights, was now a bifurcated analysis that granted broad regulatory powers to administrators and left inmates with only a single guaranteed form of uncensored communication with the media -- outgoing letters.

ANALYSIS

Though the resolution of any legal challenges to Pennsylvania's and California's regulations is far down the road, it is possible to predict the outcome. Unfortunately, based on the Court's decisions, it would appear that the regulations could stand the test of the reasonably related standard established in Turner. The Court essentially balanced away prisoners' rights.

However, there remain larger issues that the Court has side-stepped in case after case. Powell addressed some of these issues in his dissents in Pell and Saxbe, but the arguments he made are the same ones put forward for centuries by scholars of democracy and the public.

Jurgen Habermas has researched and written extensively on the role of the public sphere within a capitalistic society. A tenet of his theory of "public" is openness and access. The media play a pivotal role in society by providing information to the people. Powell expressed this thought in Saxbe when he defined the media as an "agent of the public at large" (417 U.S. 863). Thus, the news media serve a specific role -- informing the public.

There is constitutional support for Habermas' theories. Benno C. Schmidt Jr., provides a constitutional perspective which asserts that the First Amendment is saturated with laissez-faire thinking. The First Amendment was a protection for the public against government. It was written by colonists who had felt the tyranny of government and who wanted to preserve the free exchange of ideas. Schmidt refers to this sense of liberty, as manifested in the Bill of Rights, as "negative controls on official power. Consequently, the First Amendment has been viewed in negative terms: a constitutional prohibition on official interference with the free play of ideas" (Schmidt p.29). It is the same principle espoused by the Court first in New York Times v. Sullivan and later in Garrison v. Louisiana. "The First and Fourteenth Amendments embody our 'profound national commitment to the principle that debate on public issues should be uninhibited, robust, and wide-open, and that it may well include vehement, caustic, and sometimes unpleasantly sharp attacks on government and public officials' " (379 U.S. 64, 74-75, quoting from 376 U.S. 254, 270).

Censorship of inmates and the subsequent lack of information transmitted to the public serves as an example of one of Habermas' harshest criticisms of the constitutional state. He argues that the constitutional state emerged from absolutism, but operated as a tool of the bourgeois to link the government with the people. Thus, the constitutional state became "an organ of the state so as to ensure institutionally the connection between law and public opinion" (Habermas p.81). In this transformation, the public sphere became what it was trying to avoid -- an arm of the government. "In accord with its own intention, public opinion wanted to be neither a check on power, nor power itself, nor even the source of all powers" (Habermas p.82). By denying prisoners' access to the news media to air their grievances, the government's actions are tacitly consented to by a public ignorant of the real facts.

Inmate interviews are so important to the press because correspondence and telephone calls are insufficient for reporting purposes. Just the opposite, confidential, face-to-face interviews with prisoners would facilitate accurate reporting by journalists. Yet, it is this type of fact-finding that Habermas states has been avoided by the constitutional state from its inception. Without openness the bourgeois constitutional state could not exist because it relied on the principle that all human beings belonged to it through informed, relevant public discourse. "The public sphere of society stood and fell with the principle of universal access" (Habermas p.85). Because prisoners retain their First Amendment rights, they rightfully should be members of the public and participate in its discourse.

Critics of Habermas also provide support of inmates' access to the news media. Kenneth Baynes argues that Habermas' writings have been surpassed by the communications revolution. The evolution of journalism and communication has left it almost impossible for everyone in the public to have access or be heard. Instead, Baynes sees free and equal public discourse as possible within a network of institutions that include the mass media, legal argumentation and legislative debate. "In this model of the public sphere responsibility for the formation and articulation of public opinion or the 'public will' is not localized within any one institutional complex . . . but is dispersed throughout a vast communicative network" (Baynes p.323). However, if Baynes' theory holds, only attorneys, who have special privileges to meet with inmates, can ensure public discourse on the issue.

Continuing in his critique of Habermas, Baynes argues that as large media conglomerates continue to absorb more newspapers and television stations, the government should act to limit

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one-dimensional reporting. Instead of restricting the media through regulation, Baynes calls on First Amendment rights to secure "more equitable access to communication resources" (Baynes p 323).

C. Wright Mills offers a similar perspective on society, while also further explaining causes and effects of the elite-class power component. Like Habermas, Mills holds that access to the media defines which groups are heard and which groups are not. Mills argues that such "opinion-making" becomes a key element of "power-holding" and "power-getting" (Mills p 310). Thus, controlling those who are heard, as well as what they say, is at the heart of the elite's objectives.

Using Mills' theories of mass society, it is easy to apply his principles to prisoners and the media. In short, inmates represent a public in Mills' mass society that is not heard because of decisions made by the politically elite. In fact, part of Mills' definition of a public holds that an opinion "... finds an outlet in effective action, even against -- if necessary -- the prevailing system of authority" (Mills p 303-304). Thus, by definition and parallel to the logic of Habermas' writings, because prisoners are being denied access to the media, they are being denied their public status.

The revered political thinker Thomas Hobbes would likely agree with Mills and Habermas. Hobbs writes that literally every man holds some power. "The power of a man, (to take it universally,) is his present means, to obtain some future apparent good" (Hobbes p 150). He goes on to write that a person's means include his intelligence, ability and resources. For prisoners and the public alike, the media are a resource -- a resource they are denied.

CONCLUSION

Citizens have the right to free expression. As set forth by the United States Supreme Court, prisoners have rights too. Until very recently their rights were protected and prisoners, for the most part, enjoyed free expression.

This freedom of expression is important not only to prisoners as individuals, but to the public as a whole. The public includes everyone, with each person having the opportunity to become part of the public sphere. The public sphere demands something more, at the very least a commonality. This consensus is not on an issue, but on the ability to debate and discuss the issues. More importantly, the ability to debate and discuss the issues is manifest in access to the media. It follows logically that if the news media promote or at least provide a means of conveying information for public discourse, those portrayed in the news media lead the discourse. Thus, if a person, a prisoner, is denied access to lead the discourse in the media, that person is denied a position in the public sphere to debate and discuss the issue. Consequently, the public sphere immediately ceases to exist because the discussion has been limited. The rest of the public may not even realize that the public sphere has been terminated. No news is not good news. Silence, or censorship, is anti-democratic.

REFERENCES

Baynes, Kenneth. "Communicative Ethics, the Public Sphere and Communication Media." Critical Studies in Mass Communication. 11 (1994): 315-326.

Commonwealth of Pennsylvania. Department of Corrections.

Habermas, Jurgen. The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society. Trans. Thomas Burger and Frederick Lawrence. Cambridge: MIT Press, 1994.

Hobbes, Thomas. Leviathan. Ed. C.B. MacPherson. London: Penguin Books, 1985.

Lawrence, Steve. "Lawmaker, Press Groups Trying to Overturn Interview Restrictions." Associated Press 26 Feb. 1997.

Mills, C. Wright. The Power Elite. New York: Oxford University Press, 1956.

"Prison Officials Suspend Face-to-Face Interviews." News Media & The Law. Winter (1996): 12-13.

Schmidt, Benno C., Jr. Freedom of the Press vs. Public Access. New York: Praeger Publishers, 1976.

Statistical Abstract of the United States. 1996: 219.

The Conveyance of Socioemotional Cues in Computer-Mediated Communication: A Content Analysis of Internet Relay Chat

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Computer-mediated communication (CMC) is a relatively new communication technology, yet its ability to transcend both time and geographical distance creates an increasingly important role for computers in human interaction. Text-based CMC such as that used in Internet Relay Chat (IRC) is different from face-to-face interaction in that only keyboard characters can be used to convey messages which are typically conveyed using spoken words, paralinguistic cues, and nonverbal behaviors in face-to-face communication.

This study examines how users of IRC, a well-established social form of synchronous CMC, have adapted to the narrow bandwidth of the medium. 34% of IRC messages contained textual representations of socioemotional cues such as emoticons or typographical icons commonly known as smileys, and textual representations of paralinguistic cues as well as textual references to users performing real or virtual actions. These cues not only help maintain a social environment, but also allow for the emergence of a community of users who employ the cues to help create shared meaning among IRC users. The mere fact that IRC users consider themselves to be a "community" indicates that CMC cannot be a completely impersonal form of communication.

BACKGROUND

The advent of personal computers and local computer networks interacting to form a global computer network (the Internet) has revolutionized human communication by allowing people to transcend space and time by using computers as the medium for their messages. This new communication technology of computer-mediated communication (CMC) is becoming more widely used around the world every day. Although CMC provides a new medium for communication, it does not closely resemble face-to-face interaction. In face-to-face interaction, numerous channels exist for conveying information. Such an interaction provides information through the spoken message, paralinguistic cues, and nonverbal behaviors. Text-based CMC, however, only has the use of keyboard characters to convey the same message. Because this form of CMC relies solely upon text, it is said to have fewer channels through which information can be exchanged and has a more narrow bandwidth available for exchanging information than in face-to-face interaction.

Up to this point in time, a majority of scholarly CMC research has dealt with task-oriented situations and organizational environments (Sproull and Kiesler, 1986; Nickerson, 1994; Rice and Case, 1983). This research has also been conducted primarily on asynchronous CMC such as electronic mail where messages are sent electronically between computers while the addressee is not necessarily online at the same time (McCormick and McCormick, 1992; Sproull and Kiesler, 1986; Walther and Burgoon, 1992; Nickerson, 1994; Rice and Case, 1983). Because of the focus of research on task-oriented CMC, the ever-growing realm of social CMC remains essentially unstudied. While several previous studies (Walther and Burgoon, 1992; Rice and Love, 1987; Walther, 1992) searched for socioemotional cues and relational information in task-oriented environments, social CMC environments have not been studied for these cues. Socioemotional cues contain information about the expression of emotion, the relationship between "speakers," an action, or basically any reaction to a message. In face-to-face communication, these messages are expressed through channels unavailable to CMC users. Rather than examine a task-oriented environment, this study focuses on how people using synchronous communication incorporate these cues into the text-based messages to create and maintain a social environment.

The purpose of this study is to examine how users of a well-established social form of synchronous computer-mediated communication, Internet Relay Chat (IRC), have adapted to the narrow bandwidth of the medium and are able to portray relational information in a text-based medium. Synchronous CMC is most similar to face-to-face conversation in that users are logged onto the program at the same time and interact in "real time" using the keyboard as the mode of expression.

Chatlines—also known as chats—such as IRC are only one form of CMC, but they are used primarily for social purposes. Chats are multi-user programs which allow users to log onto the program simultaneously and interact with other users who are also online. Because these programs facilitate large numbers of users, the program is divided into channels. Channels are typically used for the discussion of certain topics. Chats like IRC usually have hundreds of possible channels. Some of these channels are continually in use, while others appear for a specific discussion and disappear once the discussion is done or no users remain on the channel. In IRC, a user does not see any of the interactions on the IRC program until the user joins a channel. Once a channel is joined, the user can see the conversation on that channel and can participate in the exchange of messages. Each of these messages is preceded by the user name.

Most chat programs ask for a user name. In IRC a user name is called a nickname or a nick and can be changed at any time. The name can be up to nine characters long and is usually a meaningful representation of what the user wants other users to know about him/her since that is

542

what the user is known by during the chat session. Nicknames, like the CMC environment, conceal information about the user's appearance, social class, age, and even gender. This anonymity allows users to experiment with portraying themselves however they want to be perceived. Judgments about the user can only be made based on what is revealed. For this reason, IRC becomes an identity playground and a virtual reality.

Because of the anonymity offered by CMC and its global connections to the Internet, people are interacting with others whom they have never met in person. Outside of the business world where letters and phone calls are made to strangers as a matter of practice, social relationships are now being fostered with strangers in unprecedented numbers (Kiesler, 1987). Kiesler also notes that pen pals and ham-radio operators also make interactional connections with others who are initially strangers, but these interactions are not as easily accessible to such large numbers of people as is the case with CMC. Prior to the advent of CMC, most social correspondence and telephone conversations between individuals occurred as the result of first knowing the person in another context, usually face-to-face communication.

In addition to the infinite possibilities for portraying oneself differently, IRC is also relatively unique because it is a noncommercial form of multi-user synchronous communication which has links in many different countries across the globe. Because of the number of IRC users (the system supports several thousand users at any given time), channels are a necessity. Channels, however, are not the only way that chaos is avoided. Two measures have been instated by the using community. "Firstly, users of IRC have devised systems of symbolism and textual significance to ensure that they achieve understanding despite the lack of" a broader bandwidth in other forms of communication. "Secondly, a variety of social sanctions have arisen amongst the IRC community in order to punish users who disobey the rules of etiquette—or 'netiquette'—and [to preserve] the integrity of those shared systems of interpretation" (Reid, 1991 no pag).

METHODOLOGY

This study consists of a content analysis of sixteen IRC logs recorded between October 22 and November 4, 1995 which are used to examine how users of a social form of synchronous computer-mediated communication, Internet Relay Chat, portray socioemotional cues in a text-based environment. These excerpts were collected from four IRC channels with at least two excerpts being taken from each channel. The unit of analysis is syntactical because the logs were searched for individual symbols or types of messages that could be determined from the textual message. The total number of messages exchanged in each log was tabulated and the frequency of socioemotional cues from each of the four categories calculated.

The content categories were inductively deduced from the socioemotional cues detected in the texts with the cues being sorted into the following categories: emoticons, emotional content displayed between asterisks, usage of the /me command, and paralinguistic. Emoticons are textual icons that convey emotional states and emotional content occurring between asterisks are textualized socioemotional responses. The /me command is a faculty of IRC. When the /me command is used, the user types /me followed by a message depicting an action (Hoffman, 1995 p.45). The message appears on the screen following an asterisk with the user name followed by the message. Thus, typing /me goes to bed becomes *<username> goes to bed. The category of paralinguistic cues includes vocalizations such as um, hmm, and laughter as well as emphasis on words or phrases which is depicted through the use of capital letters, the use of multiple vowels to indicate inflection, and the use of multiple punctuation marks at the end of a message. Once the four content categories were created, the data was then quantified by counting the number of times each type of message appeared.

RESULTS

There are thousands of channels on IRC. This study only examines excerpts from four IRC channels: #lonely, #love, #hottub, and #germany. In essence, the name of a channel attempts to sum up the channel topic. Overarching channel topics, however, only give a general idea of what type of communications are appropriate on that channel. The specific discussion topics within a channel change frequently, and the actual discussion may not correspond with the channel topic which is displayed to a user joining the channel. Channel operators or "chanops" are able to change the topic on the channel at any time. Different channels, as well as different topics, influenced the number of socioemotional cues displayed during a conversation.

After examining the results from the sixteen IRC texts, it is obvious that patterns of use for all four of the categories of socioemotion occur within the IRC environment since approximately 34% of all messages exchanged contained text that fit into the categories examined. With the exception of only one text, all four categories were represented in the excerpts. Channel #lonely had the overall lowest percentage of socioemotional cues in all four categories. Even though this channel hosted two textual conversations that conveyed particularly low percentages of relational information through the cues studied (9.1% and 16.7%), the remaining texts from that channel also contained low percentages of the use of these cues. Channel #love, even though only two texts were examined, remained relatively consistent in the use of socioemotional cues (30.9% and 31.3%). The #hottub channel, however, fairly consistently contained more occurrences of emotively charged cues. Channel #germany on the other hand, displayed two rather different amounts of relational information. In both excerpts from #germany, approximately the same number of messages were exchanged, but socioemotional cues appeared 25 (17.4%) more times in the second sample. These statistics provide an overall context for the further breakdown of cues into the four categories.

Table 1 shows the frequency of occurrence of the different cues used on the four IRC channels as a whole from which data was analyzed. The number of occurrences is followed by the percentage of messages in which these cues appeared.The category of emoticons represents the number of textual icons that appeared. The /me command tells how frequently messages of personal action occurred when IRC users typed their message following the command /me. The asterisks category displays the occurrence of actions appearing between two asterisks in the IRC log. The last category, paralinguistic, shows the number of times paralinguistic cues were typed into the text. The reason that equivalent occurrences in different texts produce unequal percentages and vice versa is because each excerpt contained a different quantity of messages.

Table 1: Socioemotional Cues on Each Channel

Channel	Emoticons	/me command	Asterisks	Paralinguistic	Total
#lonely	46 (5%)	47 (5.1%)	27 (2.9%)	106 (11.4%)	226 (24.4%)
#love	42 (9.5%)	36 (8.2%)	8 (1.8%)	51 (11.6%)	137 (31.1%)
#hottub	162 (12.4%)	133 (10.1%)	51 (3.9%)	165 (12.6%)	511 (39%)
#germany	44 (14.4%)	34 (11.1%)	13 (4.2%)	36 (11.8%)	127 (41.5%)

Within these categories, paralinguistic cues or the literal typing out of laughter, pauses, and vocal emphasis occurred most frequently followed by the use of emoticons. In about half of the texts, paralinguistic cues were found most often, while emoticons accounted for the highest count in most other cases. Only in three instances did the /me command appear more times than paralinguistic cues or emoticons within any given excerpt. The display of an action between asterisks was employed significantly less than the other categories. Only in two instances did the use of asterisks surpass the use of other forms of portraying the same information. Of these two instances, one occurred only once more than emoticons and the other only appeared more frequently than the /me command messages.

The consistency with which certain conventions within IRC appeared indicates that the cues these conventions provide are important to the portrayal of socioemotional information. These cues occur in varying degrees, but must be important to the messages since they account for 34% of all of the messages examined.

DISCUSSION

Although more relational information may be shared in face-to-face interaction, this study of IRC shows that socioemotional information can still be conveyed in a synchronous text-based environment. Users of IRC employ several methods by which relational cues are incorporated into the text: emoticons, /me command, actions displayed between asterisks, and paralinguistic cues. The intent of the sender can also be understood through the context provided by previous messages. Of course, there are always misunderstandings, but these also occur in face-to-face communication. Overall, however, these conventions allow for CMC to be used for social purposes while being personal, as well.

Facial expressions are a constant source of relational information in face-to-face conversation. Since emoticons are meant to convey emotions or actions which are portrayed through facial expressions, it is not surprising that they appeared in 10.4% of all messages—the second highest percentage of messages including specific socioemotional cues. In addition to representing facial expressions, emoticons are also easy to create. Most emoticons employ only two or three different keyboard characters in their construction. That makes them easy to place at the end of the rest of a message. Because they are simple to construct and are meant to convey the information that is continual in face-to-face interaction, they become a succinct means for portraying socioemotional information in computer-mediated communication and making the interaction more personal.

Emoticons make the textual conversation more personal by expressing the emotional reaction of a sender either to the sender's own message and/or in reaction to another's message. Occasionally, emoticons comprise an entire message, but they usually conclude another written message. Some of the most common emoticons are simple smileys:

the smiley :) or =) or sometimes : > or =]
the wink ;) (denotes sarcasm)
the frown : (or sometimes : [
and sticking out one's tongue : P

Other variations also occur to present slightly different effects:
a big grin may appear as :))))))) or :):):):):)
noses may also be included using a - or a +
a left-hander may turn a smiley in the opposite direction (: or d:
a smiley may also be turned to provide a better nose (c:
Other individualized emoticons :D :O :P~ 8) !.-)]:> b:) B-)

These are only some of the numerous ways in which IRC users incorporate emotional responses into the dialogue through the use of keyboard art.

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Depending on the nature of the conversation, the /me command is useful for conveying real or imagined actions performed by the user. The /me command can be followed by any verb. In some interactions the /me command is inappropriate because the conversation does not require a great deal of action while other interactions are conducive to the portrayal of personal action. Because the topic of discussion dictates the appropriateness of the /me command, it accounts for percentage differences within the same channel at different times. In addition, since the /me command is not always applicable, it did not appear as often as emoticons of paralinguistic cues which are appropriate in most cases observed during this study.

Here are some examples (as they appeared in the excerpts) of /me commands as they appear on IRC:

*<user> nods off
*<user> contemplates getting out her ginger snaps and milk
*<user> introduces himself to <user>
*<user> hugs <user> goodbye
*<user> tips his hat to the ladies
*<user> bends <user> over the table and gives her a good spanking
*<user> goes to the middle of the room and puts a water pistol to his head
*<user> starts floatin' in the air...
*<user> gives <user> a rose to brighten her day
*<user> pokes <user> with her nose cuz her fingers are bizzy
*<user> takes the duct tape off of <user> mouth..you can talk now
*<user> shakes the stuffin's out of his [IRC] sister
*<user> turns knob on <realname's> head that says "Sense of Humor" to the on position

As can be seen, these responses denote both actual actions of IRC users and metaphorical actions, as well as actions that would be occurring if the interaction were face-to-face. The reference to an IRC sister/brother is similar to several references made on various channels about "familial" relations among IRC users. One user was even preparing to leave Canada for a few weeks to visit his little IRC "sis" in California. It would be the second time they had met face-to-face. Although these /me command messages tend to be used to describe more complex actions, they can also state that the user performs a simple action. These /me commands that suggest hugs, a wink, or laughter, among other simple actions, can also be shown between asterisks in a longer message.

Actions displayed between asterisks tend to display a great deal of relational information since they are most frequently used to "give" different types of greetings. The most common use sends different types of hugs from the normal *hugs* to *bugglehugs* to *tacklehugpouncetickleandlick.* A more conventional form of this last action may be *Tacklehuggies* or *huggerz.* In addition to the hugs, asterisks are used to display a user waving to other users, sneezing, dancing around, and sighing, as well as smiling, winking, and laughing, which are also typically found in the other forms of socioemotional information exchange. Because most actions which are conveyed using asterisks can also be conveyed through emoticons or the /me command, they are not found as often (3.4%) as the other forms of conveying emotion. The advantage of the actions portrayed between asterisks is that they can be inserted into a message which otherwise does not convey the performance of an action where as the /me command requires that the whole message be devoted to the communication of an action. The most common use, however, remains as some form of hug that is sent to another user in greeting.

The last category of socioemotional cues examined in this study are paralinguistic. These cues took two forms: vocalized pauses and utterances, as well as vocal emphasis. These two forms really could have been divided into two separate subcategories under paralinguistic cues and tabulated separately. The first form usually appeared to suggest that the user was thinking about a response. As a result, it was not unusual to find hmm, um, and er typed into the dialogue, along with hahaha or hehehe to express laughter. Thus, using these vocalizations in a typed form helped make the CMC dialogue more similar to actual face-to-face transactions. Awws, uh-huhs, ho hums, naaahs, and shhhs also made it into the conversation. Huh or the use of multiple question marks seemed to indicate that the user did not understand something and was asking for clarification much as one would do face-to-face. Emphasis to messages was also added by using multiple exclamation points. This occurred most frequently in greeting friends who had just joined the channel. Capitalizing words was used to intensify the emotional impact of a word, and extra vowels in a word indicated the drawn out inflection that would be used if actually saying the word in that specific response. All of these vocal variations comprised 12% of all messages in the sample studied. Finding paralinguistic cues in greater frequency than other forms of socioemotional cues is not surprising because verbalized pauses, laughter, and vocal emphasis are a common part of face-to-face interaction. Although vocal variations account for more than 12% of relational message exchange in face-to-face interaction, the occurrence of paralinguistic cues shows that people are finding ways to convey these cues in typed dialogue, too.

The individual occurrence of socioemotional cues, however, is of little importance unless the cues can be brought together within an interaction to create shared meaning among the interactants. The following excerpt is a good representation of how various forms of the socioemotional cues examined in this study (with the exception of the /me command) were incorporated into one social interaction. In addition to being a good example of dialogue on IRC, this excerpt exposes a typographical mistake which turned into fun for other users. Since IRC is completely text-based, word games such as this tend to occur. There may not be such a thing as a literal Freudian slip in CMC, but there are typographical errors that can lead to teasing from other users if the mistake can in any way be misconstrued. One such mistake turned into teasing occurred on channel lonely:

```
<user1> well <user> I didn't learn to drive until 1910
<user1> err ooops 1990
<user2> Hehe..
<user3> hehe
<user3> 1910???
<user4> hahaha..., been lying about your age??
<user3> <user1> is soooooooo OLD
<user3> hehe
<user2> She's been lying about her age.
<user1> hahaha D =]
<user1> it was an error
<user2> Sure <user1>, I believe ya.
```

If CMC were devoid of socioemotional cues, this interaction could not have occurred because the conveyance of humor would be impossible. To understand humor, there must be shared meaning. Thus, IRC users have developed verbal and textual cues which substitute for, but are different from, the shared networks of meaning that occur in face-to-face interaction. Without the textual cues, CMC would be impersonal, but through the use of textual cues as messengers of context cues, humor and personal reactions are able to enter into the computer-mediated dialogue.

CONCLUSION

Even though the socioemotional cues occurred in varying amounts from text to text, the fact that they were present in all of the interactions is of importance. Because these cues served as initiated actions or as reactions to other messages, relational information was able to be conveyed through a completely text-based environment. As Reid puts it, "The IRC community shares a concern for care in nuances of language and symbolism, a realization of the power of language and the importance of social context cues..." (1991 no pag). Thus, those participating in interactions in the synchronous CMC environment of IRC have overcome the impersonal factors of reading an electronically encoded message on a computer screen to create a relational community.

The mere occurrence of a CMC "community" indicates that CMC cannot be truly impersonal. Even with the techniques employed by IRC users, the narrow bandwidth or limited channels of communication in CMC is unable to convey the same amount of relational information as quickly as face-to-face interaction. In addition, these conventions can only convey the information of which the sender is personally aware, since the user is sending a message about a cognitive response. Typographical errors can sometimes be equated to the leakage of information which results from nonverbal signals in face-to-face communication. Some of these differences prevent CMC from being able to convey the same information as face-to-face interactions; however, expecting CMC or any form of communication technology to be equivalent to face-to-face communication seems to follow an irrational line of thought.

This particular study has tried to show that CMC is not necessarily an impersonal form of communication, but is actually an environment in which a social community has thrived for over six years. Because IRC creators and users recognized the need for social context cues, the program incorporates methods of portraying those cues into the vocabulary of IRC users. Thus, IRC helps to show that "the physical environment of IRC may be only virtual, but the emotional aspect is actual" (Reid, 1991 no pag). Reid speaks only of IRC but the implication is that the emotional aspect could be realized within the entire community of CMC users.

REFERENCES

Hoffman, A. (1995). 50 fun ways to Internet. Franklin Lakes, NJ: Career Press.

Kiesler, S. (1987). Social aspects of computer environments. Social Science. 72, 23-28.

McCormick, N. B. and McCormick, J. W. (1992). Computer friends and foes: Content of undergraduates' electronic mail. Computers in Human Behavior. 8 (4), 379-405.

Nickerson, R. S. (1994). Electronic bulletin boards: A case study of computer-mediated communication. Interacting with Computers. 6 (2), 117-134.

Reid, E. M. (1991). Electropolis: Communication and community on internet relay chat [On-line]. Available: http://134.83.112:8080/~cs93jtl/electropolis.

Rice, R. E., and Case, D. (1983). Electronic message systems in the university: A description of use and utility. Journal of Communication. 33, 131-152.

Rice, R. E., and Love, G. (1987). Electronic emotion: Socioemotional content in a computer-mediated communication network. Communication Research. 14 (1, January), 85-108.

Sproull, L., and Kiesler, S. (1986). Reducing social context cues: Electronic mail in organizational communication. Management Science. 32 (11), 1492-1512.

Walther, J. B. (1992). Interpersonal effects in computer-mediated interaction: A relational perspective. Communication Research. 19 (1, February), 52-90.

Walther, J. B., and Burgoon, J. K. (1992). Relational communication in computer-mediated communication. Human Communication Research. 19 (1, September), 50-88.

You Eat What You Are:
An Investigation Of Key Environmental Variables On Food Choice

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Why do people eat what they do? Do we have inborn tastes or are they developed through our socialization process and environmental factors? It is hypothesized that eating behaviors and related food choices are significantly influenced by external factors such as the mass media and peer groups, and that like other learned behaviors, they are difficult to change. This study uses qualitative research techniques to evaluate the relative strength of several key environmental variables on food choices for young women, including different advertising and communication venues and television programming and their related effects on reference group impact.

BACKGROUND

The National Center for Health Statistics (1997), reports that "Thirty-five percent of women and thirty-one percent of men are obese in the United States." The connection between food, nutrition and the media has been demonstrated repeatedly. If people know that media images can lead to over eating or eating "unhealthy foods" then why do people continue to make "bad" food choices? Numerous studies (Sanders, 1995, Martorell, 1996, and Iszler, 1995) have concluded that "food is necessary to sustain life and health." People eat certain foods for a variety of reasons, least which is "good health and nutrition," The concern for good health and nutrition arises from an expanding food environment from which people have to choose. This food environment is often influenced by factors such as politics, poverty, limited personal control, and choice. Food habits are intimately related to our way of life through: values, beliefs, and life situations. Food beliefs may even be generated from misinformation and "fads" rather than sound nutritional knowledge. A person's food habits develop from the environment in which they exist (Williams, 1992).

Food habits are human behaviors which develop from personal, cultural, social, economic, and psychological influences. Habits form through a gradual process of conscious and unconscious learning in which behaviors are reinforced or punished. Culture is a key contributor to the development of food habits through everyday living and family relationships. People learn related behaviors, such as, preparing and serving food and eating rituals, as they mature. A person's behaviors, beliefs and thus culture is also influenced by the media in the form of parent influence or television programming. Images the media portrays have an unconscious effect on the exhibition of food related behaviors (Williams 1992).

In the media there are diverse images of women. The image of beauty is presented as a societal standard. The media has socialized women to believe that their bodies must fit a certain image. As a result, "more than half of all eighth graders in the United States have been on a diet." It appears that society needs to become aware that people's perceptions of diet and nutrition do not always match reality (Editor's Note: Representations of Women in the Media 1997).

According to the Editor's Note: Representations of Women in the Media (1997), different areas of advertising portray women differently. The following examples show the image of women as being tarnished and weakened. In female oriented publications, ads tend to be for beauty products and cleaning products. Women are used to create an image of beauty, attractiveness and elegance so that potential consumers equate these attributes with product usage. Television advertising portrays women as sex objects. Depending upon the target audience, women promote cologne or other 'men's' products, or cleaning supplies for women. Television advertising presents women in a shallow context with goals and inspirations rarely reaching beyond a 'spic n span' clean house or having the hair of "their" dreams. These sort of messages are being sent out to women and men world wide. Women are expected to weigh nothing and to be beautiful (Editor's Note: Representations of Women in the Media 1997).

METHODOLOGY

A qualitative research project was conducted in an attempt to create an objective study on nutritional attitudes and behaviors as influenced by external sources. Research was conducted using four focus groups of young women ages 17 to 22 from a Northeastern women's college. Participants were screened and recruited approximately 1 week prior to the date of the focus groups and mailed a confirmation letter. Telephone confirmation was made one day prior to the scheduled session. A total of 10 to 12 participants were present at each session.

One-hour structured focus group discussions were conducted with freshmen, sophomores, juniors, and seniors. Each session was consisted of two broad sections. In section I, participants discussed their general feelings about nutrition attitudes and behaviors. During section II, family, peer, and media influences were addressed. Focus groups scripts were originally developed and reflected the direct interest of the Northeastern college, a corporate partner, and larger social issues.

KEY FINDINGS

The overall attitudes of participants toward nutrition were neutral. Participants tended to be indecisive when answering questions about nutrition due to confusion over nutritional facts and media messages. For example, they viewed products as unhealthy and then an image portrays healthiness in spite of eating unhealthy products. Participants appeared to experience problems with consistency in their answering patterns when expressing feelings about nutrition and external influences.

Participants expressed negativity toward the media's portrayal of nutrition, health, and image. Participants concluded that the media over emphasizes words, such as "diet" and "thin", to convey messages. Participants felt the media is insensitive toward issues of diversity and generalizes when deciding upon the message conveyed by words and images.

One interesting finding which was consistent across all groups, was the low level of consistency between participant attitudes toward food, health, nutrition and their food related behaviors. Based upon participant comments on the mixed messages received from advertisements, this inconsistency can partially reconciled. Participants tended to feel the media portrayed contradictory images of women on television. For example, the participants saw a thin model eating a bag of chips, this apparent oxymoron may not fool the participants on a cognitive level, they may use these images to ease their conscience as they indulge on foods that are fattening and unhealthy. Thus for many of the participants, they did not think the "bad" food choice would negatively impact their self-image.

Participants noted that healthy and "normal" looking individuals are not seen on commercials. Participants mentioned the Boston Market® commercial as an effective way to show society that consuming food is natural. Participants felt the commercial was able to portray the message that people should be hungry and eat and it is not taboo. On the other hand, while promoting Participants did not feel that the media motivates people to eat healthier or look a certain way. The media tends to cause people to become self-conscious, while showing food commercials to induce hunger.

One positive aspect of nutrition in the media was the amount of nutritional education available to society. Participants felt the media causes society to think about nutrition and health related information frequently and with concern because of commercials on heart disease and health related problems. While being concerned with media images and nutritional information, participants did not view weight as an issue in the nutritional spectrum. Participants were not concerned with media images of weight enough to mimic

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the idealized images on television. They felt the media was not personally attacking them and therefore, did not see the media as having a strong case against being weight related issues.

It is evident that our socialization shapes many aspects of our life. The influences of family and peer groups are noticeable in the way in which society lives and considers everyday issues. The media definitely has an affect on the attitudes of the participants both negatively and positively. The impact of a family or peer group is even stronger, the family or peer groups are able to change the food choice of the participants through words or actions. It has been hypothesized that media has a large influence on the way people feel about nutrition, it has been noted that family and peer groups ultimately have more influence on individuals than the media. The family has a great deal of control over what the participants consume when in their company. Through, this control the family is able to influence the participants food choices. In actuality the participant will eat whatever they are served. Through this forced food consumption the family was able to influence the participants to look and think about food in a different manner. Participants negatively noted, that families and peers do not generally care about the food they consume, but are concerned with nutrition and image. One's family ultimately sends mixed messages in conjunction with the media. These messages perpetuate feelings of unhappiness and discontentment in one's life. The affect the family unit has on the participants is one of actual food choice.

CONCLUSION

The most interesting aspect of the research was the revelation that yes, participants were influenced greatly by the media in terms of eating habits and media images. They identified with wanting to be thin, beautiful and healthy, however, the motivation to change eating behaviors and attitudes was not significant. It seemed that this attitude is not unnatural in today's society. Images of beauty and health are portrayed and longed for by society. People want to look like those on television, but the reality is that they will never live the life nor have the prosperity of these images. It seems that this realization alone discourages society as a whole from pursuing better overall lifestyles. In this research it was evident that participants had problems with images portrayed as well as, nutrition in general. They did not feel there was any way to change the attitudes of society or the images of the media to reduce conflicting messages.

It is necessary to look at the media in an objective manner when dealing with nutritional images. From a health and nutrition perspective, certain recurring patterns, such as idealizing conformity to images, may prove to be interesting. This conformity seems to be a result of status quo. The exaggeration of an 'ideal' body shape seems to imply a necessity to attain a certain form in order to be fashionable, sexy, attractive, and successful. Conscious and unconscious acceptance of these images is a large factor in the lack of motivation to change eating attitudes and behaviors. These images are so overwhelming to society that it seems like an impossible obstacle to even resemble the images on television. This is an unfortunate reality when looking at ways to improve behaviors and attitudes of society with nutrition and food. As long as these media images continue to plague society negatively, whether that be with an obsessive need to be thin or an impossible image to attain, society will not be able to change the way nutrition and health is viewed. Appealing images seen on television are contrasted by society becoming dependent on quick fixes and products.

Family and peer groups influenced the participants more heavily than the media. Personal contact with family members and peers tended to have a greater effect on participants behavior than the media. Participants felt pressured and influenced by family and peers because of their words and actions. Family members were hypocritical and inconsistent in their own nutritional and eating behaviors by example. Families were critical due to self-interests and social status. Participants were bombarded with contradictory images both on television and from family and peers. Participants were socialized to have it all. The messages that were being sent were those of remaining thin without self-discipline. This caused distress for many young women, the pressure they were receiving from their family and peer groups was tremendous. Family, peer and media influences present real choices to society that distract people from making a choice for their own well-being. Let society not become so consumed with other agendas that they forget who is the ultimate decision maker, themselves.

LIMITATIONS AND FUTURE RESEARCH

Given the qualitative nature of this research, there are limitations in terms of generalizability and external validity. The use of a convenience sample and small sample size are both a external validity and generalizability issues.

Currently further research is being conducted on a quantitative level. One issue being investigated is the perception of skinny versus healthy. In further research it will be beneficial to expand on the pilot study by using a co-educational institutions and male population for comparison. The use of a male population will enable the exploration of varying perspectives on nutrition and external influences. Media images should be further investigated. Questions need to focus on the specifics of advertisements and television programming. Consumer attitudes towards product promotion can be explored through the use of product samples or direct marketing techniques. Future research should explore why consumers are discouraged by images in the media and thus, would prefer to make less externally influenced nutritional decisions. A more in depth investigation into external factors, such as, the effect of media images on individual thoughts, feelings, motivations and attitudes regarding nutrition.

REFERENCES

Editor's Note: Representations of Women in the Media. [WWW document]. URL http://www.pomona.edu/REPRES/WOMEN/editornote.html April 15, 1997

Iszler, Jocelyn et. al. "Formative Evaluation for Planning Nutrition Intervention: Results from Focus Groups." Journal of Nutrition Education 27.3 (1995): 127-31

Martorell, Reynaldo. "Role of Nutrition in Economic Development." Nutrition Reviews 54.4 (1996): 66-70.

Sanders-Phillips, K. "Correlates of Healthful Eating Habits." Perspectives in Applied Nutrition 95.5 (1995) 620

Williams, Sue Rodwell Ph.D., M.P.H., R.D. Basic Nutrition and Diet Therapy. St. Louis: Mosby-Year Book, Inc., 1992.

Weight Loss-New insights & Nutritional Therapy. [WWW document]. URL http://nutramed.com/zeno/weightcenter.htm April 20, 1997

The Nurse-Patient Continuum
A Nursing Model

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BACKGROUND

An inductive research process in which case analysis was used to identify phenomena concerning nursing practice was adopted. Each member of the group analyzed three separate and personal clinical cases in which relevant phenomena were identified. Then the phenomena were grouped into concepts and the relationships between the concepts were articulated. Each member identified the commonalties between each of the three cases and discussed patterns that were derived. This process was then conducted in a group setting in which common concepts were identified amongst fifteen different clinical cases (Boak, Dickerson, Jackson, Fabiani, & O'Quinn, 1996). Based on the relationships between the concepts a conceptual model was developed.

The utilization of the inductive research process allowed the development of a conceptual model which could be used to help guide and direct nursing practice, as well as identify theoretical propositions that could be tested. In this paper, the model will be described followed by a discussion of theoretical propositions that have been specified from the nurse-patient continuum model.

NURSE-PATIENT CONTINUUM

The Nurse-patient Continuum was developed by a group of baccalaureate nursing students who designed a model which coincides with Peplau's theory of therapeutic relationships that occur between the nurse and the patient (Forchuk, 1994). The model demonstrates a cyclic process consisting of four wheels being turned by links in a chain (see figure 1). The wheels were labeled as individual constructs: nurse perceptions, nursing care, patient outcomes, and nurse outcomes. Within each construct (wheel) five concepts (links in the chain) were identified: nurse perceptions-spirituality, health status, mental well-being, support systems, and culture; nursing care-support, empathy, therapeutic touch, communication, and compassion; patient outcomes-acceptance, hope, trust, support, and well-being; nurse outcomes-confidence, sense of purpose, growth, competency, and holistic outlook.

The nurse-patient continuum provides a framework for holistic centered nursing care. The nurse's perceptions have a direct impact on the care that is delivered. When these perceptions are positive and holistic-centered, nursing care will eventually empower the patient (Fosbider, 1994). As the patient becomes more empowered this too will impact greatly on the nurse's experience. The result being that growth on the part of the nurse influences the care that will be given to future patients (Bailie, 1996). It is important to note that the continuum can only exist and flow when all the positive components (links) are involved.

Although this may seem extremely simplistic, it is the view of the authors that this is the most forgotten part of nursing care. As healthcare continues to be dominated by politics, insurance companies, and financial issues nurses cannot forget their primary reason for being in healthcare, the patient. Nurses must initially concentrate on their perceptions of the patients for this is what sets the continuum in motion. The more effective the care delivered is the better the patient outcomes will be. The more positive outcomes that are generated on behalf of the patient, the greater the chance that the nurse will experience positive outcomes (Astedt-Kurki, and Haggman-Latide, 1992). As the nurse continues to care for patients, they will learn that each interaction with their patients is an opportunity for growth as well as an increase in their competency, confidence, sense of purpose, and view of holistic health. These implications are crucial to quality care and the advancement of the nursing profession (Styles, 1991).

THEORETICAL PROPOSITIONS

The nurse-patient continuum is not only able to be used as a basis for clinical practice but, also allows for the specification of relevant theoretical propositions which can be studied. It is important that issues relevant to nursing's clinical practice be tested. The following theoretical propositions have been identified:

(1) There is a positive relationship between a holistic nurse perception-spirituality, health status, mental well-being, support systems, culture and improved nursing care delivered.

(2) There is a positive relationship between nursing care and patient hope, trust, and support.

(3) There is a positive relationship between patient outcomes such as acceptance and nursing outcomes which include growth and holistic outlook.

CONCLUSION

Through the inductive research process individual case studies were analyzed. Concepts were identified and relationships were articulated. Based on these relationships a conceptual model was developed and theoretical propositions were specified. Through this process, issues relevant to and requiring greater understanding in clinical practice were identified and can now be studied.

REFERENCES

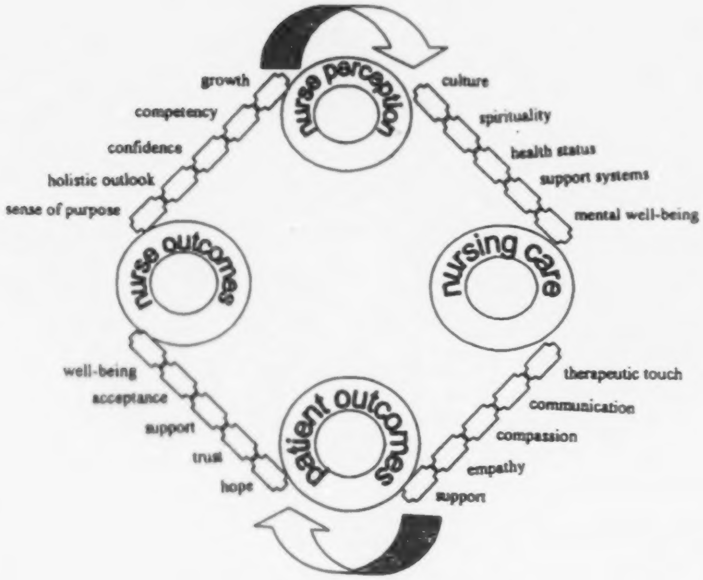
Astedt-Kurki, P. & Haggman-Laitila, A. (1992). Good nursing practice as perceived by clients: a starting point for the development of professional nursing. Journal of Advanced Nursing, 17:1159-99, March.

Bailie, W. (1996). How nurses view emotional involvement with patients. Nursing Times, 92 (9):35-6, February.

Forchuk, C. (1994). The orientation phase of the nurse-client relationship: testing Peplau's theory. Journal of Advanced Nursing, 20:532-37, January.

Fosbidder, D. (1994). Patient perceptions of nursing care: an emerging theory of interpersonal competence. Journal of Advanced Nursing, 20:1085-93, March.

Styles, M. (1991). Ten ways to know if you are getting good nursing care. Nursing and Health Care, 11(6):283, June.


nurse perception
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spirituality
health status
support systems
mental well-being
nursing care
therapeutic touch
communication
compassion
empathy
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patient outcomes
hope
trust
support
acceptance
well-being
nurse outcomes
sense of purpose
holistic outlook
confidence
competency
growth

Figure 1: Nurse-Patient Continuum

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Assessing the Effects of HIV/AIDS Peer Education on High School and College Freshmen

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Despite all the information available today to high school and college students, the number of HIV cases is growing at a deadly rate. The prupose of this study is to determine whether certified American Red Cross HIV/AIDS peer educators are effective in teaching high school and college freshmen about HIV prevention. The Health Belief Model, which focuses on knowledge, attitude, and behavior, provides the framework for the study. An experimentor developed tool of 20 "yes" and "no" questions was developed regarding transmitssion, myths, prevention, and testing. The tool was distributed as a pre-test and a post-test to 67 high school freshmen and 86 college freshmen. Data was analyzed according to the specific categories of the questions. Precentages of correct answers were determined for both groups for each question. Overall, there was an increase in knowledge; however, some minor limitations were noted which could be addressed with later research studies.

INTRODUCTION

Since 1981, society has been facing the epidemic of AIDS. AIDS affects all nations, ethnicities, races, sexes, and ages. According to the Centers for Disease Control and Prevention (1995), the number of reported AIDS cases in the United States by the end of 1995 was 319,849. The key to stopping the spread of HIV/AIDS is to know the essential facts regarding transmission. Integration of essential attitudes, behaviors, decision making and a personal belief system is critical. HIV/AIDS education is becoming more prevalent, as many schools have incorporated HIV/AIDS education into the curriculum as a required class; and in others it has become an elective. The Red Cross is responsible for the creation of peer education regarding HIV/AIDS. Many young people have taken the initiative to become certified to teach HIV/AIDS education in elementary schools and high schools, as well as colleges. The hope for this type of education is that individuals of the same age will be more attentive to the information being presented by their peers.

THEORETICAL FRAMEWORK

The Health-Belief model is a perspective that is based on the relationship between a person's beliefs and actions. Four main factors influence that relationship: age and developmental state, previous experience with illness and health, personal thoughts and goals in relation to health and illness, and the sociocultural influences (Craven and Himle, 1992, 174-175).

This model relates extremely well to this study. HIV/AIDS is almost 100% preventable, but is an epidemic in our country. Knowledge and awareness are what will change actions and behaviors. Knowledge is key in HIV prevention and this model is structured on health and beliefs about one's health. "The health belief model provides insight into the connection between the way a person sees his or her response to health, illness and treatment (Craven and Hirlne, 1992, 174-175)."

EXPERIMENTAL DESIGN

The focus of this research project was to see the effects of HIV peer education using a sample of approximately 80 freshmen high school students and 80 college freshmen as subjects in this quantitative, descriptive study. The data collectors are certified HIV peer educators who have conducted peer education classes in a private high school, as well as several freshmen dorms at a private college. The surveyed students have been educated for approximately 45 minutes on HIV/AIDS transmission.

The peer educators facilitated a game called "the transmission game," which consists of students actively participating in the HIV/AIDS presentation. The game breaks down HIV transmission into three groups which are "no risk," "high risk," and "needs more information." There are a number of cards given out with particular situations, such as "getting bit by a mosquito" and "donating blood." The students then take their card and place it under the appropriate category. Once the cards are situated on the board there is a discussion between the facilitators and the students in relation to HIV. Throughout the presentation, the facts of HIV transmission are discussed and the students are able to ask questions to further their knowledge of HIV/AIDS.

The tool that has been developed is a pre-test and a post-test that consist of 20 questions pertaining to knowledge of HIV/AIDS. The students replied to each question by circling "yes" or "no." The same tool was used for both the pre-test and the post-test. The pre-test was distributed to the students prior to the week before the peer education class by their respective health education teacher and dormitory resident assistant. The post-test was distributed approximately one week following the peer education class and collected by their respective health education teacher and dormitory resident assistant. .

DATA ANALYSIS

Data from both pre-tests and post-tests was collected by the researchers and grouped according to the number of "no's" and "yes's" for each question. High school freshmen and college freshmen questionnaire results were analyzed separately. There were a total of 67 pre-tests and post-tests from high school; and a total of 86 pre-test and 69 post-test from college students.

RESULTS

Table 1: Increase in Correct Post-test Answers on Prevention

Questions Regarding:	High School	College
Type of condom	25%	3%
Birth control pill	0%	3%

Table 2: Increase in Correct Post-test Answers on Myths

Questions Regarding:	High School	College
HIV in heterosexual women	43%	12%
HIV in homosexuals	45%	17%
Identifying an HIV+ person	1%	0%
Casual Contact	2%	5%
Insect transmission	5%	0%
Cure for AIDS	0%	7%
"Man's Disease"	3%	0%
"Innocent Victims"	6%	0%

Table 3: Increase in Correct Post-test Answers on Transmission

Questions Regarding:	High School	College
Sharing needles	0%	1%
Influence of Drugs and Alcohol	29%	32%
Mother to child	0%	1%
STD's	12%	22%
Blood donation	31%	14%
Blood transfusion	0%	0%

Table 4: Increase in Correct Post-test Answers on Testing

Questions Regarding:	High School	College
Testing at Public Health Department	17%	1%
Anonymous Testing	0%	2%
False Negative Test	3%	0%
Detection of virus strains	13%	16%

CONCLUSION

By examining the data analysis, it can be suggested that HIV/AIDS peer education is effective in increasing students' knowledge of HIV and AIDS. The research suggested the most significant improvements after education were in the following areas: prevention issues; myths on homosexuality; use of drugs and alcohol; blood donations; and testing (Mulvihill, 1996). High school freshmen's knowledge had a greater increase compared to college freshmen's knowledge after peer education. From analyzing the data, it is suggested taht college freshmen had a higher level of HIV/AIDS knowledge before peer education was initiated. This information is consistent with the literature regarding HIV/AIDS knowledge of a college level student (Calamidas, 1991).

The most significant change after education was the destruction of the myth that only homosexuals have a significant risk of contracting the virus. This can be supported with the high increase in post-test responses. In the past, some research studies suggested certain myths were evident in high school and college students (Holzman, Anderson, Kann, Arday, Truman & Kolbe, 1991). However, the myths studied in this research project implied that the majority of these myths were no longer presumptions in this population. Overall, the findings suggest that HIV/AIDS Peer Education is effective in teaching high school and college freshmen.

REFERENCES

American Red Cross. (1995). Basic fundamentals HIV/Aids instructors manual, 1.

Calamidas, E.G. (1991). Reaching you about AIDS: Challenges confronting health educators. Health values, 15(6), 55-61.

Centers for Disease Control and Prevention. HIV/AIDS Surveillance Report, 1995;7 (no.2): (19).

Craven, R.F. and Himle, C.J. (1992). Fundamentals of nursing-human health and function. J.B. Lippincott Company, Philadelphia, PA.

Holtzman, D., Anderson, J.E., Kann, L., Arday, S.L., Truman, B.I., & Kolbe, L.J. (1991). HIV instruction, HIV knowledge, and drug injection among high school students in the United States. American Journal of Public Health, 81(12), 1596-1601.

Mulvihill, C.K. (1996). AIDS education for college students: Review and proposal for a research based curriculum. AIDS Education and Prevention, 8(1), 11-25.

Relationships of Self-Perception of Balance, Technological Measures of Balance, and Fall Events Among Individuals with Parkinson's Disease

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Individuals with Parkinson's disease (PD) experience balance problems that may result in falls. One factor that may contribute to falls is incongruencies between a person's self-perception of balance and actual postural stability. If incongruencies exist, appropriate strategies may not be implemented to decrease the risk for falls. Instruments to measure self-perception of balance are not reported in the literature. The purposes of this study were to evaluate 1) reliability and 2) criterion-related validity of a new instrument to measure perceived balance by examining relationships between: (a) responses to 10 items measuring self-perception of balance with percent of stability on 10 measurement conditions assessed by a posturography instrument, and (b) self-perception of balance and the number of fall events. A convenience sample of 15 subjects was obtained from an ongoing multidisciplinary study. Data were collected by two instruments: a 10-item Self-Perception of Balance Questionnaire (SPBQ) and a computerized posturography instrument, Smart Balance Master® (SBM®). Findings suggest that the SPBQ demonstrated evidence of reliability for the six items measuring automatic control of balance (alpha= .93) and the four items measuring voluntary control of balance (alpha= .89). Evidence of validity of the SPBQ was demonstrated for automatic control of balance ($r= .70$, $p< .004$). Relationships among the SPBQ's voluntary movement items and the SBM®'s conditions were non-significant ($r= -.11$, $p< .70$). Relationships between number of fall events and SPBQ scores were non-significant for automatic ($r= -.39$, $p< .24$) and voluntary ($r= -.23$, $p< .50$) control of balance.

BACKGROUND

Parkinson's disease (PD) is a slow, progressive, degenerative central nervous system (CNS) disorder characterized by four classic features: slowness and poverty of movement (bradykinesia); muscular rigidity; resting tremor; and postural instability (Berkow & Fletcher, 1992). It is estimated that PD affects 1 to 1.5 million Americans and is a leading cause of disability (Lombardo, 1992). Approximately 1 in 50 persons, aged 60 years and older, develop PD (Field, 1991). Duvoisen (1991) states that PD is expected to increase as our aged population increases. PD is not a life-threatening disease; it is life-altering due to its chronic progressive nature. Life-altering responses may result from an individual's self-perception of his/her health.

Persons experiencing PD may alter their lifestyle in one or more areas, such as functional activity. The alterations may occur due to perceived balance impairments, which may lead one to feel threatened about falling. Falls are costly and estimated to add seven billion dollars to the U.S. health care expenditures annually (Miller, 1995). One of the factors which may contribute to falls is the incongruency of balance perception with sensitive technological measure of stability. It is important to investigate self-perception of balance among this population because they are at a high risk for falls (Tinetti & Speechley, 1989) and their perceptions of balance may predict life-alterations and fall outcomes (Lipsitz, Jonsson, Kelley, & Koestner, 1991).

Instruments to measure self-perception of balance are not reported in the literature. Technological instruments are available to assess dimensions of balance, they are expensive and not portable, limiting their use with patients. If a questionnaire were developed with evidence of reliability and validity, it could be incorporated into patient assessments by nurses and other health care providers. Patients identified with possible balance problems through this screening could be educated regarding fall risk and preventive strategies in an effort to decrease falls. Also, these patients could be referred to balance laboratories for thorough evaluation.

The purposes of this study were to evaluate 1) the reliability and 2) criterion-related validity of a new instrument to measure perceived balance by examining relationships between (a) responses to 10 items measuring self-perception of balance with percent of stability on 10 measurement conditions assessed by a posturography instrument, and (b) self-perception of balance and the number of fall events.

THEORETICAL/CONCEPTUAL FRAMEWORK

According to the Systems theory, balance is a complex process and involves coordinated actions of biomechanical, sensory, motor, and central nervous system components (Nashner, 1994). Biomechanical is defined as "the position of the body center of gravity relative to the base of support." Sensory is defined as visual, vestibular, and somatosensory inputs. Motor is defined as the complex system of joints and muscles involved. CNS components are the adaptive processes necessary to modify the sensory and motor components, including automatic and voluntary control of balance (Nashner, 1994). Individuals with PD may experience dysfunction in one or more of these areas resulting in balance impairments which potentially can lead to falls.

When balance dysfunction occurs, an individual may appraise himself as ill (functional ability below perceived capability level and an uncomfortable sense of self) (Lyon, 1996) and alter his functioning according to the degree of threat perceived. Appraisals, include self-perceptions, and are evaluated as threatening and non-threatening. Coping with threats may lead to decreased functioning or fall prevention, while appraisals of non-threatening characteristics may lead to maintenance of normal functioning or failure to take appropriate protective measures. Appropriate appraisals and coping behaviors must occur for optimal functioning and prevention of falls. Therefore, reliable and valid balance assessment instruments are needed for appropriate diagnosis and treatment of balance impairments.

METHODOLOGY

Sample

A convenience sample of 15 subjects was obtained from individuals with PD who were participating an existing multidisciplinary study of the effects of pallidotomy surgery in individuals with PD at Indiana University Medical Center. Nine subjects were male and 6 were female with ages ranging from 49 to 78 years (mean = 64.93). All subjects had been diagnosed with PD for at least three years. The subjects were evaluated for inclusion criteria prior to participation. Eligible subjects exhibited: 1) intact cognition demonstrated by following a two-part command, such as raising a hand over their head and holding it there; 2) vision of standard newspaper print, as stated in a self-report, and 3) the ability to stand unassisted for five minutes.

Instruments

Self perception of balance was measured by participants answering a 10-item questionnaire which was developed to simulate the measures of the SBM* on automatic control of balance (Eyes Open, Eyes Closed, Sway Vision, Eyes Open/Sway Surface, Eyes Closed/Sway Surface, Sway Vision/Sway Surface) and voluntary control of balance (Limits of Stability) (See Table 1). Items 1, 2, 7, 8, 9, and 10 evaluated automatic control, while items 3, 4, 5, and 6 evaluated voluntary control. Two examples are as follows: 1) Question 8 (automatic): "You are on an airplane and need to walk to the restroom. You stand on the floor without holding on to anything. As you are walking the airplane experiences slight turbulence and the floor seems to be moving slightly under your feet. How steady is your balance?"; 2) Question 6 (voluntary): "You are standing alone in your home in the daylight. You are putting on your coat to go outside to get the mail. You have one arm in your coat and now must reach behind yourself with the other arm to insert it into the coat sleeve. How steady is your balance?". Individuals selected perceived stability on a Likert scale with responses ranging from (1) Very Unstable-"I know I will fall" to (5)Very Stable-"I know I will not fall". To allow for possible instances in which and individual could not evaluate his/her balance in the situational question an N/R (No Response) option was added, valuing 0. A summative score was obtained for the self-perception of balance score. The possible scores ranged from 0 (No Response) to 50 (Very Stable).

Table 1. SPBQ item correlation with SBM® condition. [1]Automatic control of balance. [2] Voluntary control of balance.

SPBQ ITEM	SBM® Condition
Question #1	Eyes Open (EO)[1]
Question #2	Eyes Closed (EC)[1]
Question #3	Front Limit of Stability (FLOS)[2]
Question #4	Right Limit of Stability (RLOS)[2]
Question #5	Left Limit of Stability (LLOS)[2]
Question #6	Back Limit of Stability (BLOS)[2]
Question #7	Sway Vision (SV)[1]
Question #8	Eyes Open/Sway Surface (EO/SS)[1]
Question #9	Eyes Closed/Sway Surface (EC/SS)[1]
Question #10	Sway Vision/Sway Surface (SV/SS)[1]

Fall events were measured by self-reports of subjects, obtained through a guided interview and recorded on the Fall Inventory (FI). The FI consisted of questions which were easily answered and captured the dimensions of fall events regarding their complexity and relationship to postural instability (Dayhoff, Mullennax, Leal, & Hall, 1996).

Objective balance was measured by the SBM®. The SBM® is a dynamic posturography instrument which is a software driven computerized instrument consisting of dual forceplates that rest on pressure transducers and measure automatic and voluntary control of balance (NeuroCom, 1993). The SBM® demonstrated reliability (alpha = .73 - .85) in a previous study involving an elderly population (Wigglesworth, Dayhoff, & Suhrheinrich, 1995).

Procedure

An explanation of the study was provided and informed consent was obtained. Self-perception of balance was evaluated prior to the SBM® testing. A 10-item questionnaire was utilized as the evaluation tool. Objective measures of balance were then obtained using the SBM®. Complete testing time varied, ranging from 1 to 3 hours, depending on client needs.

FINDINGS

Findings suggest that the SPBQ demonstrated evidence of reliability for the six items measuring automatic control of balance (alpha= .93) and the four items measuring voluntary control of balance (alpha= .89). Evidence of validity of the SPBQ was demonstrated for automatic control of balance. The mean of the automatic SPBQ score was significantly correlated with the average automatic SBM® score ($r = .70$, $p < .004$). The relationship between the SPBQ's average score on the voluntary movement items and the average SBM®'s voluntary conditions was non-significant ($r = -.11$, $p < .70$). Graphical analysis demonstrated that self-perception of balance scores were congruent with the SBM® score (See Figure 1). Relationships between number of fall events and SPBQ scores were non-significant for automatic ($r = -.39$, $p < .24$) and voluntary ($r = -.23$, $p < .50$) control of balance. Graphic analysis depicted the variability between the self-perception of balance score and the number of fall events that individuals stated they experienced (See Figure 2).

CONCLUSION/RECOMMENDATIONS

The SPBQ was internally consistent for items measuring automatic and voluntary control of balance. There is evidence that the SPBQ is a valid instrument for measuring automatic control of balance in individuals experiencing this type of balance impairment.

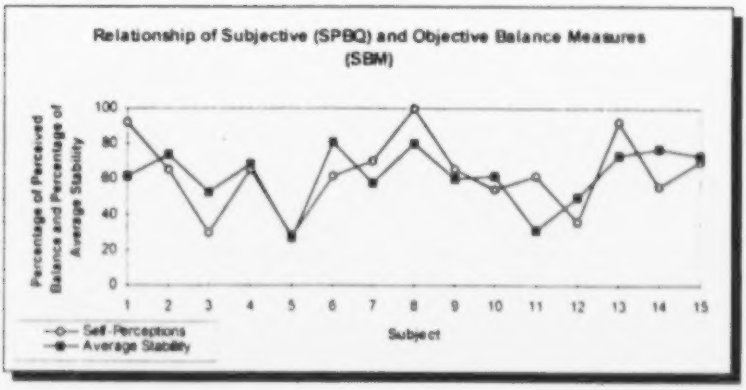

Figure 1 Relationship between SPBQ percentage score and SBM* average stability score according to each individual subject

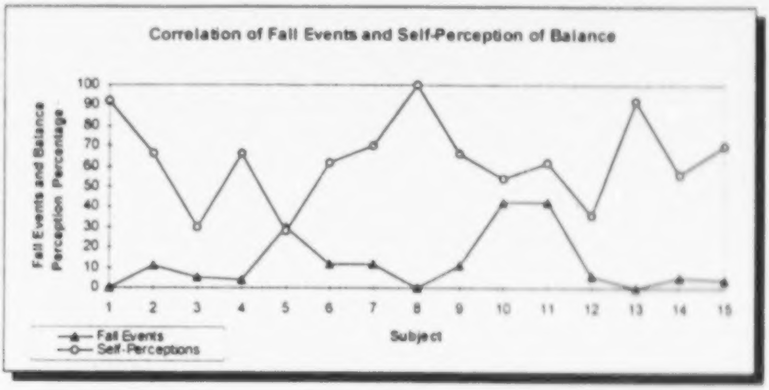

Figure 2: Correlation of number of fall events as self-reported by individual subject and the SPBQ score

Evidence of validity was not supported when assessing correlations of fall events with self-perception of balance. This finding may reflect the likelihood that some non-fallers with poor perception of balance may have taken protective measures to prevent falls, while some individuals with poor balance may have chosen to maintain their activity inspite of their perception of balance (N Dayhoff, personal communication, April 21, 1997).

It is recommended that the SPBQ be considered as a possible instrument in assessing persons with balance impairments involving automatic control in the clinical setting. It is suggested that further testing be conducted on a larger sample size. The items measuring voluntary control of balance need to be modified and re-tested before consideration for clinical practice. Future research needs to include use of protective measures to prevent falls as a covariate in understanding relationships between self-perception of balance and number of fall events.

REFERENCES

Berkow, R. & Fletcher, A. J. (Eds.). (1992). The Merck Manual. (16th ed.). Rahway, NJ: Merck & Company, Inc.

Dayhoff, N. E., Mullennax, J., Leal, K., & Hall, M. (1996). Balance and falls among adults with parkinson's disease. Unpublished manuscript.

Duvoisen, R (1991) Parkinson's disease A guide for patients and families New York Raven

Field, R (1991) Dr Parkinson's cruel disease American Health, 10 (7), 54-58

Lipsitz, L A , Jonsson, P V , Kelley, M M , & Koestner, J S (1991) Causes and correlates of recurrent falls in ambulatory frail elderly Journal of Gerontology Medical Sciences, 46 (4), M114-M122

Lombardo, M C (1992) Degenerative and other disorders of the nervous system In A A Price & L M Wilson, Pathophysiology Clinical Concepts of Disease Processes, (pp 785-800) St Louis, MO Mosby Year Book

Lyon, B L (1996) Stress-related illness as an important domain of nursing research and practice Implications for physical sensations, emotions, and functional ability as health outcome (target) variables Manuscript in preparation, Indiana University at Indianapolis

Miller, J M (1995) Falling and the Elderly In M Stanley & P G Beare, Gerontological Nursing, (pp 281-296) Philadelphia, PA F A Davis Company

Nashner, L (1994) Evaluation of postural stability, movement, and control Exercise tolerance and training for patients with neurologic dysfunction and balance disorders In S M Hasson, Clinical Exercise Physiology (pp 199-234) St Louis, MO Mosby Publishing Company

NeuroCom, International, Inc (1993) Smart Balance Master® Operator's Manual, version 3.4 Clackamas, Oregon NeuroCom, International, Inc

Tinetti, M E , & Speechley, M (1989) Prevention of falls among the elderly The New England Journal of Medicine, 320, 1055-1059

Wiggleworth, J , Dayhoff, N E , & Suhrheinrich, J (1995) The reliability of four measures of postural control using the Smart Balance Master Unpublished manuscript

Depression: Prevalence, Causes, Manifestations, and Repercussions Associated with Elderly Disability

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The average life span of individuals in the United States has increased as a result of contemporary science providing refined health care. Consequently, health care professionals have witnessed an expansion in the number of elderly in patient demographics. Due to the interweaving of physical and mental problems, depression often accompanies aging individuals encountering physical impairments, functional limitations, and disability.

How prevalent is depression in the elderly, and why are the elderly particularly vulnerable to developing it? How can depression be recognized among the geriatric population, and how is it correlated to physical disability? And lastly, what are some ways to prevent depression from manifesting itself into the lives of those who are elderly, including those facing disability? A discussion of the prevalence and causes of depression associated with elderly illness, how depression manifests itself in the lives of functionally disabled elderly individuals, and the repercussions depression may have on the individual and his or her caregiver, follows.

Although some sources state the percentages to be as high as sixty-five percent, the National Institute of Aging declares that fifteen percent of people over the age of sixty-five experience depression.[1,2] It is considered to be the most common emotional problem that the elderly experience, providing for them the highest suicide rates across any age group.[3,4]

Despite these numbers, eighty percent of older adults with depressive symptoms receive no treatment at all.[4] Less than nine percent of clinically depressed elderly individuals in a hospital setting were actually diagnosed by their primary physicians as depressed.[5] This may be because of the preconceived connotations our society holds about aging which delays opportunities for clinically depressed elderly individuals to obtain treatment. The cognitive changes that accompanies depression, such as difficulty thinking clearly or concentrating, is often misdiagnosed as dementia in elderly patients on a clinical level and senility on a societal level, or, as one might say, "a natural consequence of growing older". Also during exams, physicians seem more inclined to focus on physical rather than mental complaints from elderly individuals.

Elderly individuals may also be unable to access information about depression due to expense or unawareness. Low-income elderly may be unable to afford expensive psychotherapy where reduced or deterred fee therapy is not available. Medicare has also demonstrated in the past to be more available for physical care than mental health care. Elderly individuals may also be either too embarrassed to admit or not educated enough to realize they may have characteristics of a person who is clinically depressed.

The elderly are particularly vulnerable to developing depression due to the combination of endogenous and reactive factors. Endogenous factors occur in the absence of clear external events and are biologically based. These factors include genetics and brain disease.[6] Depressive disorders are estimated to occur among ten to thirty percent of Alzheimer's patients, forty to fifty percent of Parkinson's patients, and up to sixty-three percent of stroke patients.[6,7] Other medical illnesses often associated with depression include thyroid disease, occult neoplams, deficiency states, collagen vascular disorders, alcoholism, and infection. Drugs, including antihypertensives, antiparkinsonians, narcotic analgesics, corticosteroids, and certain drug combinations, may also elicit depressive symptoms by affecting the physiology of the brain.[8]

Reactive factors are linked to negative events, and are most likely to reflect psychological, social, and physical environmental factors. Some reactive factors particularly faced by older adults include: loss of significant others, a feeling of not living up to one's potential in the present or the past, loss of self-esteem through the loss of a job or retirement, decreased rates of participation in potentially reinforcing activities, a feeling of a loss of control of important events and outcomes in one's life, and little reinforcement from the environment. Not only are the patients themselves depressed, by thirty percent of elderly spousal caregivers have been shown to develop depression.[2]

The effects of depression can be categorized into four types of deficits: motivational, cognitive, affective, and those demonstrated by motor behavior. Motivational effects include not being able to get out of bed in the morning, reduced level of social participation or interest in pleasurable activities, and failure to respond to praise or rewards. Cognitive changes, which is one of the reasons depression is often misdiagnosed as dementia, include difficulty concentrating or thinking clearly, thinking negatively about oneself and one's future, feeling guilty or remorseful about past misdeeds, and lack of self-esteem. Some affective features include changes in mood, persistent periods of feeling depressed, tearfulness or crying, increased irritability, jumpiness, or loss of temper. Changes in motor behavior include moving about or talking more slowly than usual, changes in sleep habits, changes in appetite and weight, and functioning less effectively than usual at work or in the home.[2]

Depression has been shown through research to significantly affect an elderly individual who is recovering from impairments, functional limitations, or disability. Depression impairs physical activities, language function, resumption of social activities and community service involvement and promotes social isolation, poor motivation, dependency, and loss of control for the post-morbid individual.[6,8]

If depression is left untreated in elderly hospitalized patients, which has been proven to occur in many elderly depressed individuals, consequences include longer hospital stays, failure to achieve and maintain functional gains, intellectual impairments, depressed moods, and decreased community integration.[6]

Prevention of the development of depression can be accomplished through the efforts of the elderly individual themselves, caregivers, and health care providers. Preventative measures include social support, humor, distortion of reality, physical activity, control over day to day events, referral, education, community integration, and the recognition of different cultural perspectives.

Social support and depression have been linked in a study by Siegel and Kuykendall. They found that widowers who have a limited social support network are at a greater risk of developing depression than those who have extensive social support networks, such as those who belong to a church or synagogue. Staying active in the community is one way to develop social support networks.[8]

The greater one's sense of humor is with moderate and high levels of stress, the less chance the individual has to acquire depression. Humor may be one way to discharge built up tension from stress or to distort reality. The distortion of reality, optimistic illusions and biases about the amount of control we have over our lives are psychologically adaptive. It has been proven that judgment and perception of depressed people are not distorted, but actually quite realistic. Emotionally health people are the ones who use distortion to unconsciously protect themselves from the realities of life.[2,10]

Physical activity may also decrease a person's opportunity to develop depression and help as treatment. Various women who were involved in aerobics classes were found to have a significant amount of less stress and depression than those who were not. This could be attributed to the increased control over arousal and the relaxation that often occurs after physical activity.[10]

Control over day to day events was measured in a study with individuals in a nursing home. These individuals were divided into two groups, equal in physical health. One group had considerable control over day to day events and the second group had significantly less control. One and a half years later, the group that had more control experienced less deaths than the group that had decreased control. This may be attributed to learned hopelessness. Learned hopelessness is "a psychological state that results when an individual perceives that events in his or her environment are uncontrollable" and occurs when people learn that desired outcomes are independent of their voluntary behavior. Learned hopelessness results in the person feeling convinced that there is nothing that he or she can do to escape the situation, and the result is emotional listlessness, apathy, and depression.[10]

For health care providers, there is a multitude of screening devices that may be used if depression is suspected in an elderly individual. These scales include the Zung Self-Rating Depression Scale, the Popoff Index of Depression, the Beck Depression Inventory, and the Geriatric Depression Scale.[11] Health care professionals may also take the proper steps, depending on the setting, to refer the depressed patient to their primary physician.

Health care providers also must be able to provide the information regarding the disease process with the patient, family, and caregivers by educating the them on what the patient has experienced, what the patient may potentially experience, and the importance and appropriateness of positive support. They must also be able to formulate strategies in the hospitalized setting to facilitate community reintegration. This would include planning on the health care providers part and depends on the patient's medical, functional, psychological status, and the caregivers commitment to socialization. Home assessment, social support, and resource referral have also been shown to facilitate community reentry.[6]

Not only specific to depressed patients, health care providers must also be able to recognize the difference of cultural perspectives. When a patient and a health care provider have differing cultural ideas about health and illness, the ability to provide care may be greatly reduced. To supplement this, efforts should be made to evaluate the individuals cultural perspective and include the patient's beliefs, values, diet, and customs into the care plan. Culturally reliable educational materials should always be provided for the patient and family to improve understanding and facilitate compliance with the prescribed treatment regimen.[6]

In conclusion, it is important for our society, in particularly those involved in health care profession, to recognize the prevalence, manifestations, and repercussions of depression present with elderly disability because, as physical therapist Ruth Purtillo once wrote, "Emotional health also affects physical health, and all too often this aspect is neglected."

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REFERENCES

[1] Epstein L. Symposium of age differentiation in depressive illness: depression in the elderly. *J Gerontology*. 1976;31:278.

[2] Nevid J, Rathus S, Greene B. *Abnormal Psychology in a Changing World*. 2nd ed. Englewood Cliffs, NJ: Prentice-Hall; 1994.

[3] Butler RN, Lewis MI. *Aging and Mental Health*. 3rd ed. St. Louis, MO: Mosby; 1982.

[4] Ferucci L, Guralnik J, Marchionni N, et al. Aging and prevalence of depression. *Gerontologist*. 1990;30:314A.

[5] Rapp SR, Parisi SA, Walsh DA. Psychological dysfunction and physical health among elderly medical inpatients. *J Consulting Clinical Psych*. 1992;60:379-391.

[6] Sandin KJ, et al. Stroke rehabilitation: psychological and social implications. *Arch Phys Med Rehabil*. 1994;75:S52-55.

[7] McCollough PK: Geriatric depression: atypical presentations, hidden meanings. *Geriatrics*. 1991:46(10):72-76.

[8] Parikh R, et al. The impact of poststroke depression on recovery in activities of daily living over a two year follow-up. *Arch Neurol*. 1990:47;785-789.

[9]Siegel JM, Kuykendall DH. Loss, widowhood, and psychological distress among the elderly. *J of Consulting and Clinical Psychology*. 1990;58:519-524.
[10]Reeve JM. *Understanding Motivation and Emotion*. Fort Worth, TX: Harcourt Brace College Publishers; 1992.
[11]Lewis CB, Bottomley JM. *Geriatric Physical Therapy: A Clinical Approach*. Norwalk, CT: Appleton & Lange; 1994.
[12]Purillo R. *Health Professional and Patient Interaction*. 4th ed. Philadelphia, PA: W.B. Saunders Company; 1990.

Medical Costs and Correlates of Gunshot Wounds in Travis County, 1995

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BACKGROUND

"The choice today is not between violence and nonviolence. It is either nonviolence or nonexistence," said Martin Luther King, Jr. (1). Ironically, it was a bullet from a gun that ended his life. Within four consecutive years on the school grounds at Thomas Jefferson High School in New York, 70 students were killed, shot, stabbed or permanently injured (1). According to a report prepared for the New York state assembly, 50% of the 1,900 Jefferson High School students have some type of puncture wound on their body on any given day (1). In New Orleans, "preschoolers learned to dive for the floor in 'shooting drills'" (2). A case study of gang members revealed "many saw themselves as soldiers ready to do battle with an adversary...we got to protect our colors" (3).

The preponderance of violence that involves guns has severe consequences for hospital trauma care systems. Many patients of gunshot wounds do not have medical insurance (8-10, 13, 21-27) and trauma care for this type of injury is extremely expensive (8-10, 12-13, 20-27). The secretary and chairman of the legislative committee for the American Trauma Society, Dr. Howard Champion, said, "uncompensated trauma care is the Achilles' heel of the American health care system" (4). Firearm-related injuries continue to be a leading cause of death in the United States (6-19). Injuries attributed to firearms are the eighth leading cause of death in the United States and are the second leading cause of death for Americans aged 10-34 years (14). Among the Western industrialized countries, the United States has the highest rate of firearm-related deaths (13). Researchers at the CDC reported that from 1968 to 1991, firearm-related deaths increased by 60% (from 23,875 to 38,317) in the United States, and it is projected that by the year 2003, the incidence of firearm-related deaths will exceed the incidence of motor-vehicle crashes. Therefore, firearms will become the leading cause of injury-related death, which is the leading killer for persons aged 1-44 years in the United States (16). In Texas, the number of firearm-related deaths had exceeded the number of motor-vehicle-related deaths by the year 1991 (16). Researchers at the CDC also reported that during 1991 the 38,317 deaths caused by firearms were the fourth leading cause of years of potential life lost before age 65 (YPLL-65) in the United States, accounting for 1,072,565 YPLL-65 that year (14). The report explained the leading three causes of YPLL-65 in 1991 were nonfirearm-related unintentional injuries (2,002,616), cancer (1,772,010), and heart disease (1,312,765). However, from 1980-1991, the firearm-related YPLL-65 increased 13.6%, while the YPLL-65 caused by nonfirearm-related unintentional injury and heart disease decreased 25.2% and 18.1%, respectively. The YPLL-65 caused by cancer increased 1.1% during this same period (14).

Although firearm-related injuries are a serious problem in the United States, little is known about the extent and cost of firearm-related injuries in Travis County, Texas. The purpose of this study was to broaden our understanding of the medical and financial burden at our local level with regard to patient demographics and medical costs of gunshot wound patients. This study sought to answer three questions: (1) What was the average demographic profile of gunshot wound patients in Travis County?, (2) What were the costs for treatment of the gunshot wound patients and what proportion of this total is publicly funded or uncompensated?, and (3) What were the influential predictors for the variance in length of stay, costs and discharge condition?

METHODS

Data Collection:

Brackenridge Hospital is a Major (Level II) Trauma Center located in Austin, Texas. The Brackenridge Hospital Trauma Registry was utilized to retrospectively identify hospitalized gunshot wound patients. Patient data were based on: (1) was admitted to the Brackenridge Trauma Department between January 1, 1995 and December 31, 1995, (2) had a gunshot wound diagnosis according to classification in the Registry, (3) was a Travis County resident according to zip code, and (4) was admitted to Brackenridge Hospital. From the list of patients who fulfilled this criteria, data were abstracted related to demographics, medical costs, type of medical insurance, discharge condition, and injury type and severity. No data were available on the type of gun or bullet that caused the injury.

Variables:

Demographics: Patient demographic data included age, gender, and race. Drug use: Admitting physicians' disgression determined who was tested for the presence and amount of alcohol and illegal drugs. Results of laboratory tests were included in the data set. Discharge condition: The discharge condition indicates the patient's level of functioning upon discharge from the hospital, and

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is based on an ordinal scale from 1 to 5, with 1 being "good, previous level of functioning" and 5 indicating "death". ICD-9: The International Classification of Diseases, ninth revision, (ICD-9), was used to assess and classify the location and severity of the gunshot wounds. For statistical analyses in this study, preexisting subclassifications of the ICD-9 Manual are used.

Medical Insurance: A personal letter from the Brackenridge Hospital Emergency Director provided categories and definitions for types of medical insurance. The patient's medical insurance was classified as Private or Public/Uncompensated. Private, or commercial insurance, is defined as "any patient covered by a 3rd party payor other than a government entitlement program". This includes: Blue Cross, Commercial Insurance, HMO, Preferred Providers, City of Austin Insurance, and Champus. Public funded is defined as "any patient covered by a government entitlement program", and Uncompensated is "any patient not covered by any 3rd party payor who is considered charity care or bad debt, including all patients who may be retroactively eligible for public assistance". Public and Uncompensated includes: Contract, Certicare, MAP, Medicare, Private Pay, Law Program (jail), City/Travis MAP, and Pending MAP. Reimbursement data were not calculated until after June 30, 1996 to allow ample time for reimbursement transactions. Costs: Medical costs only included charges for inpatient care; Physician's fees are not included. Length of Stay: Length of stay (LOS) was based on dates of admission to the hospital and date of discharge from the hospital.

Analysis:

Descriptive statistics were used to describe the patient. Data were examined for outliers and coding errors. All analyses were carried out using SPSS for Windows. Correlations and linear regressions were conducted to identify associations between demographics, discharge condition, costs, length of stay and drug use.

RESULTS

Sample Description: Of the 2,186 trauma admissions between January 1, 1995 and December 31, 1995 at Brackenridge Hospital, there was a total of 138 gunshot wound patients and 111 were Travis County residents. The mean age was 24 years (s.d = 9.96), with a range of 1 to 66 years. Sixty per cent of the patients were between the ages of 15 to 24 years. Of these 111 patients, 87% were males. Thirty-five per cent of the patients were Hispanic, 31% Anglo-American, 30% African-American, 1% Native American, and 4% other. In comparison, in Travis County there were 62% Anglo-Americans, 11% African-Americans, and 24% Hispanics.

Eighty of the patients were tested for blood alcohol levels, and of these, 44 had a measurable blood alcohol determination. Twenty (18%) were legally intoxicated, with a blood alcohol concentration >100 mg/dL. Sixty-one patients were tested for the presence of illegal drugs: 16 (14%) were positive for tetrahydrocannabinol (THC) (100 mg/dL) and 12 (11%) were positive for cocaine.

Costs: The mean length of stay was 4.67 days (s.d = 6), with a range of 1 to 30 days. Total hospital charges for the 111 patients were $1.66 million, of which $1,056,000 (66%) was uncompensated or publicly funded. The average hospital charges were $15,000 per patient (s.d = $19,234), ranging from $963 to $120,000 per patient. See Table 1 for incidence and costs of gunshot wound hospitalizations for each type of ICD-9.

Table 1: Incidence by ICD-9 and Costs of Firearm-related hospitalizations for Travis County residents at Brackenridge Hospital, 1995.

ICD-9	n (%)	Total Charges	Mean Charges (SD)
Fractures	27 (24.3%)	$389,118	$14,966 ($13,693)
Intracranial injury, excluding those with skull fracture	9 (8.1%)	$98,414	$10,934 ($6,369)
Internal injury of chest, abdomen, and pelvis	20 (18.0%)	$557,560	$27,878 ($27,789)
Open wound of head, neck, and trunk	28 (25.2%)	$372,074	$13,288 ($21,130)
Open wound of upper limb	11 (9.9%)	$60,864	$5,533 ($4,501)
Open wound of lower limb	10 (9.0%)	$37,790	$3,779 ($1,451)
Injury to blood vessels	5 (4.5%)	$139,005	$27,801 ($21,603)
Other	1 (.9%)	$1,862	$1,182 (N/A)
Total	111 (100%)	$1,662,706	$14,979 ($19,234)

Severity and Discharge Condition: Seventeen (15%) of the patients died. Six of the patients who died had fractures, seven had intracranial injury, excluding those with skull fracture, three had an internal injury of the chest, abdomen, and pelvis, and one had an open wound of the upper limb. Four of the 111 patients sustained disabilities between a moderate level retaining the ability to perform self care to severe disability requiring dependence for self care upon discharge. Therefore, ninety (81%) of the gunshot wound patients were discharged in good condition, with previous level of functioning.

Outcome predictors: Table 2 summarizes linear regression results. The best predictors of length of stay, charges, and discharge condition were the type of injury (ICD-9), with sociodemographic variables, or alcohol and drug usage not contributing to the explained variance. Seventeen per cent of the variance in length of stay and 14% of the variance in charges were explained by having an internal injury of the chest, abdomen, and pelvis. Thirty-two per cent of the variance in discharge condition were explained by an intracranial injury, excluding those with skull fracture and fractures.

Table 2. Variance in LOS, Charges, and Discharge Condition for firearm-related hospitalizations for Travis County residents at Brackenridge Hospital, 1995.

Dependent Variable	Predictor Variables	Adjusted R Square	Standard Error of the Estimate
Length of stay	Internal injury of chest, abdomen, and pelvis	.17	5.28
Charges	Internal injury of chest, abdomen, and pelvis	.14	$17,408.48
Discharge Condition	Intracranial injury, excluding those with skull fracture, fractures	.32	1.16

DISCUSSION

This study utilized retrospectively collected data on firearm-related injuries during a one-year period, from January 1, 1995 to December 31, 1995, at Brackenridge Hospital Trauma Center. The sociodemographic profile findings in this study are very similar to profiles reported by other investigations (6, 8, 9, 11-14, 20-22, 25, 28, 29). Across these studies, a disproportionate number of the gunshot wound patients are men, young, and minorities. Eighty-seven per cent of the patients in this study are males, compared to only having 50% males in the general Travis County population for 1995 (30). A similar two-year study conducted in Travis County from 1991 through 1992 also reported 87% of hospitalized gunshot wound patients were male (31). The percent of male gunshot wound victims is consistent with previous studies in which 81% to 96% were males (6, 11, 12, 21, 22, 25, 28, 29).

Compared to the previous Travis County investigation for the years of 1991-1992, there was an 11% increase in firearm hospitalizations for patients aged 15 to 19 years, rising from 25% to 36% (31). There was also a 24% increase in the number of patients between 20 and 24 years. Overall, 60% of the patients were between 15 and 24 years of age. Fiedler, et al. (22) reported 73.5% of their gunshot wound patients to be between 15 and 35 years. In national estimates, Annest, et al. reported 120 per 100,000 of the firearm-related patients to be aged 15 to 24 years (6). Additionally, the CDC reported firearm injuries for Americans aged 10 to 34 years to be the second leading cause of death (14).

While the Travis County general population for 1995 was reported to be 62% Anglo-American, 11% African-American, and 24% Hispanic, the patients distribution this study found is 31% Anglo-American, 30% African-American, and 35% Hispanic, thereby confirming that minorities suffer a disproportionate number of gunshot wounds. Numerous other studies also report African-American and/or Hispanics to be disproportionately represented from the general population for non-accidental injuries, including gunshot wounds (6, 8, 9, 13, 20, 21, 25, 29).

Since assessments of alcohol and illegal drug presence at the time of admission were at the physicians' disgression, results must be interpreted cautiously with regard to a relationship with firearm-related injuries. Forty per cent of the 111 patients in this investigation had a measurable blood alcohol determination and 18% were legally intoxicated, with a blood alcohol concentration >100 mg/dL. Fourteen per cent were positive for tetrahydrocannabinol (THC) (100 mg/dL) and 11% were positive for cocaine. A study at the Harborview Medical Center in Seattle reported half of their 402 patients for non-accidental injuries had a measurable blood alcohol determination and one-third of the 358 assault victims were legally intoxicated (blood alcohol concentration >100 mg/dL) (8). Also, 76% of the 624 assault victims at the Harbor-UCLA Medical Center in Los Angeles had a blood alcohol determination in a two-year investigation (10). It is clear many patients of non-accidental injuries including gunshot wounds, present with alcohol consumption, and sometimes drug usage. However, the most accurate assessments can only come from consistent testing among all gunshot wound admissions. It was not explored whether these values reflect the alcohol and drug usage within the general population.

Of the 111 patients in this study, seventeen died. Thirteen (76%) of these deaths were attributed to some type of gunshot wound to the head. More specifically, seven were intracranial injuries without skull fracture. Although not investigated, this may lead to the suspicion of suicide or intentional execution at a close range. Linear regression analysis for variance in this study demonstrated the primary predictors for discharge condition, including death, were sustaining an intracranial injury without skull fracture or a gunshot wound that resulted in a fracture on any anatomic region of the body. These two factors attributed to 32% of the variance for discharge condition. A study by Klein et al. (10) reported one-fifth of their deaths related to intentionally assaulted victims were caused by cranial trauma. Similarly, Fiedler et al. (22) found that among the 45 patients in their study that had a gunshot wound to the head and neck, one-fourth died. These findings demonstrate firearm injuries to the head are often fatal.

The average length of stay for the 111 patients in this investigation was 4.67 days per patient, with a range of 1 to 30 days. This average is low considering other studies reported between 5.7 to

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11 days average length of stay per patient for gunshot wound injuries (11-12, 20-22, 31). The average length of stay for gunshot wounds during 1991-1992 in Travis County was 6 days (31), as compared to 1995, a 22% decrease in length of stay occurred. It would be interesting to have data from 1993-1994 for a longitudinal analysis of length of stay trends in Travis County. A gunshot wound to an internal portion of the chest, abdomen, and pelvis predicted 17% of the variance for length of stay. Sociodemographic factors, alcohol and illegal drug usage, and type of medical insurance were not significant predictors for the variance in length of stay.

A 1990 article in *Time* reported for Americans under 65 years, 75% have some type of medical insurance (10). However, many investigations about non-accidental injuries, including gunshot wounds, report a very large proportion of the victims to be uninsured or publicly funded (4, 8-10, 21-25, 27-29). This study found 66% of the patients to be publicly funded or without funding of any kind. As a result, $1,056,000 of the total $1.66 million is left to the taxpayers. Bear in mind, these sums of costs only reflect medical costs to the hospital and are not including physicians' fees, physical therapy, hospital readmissions, rehabilitation services, lost wages, disability settlements, and legal fees. These additional costs plus hospital costs reflect society's financial burden from gunshot wounds and represent an immense economic impact. Although the average length of stay for 1995 was 22% less than 1991-1992, costs increased significantly. While the 1991-1992 average per patient was $10,300 (31), the average for 1995 was $15,000, demonstrating a 31% increase. The financial consequences to society and trauma centers from gunshot wounds are taking their toll. Dr. Arthur Kellerman, director of the emergency department at the Regional Medical Center in Memphis, Tennessee said, "The current situation in emergency departments can't continue without something breaking...This is a full-blown, certified crisis" (5). Nelson et al. poignantly explained, "Unfortunately the firearm is so ingrained in the American experience that one must conclude gunshot injuries and fatalities are simply a part of the cost of living in America today" (13).

This study better defined the sociodemographic profile and financial scope of hospitalized gunshot wound patients in Travis County, Texas during 1995. The results can be used as a tool to compare with previous and future studies in Travis County to improve the situation on a local level, as well as to compare to similar studies across the nation.

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REFERENCES

Morrow, L. (1992, March 9). Childhood's end. Time, 139, (10): 22-4.

Lacayo, R. (1996, January 15). Law and order. Time, 147, (3): 48-55.

Davis, R. H. (1995). Cruising for trouble: gang-related drive-by shootings. FBI Law Enforcement Bulletin, 64, (1): 16-23.

Skolnick, A. (1992). Congress acts to resuscitate nation's financially ailing trauma care systems. The Journal of the American Medical Association, 267, (22): 2994-5.

Vikhanski, L. (1992, March). Emergency departments face a growing crisis in care. Medical World News, 33, (3): 50-2.

Annest, J., Mercy, J., Gibson, D., Ryan, G. (1995, June 14). National estimates of nonfatal firearm-related injuries: Beyond the tip of the iceberg. The Journal of the American Medical Association, 273, (22): 1749-54.

Cornwell III, E., Jacobs, D., Walker, M., Jacobs, L., Porter, J., Fleming, A. (1995, June 14). National medical association surgical section position paper on violence prevention: A resolution of trauma surgeons caring for victims of violence. The Journal of the American Medical Association, 273, (22): 1788-9.

Luna, G., Kendall, K., Pilcher, S., Copass, M., & Herman, C. (1988). The medical and social impact of nonaccidental injury. Archives of Surgery, 123, (7): 825-7.

Robicsek, F., Ribbeck, B., Walker, L., Thomason, M., Hollenbeck, J., & Baker, J. (1993). The cost of violence: The economy of health care delivery for non-accidental trauma in an urban southeastern community. North Carolina Medical Journal, 54, (11): 578-82.

Klein, S., Kanno, I., Gilmore, D., Wilson, S. (1991, December). The socioeconomic impact of assault injuries on an urban trauma center. The American Surgeon, 57, (12): 793-7. (From Time, 1990, 135, 58-69.)

Washington, E., Lee, W., Ross, Jr., W. (1995, January). Gunshot wounds to the extremities in children and adolescents. Orthopedic Clinics of North America, 26, (1): 19-28.

Zavoski, R., Lapidus, G., Lerer, T., & Banco, L. (1995). A population-based study of severe firearm injury among children and youth. Pediatrics, 96, (2 Pt 1): 278-82.

Nelson, C., Puskarich, C., Marks, A. (1987, September). Gunshot wounds: Incidence, cost, and concepts of prevention. Clinical Orthopaedics and Related Research, (222): 114-21.

Centers for Disease Control and Prevention. (1994, August 26). Firearm-related years of potential life lost before age 65 years- United States, 1980-1991. Morbidity and Mortality Weekly Report, 43, (33): 609-611.

Centers for Disease Control and Prevention. (1995, March 10). Emergency department surveillance for weapon-related injuries- Massachusetts, November 1993- April, 1994. Morbidity and Mortality Weekly Report, 44, (9): 160-9.

BEST COPY AVAILABLE

Centers for Disease Control and Prevention. (1994, January 28). Deaths resulting from firearm- and motor-vehicle-related injuries- United States, 1968-1991. Morbidity and Mortality Weekly Report, 43, (3): 37-42.

Centers for Disease Control and Prevention. (1993, June 18). Mortality trends and leading causes of death among adolescents and young adults- United States, 1979-1988. Morbidity and Mortality Weekly Report,42, (23): 459-62.

Centers for Disease Control and Prevention. (1997, February 7). Rates of homicide, suicide, and firearm-related death among children- 26 industrialized countries. Morbidity and Mortality Weekly Report, 46, (5): 101-5.

Centers for Disease Control and Prevention. (1996, September 6). Firearm-related deaths and hospitalizations- Wisconsin, 1994. Morbidity and Mortality Weekly Report, 45, (35): 757-60.

Weaver, L., Hansraj, K., Idusuyi, O., Akiyama, C., Ribeiro, J., Fenison, A., Willoughby, D. (1995, January). Gunshot wound injuries: Frequency and cost analyses in South Central Los Angeles. Orthopedic Clinics of North America,26, (1): 1-7.

Martin, M., Hunt, T., Hulley, S. (1988, November 25). The cost of hospitalization of firearm injuries. The Journal of the American Medical Association, 260, (20): 3048-50.

Fiedler, M., Jones, L., Miller, S., Finley, R. (1985, July). Review of gunshot wounds in Dayton, Ohio. The Archives of Surgery, 120, (7): 837-9.

Mackersie, R., Davis, J., Hoyt, D., Holbrook, T., Shackford, S. (1995, August). High-risk behavior and the public burden for funding the costs of acute injury. The Archives of Surgery, 130, (8): 844-9.

Hutson, H., Anglin, D., Spears, K. (1995, October). The perspectives of violent street gang injuries. Neurosurgery Clinics of North America, 6, (4): 621-8.

Ryan, M., Leighton, T., Pianim, N., Klein, S., Bongard, F. (1993, December). Medical and economic consequences of gang-related shootings. The American Surgeon,59, (12): 831-3.

Laskowski-Jones, L. (1993, April). Will trauma centers become extinct?: A review of factors affecting trauma center financial viability. The Journal of Emergency Nursing,19, (2): 121-126.

Mock, C., Pilcher, S., Maier, R. (1994, April). Comparison of the costs of acute treatment for gunshot and stab wounds: Further evidence of the need for firearms control. The Journal of Trauma, 36, (4): 516-522.

Wintemute, G., Wright, M. (1992, October). Initial and subsequent hospital costs of firearm injuries. The Journal of Trauma, 33, (4): 556-560.

Payne, J., Berne, T., Kaufman, R., Dubrowskij, R. (1993, February). Outcome of treatment of 686 gunshot wounds of the trunk at Los Angeles County Medical Center: Implications for the community. The Journal of Trauma, 34, (2): 276-281.

The Texas Department of Health. (1995). Travis County Demography (on-line). Available: http://www.tdh.state.tx.us/programs/shd&pa/cfs227.htm

Zane, D., Preece, M., Elerian, N., Svenkerud, E., Perrotta, D., Wilson, M., Schwertfeger, R., Rtezlaff, C., Carmack, N. (1994, October 24). Gunfire in a Texas county: A multidisciplinary study of firearm-related deaths and hospitalizations. Unpublished manuscript.

Family Caregivers' Perceptions of Pallidotomy Surgery
Expectations, Satisfaction, and Health Dysfunction

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Pallidotomy surgery may improve everyday functioning of persons with Parkinson's disease (PD) and thus, decrease the care demands on family caregivers. No studies have examined the family caregivers' perceptions of outcomes of the surgery. The purposes of this study were to: (1) describe the family caregivers' met expectations of the outcomes of pallidotomy surgery, and (2) describe the caregivers' satisfaction with the surgical outcomes. A secondary purpose was to compare caregivers' and patients' perceptions of patients' health dysfunction post-surgery and the extent of met expectations of and satisfaction with the surgical outcomes. The sample consisted of 10 patients and their caregivers (N=20). Findings indicated that caregivers were somewhat satisfied with the surgical outcomes and their expectations were partially met. Caregivers perceived a level of functioning similar to the patients with the exception of 3 areas where the caregiver perceived a lower level of patient functioning. There were no significant differences between caregivers and patients in the extent of met expectations of and satisfaction with surgical outcomes.

BACKGROUND

Parkinson's disease (PD) is a chronic illness that affects an estimated one in 50 people over the age of 60 in the United States (Field, 1991). PD is a life-altering condition rather than a life-threatening condition, that is characterized by impairments in movement, speech, balance, and swallowing (Duvoisen, 1991). Such impairments frequently result in the need for assistance from family members, especially spouses who are typically the primary caregivers. Family caregivers play an important role in providing health services for chronically ill individuals, such as persons with PD (Boland & Sims, 1996). However, care of the chronically ill person can have a negative impact on the caregiver, such as feelings of burden, personal strain, and social isolation (Boland & Sims, 1996).

The primary treatment of PD is drug therapy (Duvoisen, 1991). While drug therapy is initially effective in decreasing PD symptoms, over time the drug effectiveness decreases, resulting in the need for higher drug dosages and, concomitantly, the occurrence of drug side effects. Pallidotomy surgery is one of a very few treatment options available to individuals who no longer experience satisfactory relief of PD symptoms with drug therapy. The surgery, pallidotomy, involves inserting a probe into a very precise location of the globus pallidus of the brain and making a small lesion. Little has been published regarding the outcomes of this procedure, and no studies have focused on the family caregivers' perceptions of surgical outcomes. This study attempts to address the gap in knowledge.

The purposes of this study were to: (1) describe the family caregivers' met expectations of the outcomes of pallidotomy surgery, and (2) describe the caregivers' satisfaction with the surgical outcomes. A secondary purpose was to compare the caregivers' and patients' perceptions of patients' health dysfunction post-surgery and extent of met expectations of and satisfaction with the surgical outcomes. The findings of this study will provide information for family caregivers and health care providers about the potential benefits and problems of pallidotomy surgery from the family caregivers' perspectives and, thus, may assist nurses in helping patients in making decisions about whether to undergo the surgery

RELATED LITERATURE

Findings from research indicated that caregiving of chronically ill persons can have a negative impact on the caregiver, such as personal strain, social isolation, and depression (Biegel, Sales, & Schulz, 1991, Boland & Sims, 1995) Only two studies were found that specifically focused on persons caring for individuals with PD (Dura, Haywood-Niler, & Kiecolt-Glaser, 1990, Wallhagen & Brod, 1997) One study found that the caregivers of persons with PD experienced more depression than a comparative group without caregiving responsibilities on an interviewer rating of depression, but not on a self-report measure (Dura et al , 1990) Findings from the second study suggested that the negative impact of caregiving may be decreased by increasing symptom control (Wallhagen & Brod, 1997)

Whether pallidotomy surgery is effective in decreasing the symptoms of PD and thus, decreasing the negative impact of caregiving on the caregiver is not known as no studies were found that examined the outcomes of the surgery from the caregivers' perspectives One study by Backer (1997) focused on outcomes of the surgery from the patients' perspectives A prospective longitudinal design was used to study 22 patients with PD undergoing pallidotomy surgery The purposes of the study were to (1) examine the extent to which patients' expectations of the surgical outcomes were met, (2) examine changes in health dysfunction from the preoperative to postoperative periods, and (3) determine whether expectations met, health dysfunction, and demographic factors predicted patient satisfaction with surgical outcomes Findings indicated that more than half of the patients' expectations for the outcomes of the surgery were met and patients' health dysfunction significantly decreased Patient satisfaction increased as more patient expectations were met, patients experienced less emotional health dysfunction, and patients were better educated

In summary, there is empirical evidence that the care demands placed on caregivers of persons with PD may have a negative impact on the caregiver Findings from one study of persons with PD undergoing pallidotomy surgery suggested that the surgery may result in decreased demands on caregivers No studies were found, however, that specifically examined the outcomes of pallidotomy surgery from the caregivers' perspectives

METHOD

Sample The convenience sample consisted of 10 patients with PD who received a unilateral, stereotactic pallidotomy, and their spouse caregivers (N=20), age 45 to 71 years (mean= 61 years, SD= 8 21) The sample was obtained from a large, multi disciplinary study of patient outcomes of pallidotomy surgery There were six female and four male caregivers All subjects were Caucasian with the exception of one Asian American Only one subject reported less than a high school education, 11 had completed high school, 8 reported college or trade school education, and 3 had a college degree or higher

Instruments A revised version of the interview guide used with PD patients in the larger study was used in this study The interview guide consisted of open- and closed-ended questions that assessed the caregivers' expectations of and satisfaction with the surgical outcomes Demographic data (i e , the caregivers' relationship to PD patient, age, level of education, and race) were collected to describe the sample

The Sickness Impact Profile (SIP Bergner, Bobbitt, Carter, & Gilson, 1981) was used to measure patients' health dysfunction The SIP consisted of 136 items which assessed health dysfunction in 12 different categories Additionally, categories were aggregated into physical dysfunction, psychosocial dysfunction, and overall total SIP scores This measure has been used previously with PD patients and was found to provide a more comprehensive measure of functioning than PD-specific scales(Longstreth et al , 1992)

Procedure Data were collected by the investigator during a face-to-face interview Informed consent was obtained prior to the interview which took approximately 30 minutes to complete

Data Analysis Categories of caregivers' expectations of surgical outcomes were developed based on common themes A reliability check was performed by determining agreement between the investigator and mentor in the classifications of data Descriptive statistics were used to describe caregivers' expectations met and caregiver satisfaction The Kruskal-Wallis test was used to determine differences between caregivers' and patients' satisfaction with surgical outcomes and perceptions of patients' health dysfunction following pallidotomy surgery

RESULTS

Family caregivers' expectations of surgical outcomes were classified into the following categories (1)physical symptoms, i e , decreased sleep disturbances, less tremor, and less dyskinesia,(2)functional abilities, i e , improved walking, increased productivity, decreased falls, (3)changes in treatment, i e., stabilization of medications, (4)resumption of previous roles, i e , increased participation in household chores, and (5)other, i e , to improve in some way Most expectations of surgical outcomes related to physical symptoms and functional abilities The percent of caregivers' expectations met ranged from 33% to 100% (Mean= 77%) Although no significant differences between groups were found, there was a trend for caregivers to report a higher number of met expectations (Mean= 12 75) than patients (Mean= 8 25, p= 08)

Family caregivers reported being more than somewhat satisfied with the outcome of the surgery (Mean= 2 30, S D = 1 09) No significant differences were noted between caregivers and patients on level of satisfaction with surgical outcomes or perception of patients' total health dysfunction

Family caregivers and patients rated the dimensions of patients' health dysfunction similarly with one exception, ambulation dysfunction Caregivers rated patients ambulation dysfunction significantly lower (Mean= 7 95, p= 05) than patients (Mean= 13 05)

CONCLUSIONS

The family caregivers in this study were more than somewhat satisfied with their respective family member's surgical outcomes following pallidotomy surgery In general, pallidotomy surgery met the majority of the family caregivers' expectations of the surgical outcomes This may have, in part, contributed to their satisfaction with the surgical outcomes In a sample of patients with PD who underwent pallidotomy surgery, Backer (1997) found that the more patients' expectations of surgical outcomes were met, the higher their satisfaction with surgical outcomes The caregivers expectations of the surgical outcomes mainly focused on improving patients' functional abilities and decreasing physical symptoms Caregivers and patients had similar perceptions of patients' health dysfunction with one exception, ambulation dysfunction, in which caregivers rated patients' ambulation dysfunction significantly lower There were also no significant differences between caregivers and patients on level of satisfaction with surgical outcomes

RECOMMENDATIONS

One limitation of this study was the small sample size Thus, the findings of the study cannot be generalized to the population at large Future studies need to include a larger and more representative sample of family caregivers of persons with PD

REFERENCES

Backer, J (1997) Patients' perceptions of pallidotomy surgery Expectations, health dysfunction, and satisfaction Manuscript in preparation

Bergner, M , Bobbitt, R , Carter, W , & Gilson, B (1981) The sickness impact profile Development and final revision of a health status measure Medical Care, 19(8), 787-805

Biegel, D E , Sales, E , & Schulz, R (1991) Family caregiving in chronic illness. Newbury Park, CA Sage

BEST COPY AVAILABLE

Dura, J. R., Haywood-Niler, E., & Kiecolt-Glaser, J. K. (1990). Spousal caregivers of persons with Alzheimer's and Parkinson's dementia: A preliminary comparison. *The Gerontologist*, 30(3), 332-336.

Duvoisen, R. (1991). *Parkinson's disease: A guide for patients and families.* New York: Raven.

Longstreth, W., Nelson, L., Linde, M., Munoz, D. (1992). Utility of the sickness impact profile in Parkinson's disease. *Journal of Geriatric Psychiatry and Neurology, 5,* 142-148.

Wallhagen, M. & Brod, M. (1997). Perceived control and well-being in Parkinson's disease. *Western Journal of Nursing Research, 19*(1), 11-31.

Living on the Health Care Drawing Board: An Analysis of the Availability of Health Care to Low-Income Families in Los Angeles

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Health care reform is central to the U.S. agenda, but is in great need of improvement, especially in big cities like Los Angeles. Low-income families and ethnic minorities have little or no access to health care. Los Angeles County is attempting to implement a new health system in order to increase the likelihood of access to less costly primary and preventative care at community clinics. Under the new system in Los Angeles County, a number of clinics will close, further complicating the issue of health care access by increasing the distance to health care facilities for segments of the population. Using GIS, availability of health care services has been compared to demographic profiles of surrounding communities in an effort to assess the impact of the new health care delivery system in Los Angeles County.

> Everyone has the right to a standard of living adequate for
> the health and well-being of himself and of his family,
> including food, clothing housing and medical care and
> necessary social services and the right to security in the event
> of. . . sickness. . . .(Universal Declaration of Human Rights)

INTRODUCTION

Health preservation is essential to our everyday life. People go to great measures to assure themselves that they are in excellent health. Many families and individuals are pressed to find a way of maintaining good health for themselves and for their family members. Spector (1991) points out that human beings have resorted to different methods ranging from mágic and witchcraft to immunizations in an ongoing attempt to prevent sickness and maintain a healthy lifestyle. This process may include cultural rituals to prevent evil-eye[1] to undergoing intense chemotherapy to fight a carcinogenic tumor. These procedures arguably lead one to believe that everything is well, however, there are social and economic elements that affect an individual's health as much as biological and environmental factors. The World Health Organization (WHO) believes that health is much more than the absence of diagnosed physical disease, although the "medical model" of medical training tends to stress this aspect of health. The WHO recognizes that there are many natural as well as man-made factors that are responsible for an individual's health or lack thereof which contradicts what the North American health care provider has been socialized to believe: that modern medicine is the answer to *all* of humankind's needs and that only microorganisms are responsible for the illnesses people experience.

MATERIALS/METHODS

The study area presented and analyzed in this essay includes the cities located to the Southwest of the 2 and 101 Freeways, North of the 105 Freeway, East of the 405 Freeway as well as the ones West of the 710 Freeway[2]. (See Map 1) Most of the cities comprising the study area are made up of a variety of ethnic groups. The GIS and ArcView programs used in this research allow the author to create a spatial model of the location of the study area in relation to other cities. These computer programs also enable one to create spatial images of the statistics being analyzed. This is of extreme importance in order to provide the reader with a greater understanding of the information being presented and of the geographic location of each city within Los Angeles County. GIS and ArcView help to demonstrate the association between communities and the income of the people who reside in them. GIS and ArcView help in the design of maps that depict the study area in detail as well as the location of the clinics being examined.

RESULTS

The demographics of the study area as well as the location of the clinics serve to provide the reader with a greater understanding of the distinct groups from which Los Angeles County is made up. The 1990 Census data for Los Angeles County which clearly shows the areas in which the Latinos and African-Americans live; these are the two major ethnic constituents of Los Angeles County. The Anglos make up the remaining group represented in this study. For the most part however, the latter do not reside in low-income areas, and are not caught in the predicament of accommodating to the ever-changing, cost-rising world of health care since most of these individuals already belong to a health care plan.

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[1] The evil-eye is primarily a belief that someone can project harm by gazing or staring at another's property or person. This belief is probably the oldest and most widespread of all superstitions, and it is found to exist in many parts of the world, such as Southern Europe, the Middle East, North Africa and Latin America.

[2] The Geographic Information System (GIS) and ArcView were used as tools to diagram the cities within the study area.

The cost of health care has risen every year. According to the Organization for Economic Cooperation and Development (OECD), people in the U.S. spent $2.868 on health care in 1991. Further, the OECD stated that in 1992 there were over 10 million children, 6 million unemployed, and 5 million part-time workers who did not have any type of health insurance. Today there are about 37 million people who are uninsured. Los Angeles alone has an estimated 2.6 million people in the county, most of whom are working, without health insurance with an additional 1.8 million residents on Medi-Cal. (Rabin, 1996) "A country's wealth should relate to the public's health, but the United States falls behind many industrialized nations that spend less money on health care." (Brown, 1989) Although some of these people may be serviced by private institutions or Health Management Organizations (HMOs), the main focus is on the role of the County's Health Centers in the delivery of health care to poor families and uninsured individuals. At the same time, it is believed that many of these individuals do not seek medical attention because they do not know where to go for affordable health care.

Even with all the changes that have taken place, low-income people are still victims of a private system that caters to the affluent. This is a system that is not attentive to the needs of poorer people who are experiencing distress. The lack of attention paid to patients is expressed in the form of sacrificing treatment for someone who cannot afford health care, and offering it to those who can. In spite of the fact that there are places where the needy may go for health care, they are still referred elsewhere when an emergency arises. In some cases, patients are not assisted on the basis that a language barrier exists or there is a lack of trained personnel due to government cutbacks on health care.

People also have to worry about making enough money to support themselves and their families. In many cases, these individuals fall under the poverty level, creating serious problems for maintaining health care. Even though this level rises constantly according to the economy of the country it does not mean that people's lifestyles are improving. "As of August 1990, the figures for a non-farm family of four was $12.600." (Hevesi, 1990) Families or individuals who fall beneath this line encounter a difficult time when it comes to making payments on a health plan in addition to their bills. The poverty line is defined so that the family income provides a satisfactory diet, without any regards to the other factors that affect an individual's health. It also depends on the size of each family and is modified each year to the consumer price index. (Spector, 1991) Dutton further advocates this idea by stating that:

> illness is disproportionately concentrated in the lower social class areas. There is a large gap between those at the bottom . . . and those at the top in nearly every measure of morbidity and mortality. . . despite the increased access provided by the public entitlement programs, the poor still have lower rates of utilization . . . fewer services at all ages relative to illness levels, less preventive care. . . and greater financial and organization barriers to access.

In short, not enough time and effort are being put in creating the blue prints for a system that will assist the underprivileged in attaining adequate health care. It also asserts that there is a low rate of utilization amongst the poor. This may be attributed to the lack of health centers in areas that have greater concentration of low-income families.

The County Health Centers as well as other health care providers in the 1990s are faced with a rapidly changing system of health-care delivery. A more technical and far less personal system has been created and it is nearly impossible for people with marginal incomes and no insurance to obtain the needed care. This is a major determining factor in the quest for health care since historically, poorer ethnic groups have not had the resources to acquire the medical attention they need. Most poor people live in substandard conditions, which pose numerous health risks such as: "rats, poisons, fires, inadequate heat and plumbing, dangerous electrical wiring, trash, deteriorated structures and crowding." (Brown, 1989; Rainwater, 1966) Living in these conditions give rise to serious health conditions such as stress, less opportunity to rest and recover as well as more vulnerability to infection due to structural and sanitary conditions of the environment in which they live. Even if "social class is measured by income, education, or occupation, much of the same pictures emerge: those at the bottom have the highest rates of death and disease." (Dutton, 1986) This is particularly true for individuals who are involved in strenuous activities that are required for work. This same population has transportation problems in accessing centralized health care. It is important to take notice that most of the County's Health Centers are located in proximity to one of Los Angeles major Freeways, the 110. At first glance one may surmise that they are readily accessible by means of private transportation, but the truth is that it is hard to get from one place to another in a city where *wearing a car* is a necessity if one wishes to survive. Sometimes it is difficult for people to receive the necessary care because they lack any type of transportation and cannot come up with the necessary fare to get from their homes the County's Health Centers and in some cases, from health center to health center and finally back to work or home. The rising cost of health care, the costly fee for transportation compounded with its slow pace, make it extremely difficult for individuals to receive immediate attention and adequate care when needed.

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These incompetent methods of healing also affect the way in which people interpret and respond to the signs and symptoms of illnesses. Many people, especially those from developing nations, have their own ways of life and beliefs that are distinct from the ones to which North Americans are accustomed. These settlers from abroad continue to carry on their cultural as well as religious rituals used by their ancestors when faced with illnesses. As Spector (1991) states, this is true of immigrants from México, Central and South America and those from Eastern Europe. She goes on to say that these people "... share the problems and hopes and dreams of earlier immigrants and have their traditional health and illness beliefs and practices." This, however, is contradictory to what the Western health care provider believes and as a result, many people are turned away because of the cultural insensitivity expressed. Although the modern medical world may see these methods as rustic, it is up to the "modern" world to teach these individuals that there are effective alternatives to traditional methods of healing.

In some cases, people find themselves hoping for natural recovery, due to fear of being deported under Proposition 187: an inhuman bill denying needed medical, non-emergency services to undocumented people. This makes one wonder: What measures are being taken to prevent the spread of diseases such as TB or AIDS when people are not given the appropriate medical treatment? In the case of infectious diseases, individuals at high risk put others in danger of being wrongfully infected with a potentially fatal disease. Viruses and bacteria attack everyone regardless of whether these people are undocumented or not and Proposition 187 is a slap in the face of health care givers whose primary goal is to provide the best medical treatment to the masses without discrimination. This same concern was voiced by one of the Triage nurses at the Curtis R. Tucker Health Center in Inglewood, CA, whose patients are roughly 70% Latinos and 25% Blacks with few Asians being assisted throughout the year. She expressed her concern about living conditions of the patients who reside in the neighboring areas because many do not get tested for venereal diseases (VD) or for Tuberculosis (TB). She believes that Proposition 187 has had an enormous impact on the immigrant community who fear being deported if they try to receive medical care. This creates an even greater problem for the community because it means that the infected or "hot" patients are spreading diseases and are victims of a system that is unfriendly to the undocumented. This is especially true considering that many people tend to wait until the illness has become too complicated to prevent and sometimes do not receive adequate care because they are afraid of being victims of new laws that deny assistance to the poor and undocumented.

Phillips and Verhasselt (1994) are quick to add that there are also many examples of how economic development affects health status in a growing economy. On the one hand, there is an increase in "life expectancy, falling infant, child and maternal mortality rates and enhanced access to services". On the other, this type of "development" can cause many side-effects to the population in what Phillips calls the "health by-products" of industrialization. These "by-products" include: "... risks from new dangers at work, exposure to toxic substances, effluent radiation, traffic pollution and general industrial noise and waste in the environment. . . ." These people are the ones who typically find themselves the victims of inadequate care. As a result, there is a population of people not serviced by private health providers simply because these people cannot afford the ever rising cost of health care.

The number of Americans lacking health insurance has dramatically increased every year since the early 1980s due to the lack of availability. According to sources at the County's Health Centers, availability is a major factor in the health care world. It is true that the County's Public Health Centers offer cost-effective service to its patients, but the lack of government funding has forced several centers to downsize and cut down on the number of services offered as well as to reduce the number of patients seen per day. Phillips and Verhasselt (1994) state that:

> Recession. . .and debt servicing. . . have reduced public expenditure on health and welfare. The links between regional, economic and environmental factors and the health of a population are becoming clearer.

These factors have created a faulty system in Los Angeles County due to the lack of prioritizing as well as all the cutbacks with which the health system has been plagued. Moreover, one can see the results of the governmental cutbacks on the quantity of Health Centers left as well as the number of services they now offer to the poor and uninsured.

Downsizing has forced the County health providers to refer people to other potential health care providers (managed by HMOs) in the areas adjacent to the already existing health centers. This creates problems for the centers that remain open because it overloads their sites. In 1995, the Clinton administration allocated $16.6 million in gross appropriations to the County's Health Centers, but most of the original patients (and their friends) had already been snatched by the HMOs, which began servicing individuals who qualified for or already had Medi-Cal.

In turn, the loss of patients to the HMOs has a great effect on the number of patients who attend the County's Health Centers. In 1994-95, the number of outpatient visits was about 4 million, but when the centers began closing down, the number dropped to 3.2 million per year. With this in mind and the new contracting of the clinics, Los Angeles County officials estimate that in the 1996-97 period, there will be about 3.65 million outpatient visits. (Rabin, 1996) All these changes have put a strain on the patients who are now forced to find the needed care somewhere else until the County's Health Centers begin providing care for these patients once again.

The poor have recently encountered an even greater problem: the closure of several County clinics, which puts them in an even greater predicament. The poor are now constrained to the few

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resources they have at home, thus putting them at greater risk of a serious illness or relapse. Some of the Health Centers have gone from being major providers of several services to simply offering one service, while others have received an excess of patients due to the closure of other centers. Even after all the downsizing, Los Angeles County health officials found a way of working together with private health institutions in an effort to balance public health with the ever-changing methods of providing adequate attention. This, however, puts a strain on the few County workers left as well as on the patients because they now have to rely on the expensive HMOs as their sole health care provider. The primary goal of HMOs is to keep prices down by limiting patient visits per year. This method, however, is not effective because should patients need further care they will only receive assistance at outrageous prices. This explains why there are many individuals without health insurance who are becoming victims of relapses when minor illnesses such as a cold become serious ones such as pneumonia.

County officials on the other hand, have made their services more available to some low-income individuals who may not have earned enough to afford quality care in the past. Some of the Health Centers that are still open provide services ranging from immunizations to TB testing. When emergencies arise the patients are referred to the nearest emergency ward, such as the Charles Drew Medical Center in South Central Los Angeles. In addition, some of the Comprehensive Centers offer semi-emergency services at their Urgent Care centers, which work as intermediaries between the outpatient clinic and the Emergency center. If an individual comes to the Comprehensive Center's Urgent Care Clinic, he/she is diagnosed and assisted according to the type of trauma from which they are suffering and transported to a neighboring Emergency Services provider.

Although the County clinics provide inexpensive health care to the poor and have ameliorated the health status of many poor individuals, they have not been enough to improve the well-being of the large population of uninsured people that has increased in the past few years. As of 1991 of all the industrialized nations, the U.S. and South Africa were the only ones without a comprehensive national health program. (Spector, 1991) As a result, county officials were hoping that by the end of the 1996 fiscal year, they would be able to double the number of outpatient clinics in the community from the present 39 to 83, "through the most extensive use of partnerships with private medical groups in the county's history. It is a dramatic departure from the traditionally separate public and private health care systems in the county." (Rabin, 1996) This would allow those uninsured individuals to obtain care at new, closer locations enabling workers to miss fewer days from work.

People are forced to rely on the County's Public Health Centers to receive care because most families qualify only for Medi-Cal; this is a federal-state type of assistance and it is available to individuals and families who meet the low-income criteria and are not covered by any type of health insurance. In an attempt to receive suitable care, some people have attempted to become part of an HMO-related health plan. This however, has not been of much benefit to those low-income people who are seeking professional treatment because they still face financial difficulties. Many of the people who have adequate documentation for return to the U.S., find it easier to drive to Tijuana, México to receive the same treatment for a lower cost from someone who speaks their language. County officials not expecting low-income patients to seek and find affordable health care in other countries, are now faced with the great deal of competition in the U.S. between private health care providers whose practices have caused an increase, rather than reduction in health care cost in Los Angeles.

Instead, County officials have created a system in which they will incorporate health care providers from the private sector. According to Luft, "the underlying notion of this type of competition is that people would be given a choice, usually on an annual basis, to choose among a set of health plan options to provide their care for the coming year." With all this in mind, one may have the misconception that the Health Center's services are free because of the fact that they cater to the less affluent, but one must realize that their services are provided at an affordable price for most, while others require further financial assistance.

CONCLUSION

Although the County health centers have been able to render their services to great numbers of poor and uninsured individuals, the cutbacks they have received along with the closure of some of these centers has made an enormous impact on how one views health care delivery. In addition to the lack of services and personnel at the clinics, one can clearly see that there are other underlying factors that prevent people from receiving the care they need. These factors, linked with the expansion of private clinics have prevented those at the bottom of the economic ladder from receiving health care because of their inability to pay such high prices for it. As the number of uninsured people increases due to the high prices of health plans, the quality of care diminishes at an astonishing rate.

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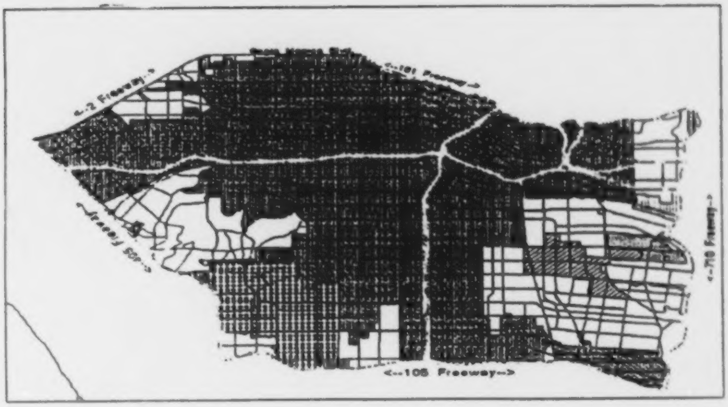
MAP 1: STUDY AREA



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REFERENCES

Brown, Phil. Perspectives in Medical Sociology. Belmont, CA: Wadsworth Publishing Company. 1989.

Claude, Richard Pierre and Burns H. Weston, eds. "The Universal Declaration of Human Rights." Human Rights in the World Community: 2nd Edition. Pennsylvania: The University of Pennsylvania Press. 1992.

Dutton, Diana. "Social Class, Health, and Illness." Perspectives in Medical Sociology. Ed. Phil Brown. Belmont, CA: Wadsworth Publishing Company. 1989.

Goldberg, Mark. "American Health Care Reform: Separating Sense from Nonsense." Understanding Health Care Reform. Ed. Theodore R. Marmor. New Haven and London: Yale University Press. 1994.

Helms, Robert, ed. American Health Care Policy: Critical Issues and Reform. Washington, D.C.: The AEI Press. 1993.

Hevesi, D. "Health Conditions Worsen for Young." *The New York Times* 89 (July 15, 1990): 20.

Marmor, Theodore. Understanding Health Care Reform. New Haven and London: Yale University Press. 1994.

McKenzie, Nancy. Foreword by Barbara Ehrenrich. Beyond Crisis: Confronting Health Care in the United States. New York: Penguin Books USA, Inc. 1994.

Phillips, David and Yola Verhasselt, eds. Health and Development. London and New York: Routledge. 1994.

Phillips, David. Health and Health Care in the Third World. London: Longman. 1990.

Spector, Rachel. Cultural Diversity in Health and Illness: 3rd Edition. New Jersey: Appleton & Lange. 1991.

Willis, David, ed. Health Policies and Black Americans. New Brunswick (USA) and Oxford (UK): Transaction Publishers. 1989.

Fathers, Food, and Fun: A nutrition Education Program for Low-Income Urban Fathers and their Children

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Low-income urban fathers constitute both an unserved population and a population in need. Nutrition education programs that focus on the specific needs of this group simply do not exist in the Twin Cities. We conducted focus groups with the target audience and designed a complete curriculum for nutrition education specifically for this group. This paper gives an overview of the design process and the resulting curriculum, with specific attention to a sample lesson covering food safety.

BACKGROUND

In recent years, Americans have become more aware of men's rights and family obligations. The Million Man March and Promise Keepers are two examples of this movement. In preparation for our research, we identified 19 support programs for men in general and 17 for fathers specifically in the Twin Cities. We contacted each of them, and none offered nutrition education. A nationwide literature search revealed only one nutrition program designed for fathers, and that was a program to educate fathers about the benefits of breast feeding. The changing structure of American households has led to an increasing number of single-parent families headed by fathers. Clearly, fathers are a population that could benefit from nutrition education.

METHODS

Local support programs for fathers were identified and the directors of these programs were invited to participate in focus groups. Two such focus groups were conducted with 14 participants. Questions were asked during these focus groups concerning their facilities, programs and participants. The program directors were also asked what age child presents the most difficulty to the fathers in their programs. Finally, the directors were asked for advice on what to cover in our upcoming focus groups with the fathers.

During a second series of three focus groups, 16 low-income fathers who lived in urban areas and participated in local support programs for fathers were asked about their opinions and attitudes toward nutrition and cooking, their motivation to participate in a nutrition education program, what they would like to learn, and what qualities they would prefer in an instructor.

Based on the results of these focus groups, a nutrition education curriculum was designed and implemented. The authors of the curriculum were available to the instructor for questions and revisions while the first two groups of participants completed the program. Revisions were made as necessary. Fathers enrolled in subsequent groups, as well as a group of control subjects who did not participate in the program, were asked to complete questionnaires before commencement and after completion of the program to measure its efficacy. Results of this evaluation will be reported at the annual conference of the Society for Nutrition Education this summer.

RESULTS

Fathers are motivated primarily by their love for their children. Some fathers saw a nutrition education program as a chance to spend quality time with their children. Fathers also felt they would be more likely to participate in a program that celebrated their culture, as well as others. Having fun was also a motivating factor.

Fathers were mostly interested in learning about basic and practical matters. Cooking skills, basic nutrition, food safety, and feeding their families within a limited budget were priorities. Also expressed was a desire to learn about different ethnic foods. The most frequently mentioned subject of interest was cooking.

Several concerns were brought up in the focus groups, such as transportation to and from the lessons and child care. Most stated that they would feel more comfortable if the lessons were taught at a location near their home by a male instructor, preferably a father, who was well-educated in nutrition. Many complained of receiving conflicting or incorrect nutrition messages from the media or health care professionals, suggesting that a trustworthy and well-educated instructor could help sort fact from fad. Others were concerned that not all participants would be custodial parents; they did not want fathers to be left out because they could not bring their children to the lessons. Very young children and teens were identified as the most difficult ages for parents to deal with.

Whether children should be present during instruction was a somewhat controversial issue. As stated earlier, some fathers viewed these lessons as an opportunity to spend time with their children. Others, however, preferred to learn the material first and teach it to their children themselves. They did not want the children to be a distraction, and some were worried about looking foolish in front of their children.

A complete and in-depth review of the results of these focus groups has been submitted to the *Journal of Nutrition Education*, and will be presented at this year's conference of the Society for Nutrition Education.

LESSON DESIGN

Six lessons were designed based on the above results. Each included fun, hands-on activities and food preparation, and each was planned to last two hours. Because very young children and teens were identified as being the most difficult ages for fathers to manage, the lessons were designed for fathers of children between the ages of four and eleven. It was felt that fathers of children within this range would be less likely to become preoccupied or distracted with problems associated with raising their children at the expense of their participation in the program. The six lessons are:

Five Alarm Chili:	*exploring the versatility of food, intro to Food Guide Pyramid*
Germ Warfare:	*food safety*
Play the Hand You're Dealt:	*meal preparation with scant resources*
Cooking with Power Tools:	*using utensils and following recipes*
Taster's Choice:	*exploring ingredients and taste preference*
A Child's Perspective:	*developing reasonable expectations for children's eating habits*

SAMPLE LESSON: GERM WARFARE

In this lesson, fathers learn about issues of food safety by participating in three activities: Safeburgers, The Smell Activity, and Mr. Jicama-Head. What follows is a description of this lesson, and not the actual wording in the lesson itself.

Safeburgers:

Participants work UV-fluorescent powder (representing germs) into a modeling compound (representing an uncooked hamburger patty). When this is done, the area is viewed under UV light. Glowing powder represents the transfer and spread of germs from the uncooked meat. Participants then clean their work surface, utensils, and their hands, and view the area again under UV light to see how effective their cleaning was.

The key points of this lesson are that germs spread from uncooked meat, and that hands, work surfaces, and utensils must be washed before and after coming in contact with uncooked meat.

The Smell Activity:

Participants are given cards with food safety scenarios printed on one side and a scratch-n-sniff label affixed to the other side. After reading the card and sniffing the label, participants will be engaged in a discussion about the particular concept of food safety represented in the scenario. Following is a typical scenario:

> "Dear-Ol-Dad and his children love chili. He usually makes very large batches of chili and keeps the leftovers in the refrigerator. This particular batch of chili was left on the counter from suppertime (6:00) until bedtime (10:30). Dear-Ol-Dad looked at the chili. It looked normal. It smelled like the label on the back of this card. Dear-Ol-Dad loves his children, and he would never do anything to risk their health, but food is expensive and money is tight. What should Dear-Ol-Dad do with the chili?"

The label on the back of the card smells like unspoiled chili.

The key points in this activity are that smell can be misleading and can not be trusted to determine the safety of a given food, and that knowledge is the best tool for determining a food's safety. Other points covered in this activity are that leftovers must not be left to stand at room temperature for more than two hours and that hamburger must be cooked at least medium-well before it is safe to eat.

Mr. Jicama-Head:

Participants break up into groups and prepare fresh, raw vegetables by washing, sorting, and cutting them. Pieces of vegetables are affixed with peanut butter to a large slice of jicama (also known as "Mexican potato") to form a face. The groups then display their creations before eating them.

The key points of this lesson are development of food preparation skills, proper washing technique, and discarding questionable food. Also stressed are the fact that children enjoy raw vegetables, which are more nutrient-dense than when cooked. Creativity and fun are encouraged.

The Germ Warfare lesson includes fun activities, food preparation, and food safety instruction, all of which were identified in our research as items our participants wanted. In addition, the activities can be done by the fathers with or without their children present.

CONCLUSION

Fun and active lessons and activities for low-income urban fathers and their children were designed based on research. To our knowledge, this is the first time such a program has been developed for this population.

This curriculum is currently being used in the Twin Cities by the University of Minnesota Extension Service, and it is expected to become available to other organizations in the near future. For more information, contact the authors at the above address.

ACCOUNTING FOR THE EFFECTS OF HURRICANE HUGO

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ABSTRACT

Hurricane Hugo blew into the Carolinas leaving hundreds of thousands of customers without power for up to two weeks. This research examined the effect of Hurricane Hugo on the financial statements of selected electric utilities. The methodology included accounting policy analysis and ratio and trend analysis. Policy choice centers on the issue of capitalizing versus expensing hurricane-related costs. The results show that capitalization had a smoothing effect on report income. Ratio analysis reveals a decline in key indicators such as the current ratio and debt/equity ratio.

INTRODUCTION

In September of 1996 Hurricane Fran slammed into coastal areas of North Carolina and into the Research Triangle Park (RTP) area where North Carolina Central University is located. The storm had eighty-five MPH winds when it hit the RTP. Tens of thousands of trees were downed; power lines and transformers were knocked out; and thousands of homes had structural damage. Electrical services were disrupted for up to fourteen days.

The storm had a devastating effect on coastal and piedmont North Carolina. Economic activity slowed as residents were unable to travel the streets and roads in the first days after the storm. As the roadways were cleared, economic activity increased above pre-storm levels.

This research examines how Duke Power Company, the largest electric utility in North Carolina, accounted for a natural disaster. Financial accounting for Hurricane Hugo, which occurred in 1989, was studied in order to have financial results for periods subsequent to the natural disaster and also to have published results for rate adjustment cases. Some of the questions investigated were: (1) Which costs from the storm were capitalized and which costs were expensed? and (2) What was the impact of the storm's costs on the company's income statement and balance sheet?

METHODOLOGY

Electric utilities are regulated entities. In this research, the rate-setting process for utilities is reviewed along with regulatory procedures for responding to a natural disaster. Regulatory accounting and Generally Accepted Accounting Principles (GAAP) are compared. The annual financial report and the notes to the financial statements were examined to determine how the companies accounted for the hurricane costs. Interviews were conducted with Michael C. Maness, CPA, Supervisor, Electric Section, Accounting Division, Public Staff, North Carolina Utilities Commission and with Cal Owens, Asset Accounting, Duke Power Company. Financial ratio and trend analysis were used to analyze the results of operations and financial position over a three-year period surrounding the event year.

UTILITY REGULATION

Public utilities in North Carolina come under the jurisdiction of several regulatory bodies including the North Carolina Utilities Commission (NCUC) and the Federal Energy Regulatory Commission (FERC). Companies that also operate in South Carolina are subject to regulation by the Public Service Commission of South Carolina (PSCSC). The NCUC and the PSCSC must approve rates for retail sales within their respective states. The FERC must approve rates for sales to wholesale customers. The NCUC seeks to set rates which allow utilities to recover reasonable costs and earn a reasonable return on investment.

Retail fuel costs are reviewed annually and during general rate case proceedings in North Carolina. In the wholesale and South Carolina retail jurisdictions, fuel costs are reviewed semiannually. Following such review, changes may be made in costs included in the base rates.

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Utilities are allowed to adjust rates for past over- or under-recovery of fuel costs.

Policies established by state utilities commissions and the FERC determine how utilities account for costs associated with a natural disaster. Utilities must classify their costs by units of property. The FERC defines what the utility companies can consider a unit of property . It also prescribes the minimum level of units of property that a utility company is allowed to have and places a ceiling on the amount of units of property.

Costs associated with a natural disaster are capitalized or expensed based upon how these costs are categorized. If the item of property is not classified as a minor item, its costs are capitalized. Costs of minor items are expensed. However, the NCUC can and did permit Duke Power Company to capitalize expenses associated with the hurricane, by placing those costs in a deferred debit account. Duke Power Company was then allowed to amortize those costs over a five-year period.

RATIO AND TREND ANALYSIS

Ratios are benchmarks against which to evaluate a company's effectiveness. This study focuses on several standard ratios which are used in financial statement analysis including current and quick ratios, return on assets, return on average common equity, earnings per share (EPS), and debt ratio. Both industry comparisons and trend analysis were used.

The current and quick ratios measure a company's ability to meet its currently maturing financial obligations. (See Table 1.) The current ratio declined from 1.78 to 1.25 over the period 1988 to 1989. This deterioration in the ratio was due to a 48 percent increase in current liabilities while current assets increased by only 4.6 percent. The ratio declined slightly in 1990. As would be expected, the quick ratio also declined over the period from 1.21 in 1988 to 0.85 in 1989. It should be noted, however, that while Duke Power Company's current and quick ratios declined over the period, its ratios are significantly better than the averages for the industry.

Table 1: Liquidity Ratios

	1988		1989		1990	
	Industry*	Duke Power	Industry	Duke Power	Industry	Duke Power
Current Ratio	1.0	1.78	1.0	1.25	0.9	1.20
Quick Ratio	0.5	1.21	0.6	0.85	0.5	0.76

*Companies with assets of $250 million or more.

The return on total assets (ROA) shows the amount of net income earned in relation to total assets. This ratio is an indicator of how efficiently a company uses its economic resources. Duke Power Company's ROA declined by only 2.7 percent in 1989 but was down by 10.5 percent two years after the storm. The company again compared favorably with others in its industry. (See Table 2.)

Table 2. Profitability Ratios and Earnings Per Share* (EPS)
(in percent except EPS which is in dollars)

	1988		1989		1990	
	Industry**	Duke Power	Industry	Duke Power	Industry	Duke Power
Return of Assets	6.5	8.34	5.7	8.7	6.2	8.0
ROA - Common	4.7	13.4	2.4	14.7	4.7	13.1
EPS**	------	2.45	------	2.56	------	2.40

* Shown after stock split in 1990
**Companies with assets of $250 million or more.

Return on average total equity is a measure of the company's profitability. The ratios are higher than the return on total assets ratios, indicating favorable financial leverage. The ratios increased from 13.4 percent in 1988 to 14.7 percent in 1989. These ratios show that Duke Power

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Company successfully used borrowed funds to earn a return greater than the interest paid on those funds. Therefore, stockholders benefitted.

Earnings per share (EPS) increased 4.5 percent over the year from $2.45 a share to $2.56 a share. However, EPS was down two percent over the two year period.

The debt ratio shows the percentage of total assets provided by creditors. (See Table 3.) It is an indicator of the long-run solvency and stability of the company. This ratio provides evidence of the safety of investments by bondholders and stockholders. Duke Power Company's debt ratio showed only a percentage point change over the 1988-1989 period, from 53.6 to 54.6 percent. As Table 3 shows, the contribution of debtors to the company capitalization was relatively constant for the periods reported. Again, Duke Power Company's ratios are significantly better than those for the industry.

Table 3: Stability Ratio (in percent)

	1988*		1989		1990	
	Industry*	Duke Power	Industry	Duke Power	Industry	Duke Power
Debt Ratio	62.1	53.6	62.3	54.6	58.4	54.7

*Companies with assets of $250 million or more.

SUMMARY AND CONCLUSIONS

Ratio and trend analysis show no effect of the hurricane cost on the profitability and financial position of Duke Power Company in the year of and the year following the storm. These results are attributed to the regulatory environment in which the utility operates. Utility accounting permitted Duke Power to capitalize $44 million and to treat an additional $19.5 million as deferred credits, essentially capitalizing those costs as well. The North Carolina Utilities Commission permitted the company to write the $19.5 million cost off over a five-year period. Included in the $19.5 million was $11 million cost of removing old units of property that were damaged or destroyed by the storm. Under current GAAP, nonregulated companies would have to expense those costs in the year incurred. The result of this treatment is to reduce the effect of the storm on the bottom line of the income statement and to increase reported assets on the balance sheet. In other words, the result is a smoothing of income.

FURTHER RESEARCH

This study has investigated the effect of Hurricane Hugo on the financial statements of one utility company. Historical data have been used. It would be interesting to see what the effects on the financial statements would be if nonutility accounting (current GAAP) had been used in accounting for the costs of the storm. It would also be interesting to compare the accounting by smaller companies with Duke Power Company's accounting for the cost of the storm. There may be differences in units of property capitalized and in the time period over which deferred credits were depreciated.

REFERENCES

Almanac of Business and Industry Ratios 1991 Ed. Prentice Hall, Englewood Cliffs, NJ, 1991.
Almanac of Business and Industry Ratios 1992 Ed. Prentice Hall, Englewood Cliffs, NJ, 1992.
Almanac of Business and Industry Ratios 1993 Ed. Prentice Hall, Englewood Cliffs, NJ, 1993.
Duke Power Annual Report to Shareholders 1989. Charlotte, NC.
Duke Power Annual Report to Shareholders 1990. Charlotte, NC.
Eighty-First Report of the North Carolina Utilities Commission Orders and Decisions. NC Utilities Commission, Raleigh, NC, 1991.

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Changes in Smokeless Tobacco Utilization Patterns Among School-Aged Children

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A study on the introduction to and use of smokeless tobacco in elementary age school children (Lisnerski, et al.) indicated that: 22.4% of children surveyed reported having tried smokeless tobacco at least once, while 5.72% reported continued use. This study received national attention from educators and the media. Since this study, educational efforts and state legislation have been changed to reduce or discourage the introduction and use of smokeless tobacco. The purpose of the follow-up study was to determine if these changes have been effective, and if there was a significant shift in demographics of underage users. The results of the follow-up study indicate a decrease in the use of smokeless tobacco products among children. This indicates that the changes in curriculum and legislation were effective in reducing the use in underage children.

INTRODUCTION

In the Fall of 1987 a study was conducted on the introduction to and use of smokeless tobacco in school-aged children (Lisnerski, et al.). Results indicated that: 22.4% of the children surveyed reported having tried smokeless tobacco at least once, while 5.72% reported continued use. Results also indicated that 36 percent of male rural first graders had tried smokeless tobacco, increasing to 70 percent by the seventh grade. Overall, rural males were more likely to have tried or be regularly using smokeless tobacco than were urban males or females. Other questions correlating with smokeless tobacco use indicated that it is predicted by three general concerns: a) perceived flavor, b) self-concept and presentation to peers, and c) family influence (Lisnerski, et al.). That study received national attention by educators and the media. Since that study, local educational efforts and state legislation have been changed to reduce or discourage the introduction and use of smokeless tobacco.

This follow-up study was done to assess the effects of a change in North Carolina legislation and a change in the school systems health education curriculum on smokeless tobacco use in school aged children. In a similar study conducted in Palm Beach County Florida, it was found that despite the enactment of state laws (October 1, 1992 and May 20, 1994), prohibiting the sale of tobacco to persons aged <18 years, 35 percent of minors were successful in making attempts to purchase smokeless tobacco (Bridges, Welsh, and Malecki, 1995). The same study was also conducted in Missouri and Texas. Even though laws were enacted prohibiting sale of tobacco to those under 18, 46.1 percent were successful in purchasing in Missouri. In Texas, 62.8 percent of minors were able to purchase tobacco products. These findings are being used to support legislation for stronger enforcement of laws and penalties to restrict minors' access to tobacco products (Romeis, Brownson, Davis, et al., 1993).

National surveys of adults indicate the highest prevalence of use now occurs among young adult males (Boyd, and Glover, 1989). According to a 1989 report of the U.S. Surgeon General, an 11-year-old girl in central Massachusetts achieved a 75 percent purchase rate of tobacco. Altman et al reported a purchase rate of 74 percent by minors aged 14-16 years in Santa Clara County, California. In Decatur, Illinois, Doctors Ought to Care (DOC) chapter reported a 63 percent rate of purchase for an 11-year-old girl and a 78 percent rate for a 16-year-old. Studies in Canada and England produced similar results, with a 79 percent to 87 percent purchase rate in Manitoba, and a 91 percent purchase rate by 16-year-olds in Avon,

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England (Hoppock, and Houston, 1990) A study performed in urban public school students in Los Angeles and San Diego indicated the use of smokeless tobacco is more common among men than women and among Caucasians than African Americans, Hispanics, and others Twenty percent of the male respondents and 5 percent of the females reported use of smokeless tobacco at least once, 10 1 percent of males, and 3 1 percent of females who had never tried smokeless tobacco by seventh grade started to use it by eighth grade Among Caucasians, about 30 percent of boys reported trying smokeless tobacco at least once and 13 7 percent of those who had never used smokeless tobacco by seventh grade started experimenting by eighth grade (Hu, Hedeker, Flay, et al)

The 1987 study (Lisnerski et al) was vital in providing data on the relationship between age, smokeless tobacco use, and the demographic and attitudinal correlates of smokeless tobacco use It has helped in the assessment of health risks and in the design of health education programs State laws have been brought into effect to help in the reduction of purchase of tobacco across the United States North Carolina state law, effective January 1, 1995, states that if any person shall knowingly sell, give away or otherwise dispose of, directly or indirectly, cigarettes, or smokeless tobacco products to any minor under the age of 18, he shall be guilty of a class 2 misdemeanor (The Department of Justice of the State of North Carolina, 1996) Changes in the health education curriculum have also been made to incorporate discussion considering the negative impact of tobacco on school children On August 11, 1995, the Federal Drug Administration (FDA) issued a lengthy proposal to regulate the sale and promotion of tobacco cigarettes and smokeless tobacco products to minors The proposal includes three categories of regulations The first being the prohibition on sales to people under the age of eighteen The second is to limit the ability of the industry to market their product The third is a proposal to establish a public educational program to help educate people about the harmful effects of tobacco (Zieve, 1996)

METHODS

The author slightly modified the two versions of the smokeless tobacco inventory used in the 1989 published study These surveys were administered to a total of 478 school children in western North Carolina The total sample was broken down by grade, sex, and rural or urban residence Included were 98 first graders, 120 third graders, 143 fifth graders, and 117 seventh graders There were 239 males, and 217 females, and 22 children who failed to specify gender on their questionnaires Rural residence children were designated by school districts with less than 153 people per square mile, n=234 and urban residence children by school districts with more than 1906 people per square mile, n=244 A stratified random sampling algorithm was used Appropriate rural and urban schools were identified and classes were randomly selected within each grade level until approximately equal sample sizes were attained for each combination of grade and residence

One questionnaire was administered orally to first graders, a written version was given to third, fifth, and seventh graders Several refinements were made in the questionnaire as a result of the change in North Carolina legislation and the school system's health education curriculum The resulting questionnaires consisted of three questions identifying gender, age, grade and 20 questions, for third, fifth, and seventh graders, asking about use of smokeless tobacco, attitudes towards smokeless tobacco, familial, peer-group, and role-model use, recent purchasing of tobacco products, recall of smokeless tobacco advertisements and awareness of health risks associated with the use of smokeless tobacco and cigarettes A shorter version with only 12 questions was administered to the first graders The new questions were tested to ensure clarity to the younger students A "don't know" response added to "yes" and "no," was still a part of appropriate questions on both questionnaires Guidelines were developed restricting teacher involvement in questionnaire administration to prevent response biases and evaluation apprehension on the part of the students It was emphasized throughout each session that the questionnaires were entirely anonymous, that names should not be written on the forms, and that responses cannot be traced back to the individuals

RESULTS

With the exception of questions on age, grade, and sex, subjects' responses on the questionnaire consisted of "yes," "no," and for some items, "don't know." Since the data is primarily categorical in nature, a parametric analysis must be approached with caution The basic demographics of smokeless tobacco use is provided and broken down by grade, rural or urban residence, and gender The use of multiple regression for this analysis was deemed unnecessary

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because of its particular sensitivity to non-normal distributions and because list-wise deletion of subjects with missing data and "don't know" responses produced regression analysis with either too few questions included, or too few subjects.

Overall, 8.55 percent of the respondents reported having tried smokeless tobacco at least once, compared to 22.4 percent in 1987. For those who continue use, 2.48 percent was reported compared to 5.72 percent in 1987. These overall percentages were broken down by first, third, fifth, and seventh grades, rural or urban residence, and gender.

The percent of children who had tried smokeless tobacco (see Table 1) has overall decreased. Significant increases have come in the areas of rural males, decreasing from 48.9 percent in 1987 to 19.83 percent in 1997, and rural females, 20.0 percent to 2.73 percent. There were cases in which percentages from the 1987 study increased. In the first grade, urban males who have tried smokeless tobacco increased from 5.7 percent in 1987 to 15 percent in 1997. Also, urban females increased from 7.9 percent to 9.1 percent. In the third grade, the only increase in experimentation came in the urban males where 0.0 percent had tried in 1987 compared to 3.4 percent in 1997. In the seventh grade, 3.3 percent increased to 8.7 percent in 1997.

Table 1. Have Tried Smokeless Tobacco by Grade, Sex, and Rural or Urban Residence

Question 1. Have You Tried Smokeless Tobacco?
(percent answering "yes")

	Grade									
	First		Third		Fifth		Seventh		Mean	
	'87	'97	'87	'97	'87	'97	'87	'97	'87	'97
Urban Males	5.7	15	0.0	3.4	9.4	0.0	38.2	10.3	13.3	7.18
Rural Males	36.4	15.8	44.7	6.1	41.9	13.3	72.5	44.1	48.9	19.83
Urban Females	7.9	9.1	3.4	0.0	12.1	0.0	3.3	8.7	6.7	4.45
Rural Females	12.9	0.0	19.4	0.0	12.1	4.2	35.5	6.7	20.0	2.73
Mean	15.7	9.96	16.9	2.38	18.9	4.38	37.4	17.45	22.2	8.55

With respect to "still use" smokeless tobacco, the overall percentages decreased for each class of residence with the exception being the urban females who increased from 1.5 percent in 1987 to 2.8 percent in 1997 (see Table 2). Although there are decreases in continued use of smokeless tobacco, some increases in percentages have occurred. In the first grade, urban males increased from 2.9 percent in 1987 to 10 percent in 1997. Also, the urban females had a substantial increase in their continued use of smokeless tobacco. In 1987, 2.6 percent reported continued use while in 1997, 9.1 percent have been reported. For the seventh grade, there was only a slight increase in continued use among rural males from 20 percent in 1987, to a reported 20.6 percent in 1997.

In summary, the data concludes that since 1987 overall experimentation and continued usage of smokeless tobacco has decreased. Individual increases in "have tried" smokeless tobacco occurred in the urban male and female first graders, urban male third graders, and urban female seventh graders. In the case of "still use" smokeless tobacco, the overall percentages decreased except for a slight increase in the urban female population. Individually, significant increases in continued usage occurred in urban male and female first graders, and also a slight increase in rural male seventh graders.

DISCUSSION

There appears to be a significant reduction in the trial and continued usage of smokeless tobacco in school-aged children. The only exception is male and female first graders. Their increase in experimentation and continued use may be a result of the fact that smokeless tobacco education does not begin until the third grade. It may also be a result of what is called magnet

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Table 2. Still Use Smokeless Tobacco by Grade, Sex, and Rural or Urban Residence

Question 2. Do You Still Use Smokeless Tobacco?
(percent answering "yes")

	Grade									
	First		Third		Fifth		Seventh		Mean	
	'87	'97	'87	'97	'87	'97	'87	'97	'87	'97
Urban Males	2.9	10	0.0	0.0	9.4	0.0	2.9	0.0	3.8	2.5
Rural Males	9.1	0	12.8	0.0	12.9	0.0	20.0	20.6	13.7	5.15
Urban Females	2.6	9.1	0.0	0.0	0.0	0.0	3.3	0.0	1.5	2.28
Rural Females	6.5	0	2.8	0.0	0.0	0.0	0.0	0.0	2.3	0.0
Mean	5.3	4.78	3.9	0.0	5.6	0.0	6.6	5.15	5.3	2.48

schools which bring students in from a larger area instead of one neighborhood. This occurrence may allow for different samples to be over-represented or under-represented as compared to the 1987 study. School-aged children who report trying and still using smokeless tobacco also report having purchased it within the school year. This indicates that even though Legislation has been enacted prohibiting the sale of smokeless tobacco to those under the age of 18, children are still finding ways to purchase the smokeless tobacco products. Of the school-aged children who report trying and still using smokeless tobacco, over 71 percent report knowledge of the harmful effects resulting from continued usage. This shows that the current education curriculum is affective in giving knowledge of smokeless tobacco, yet some children continue their use.

REFERENCES

Boyd, G., and Glover, E. The Journal of School Health. Smokeless Tobacco Use by Youth in the U.S., Vol 59, May 1989, pg. 190

Bridges, F., Welsh, F., and Malecki, J. Morbidity and Mortality Weekly Report. Minors' Access to Smokeless Tobacco-Florida, 1994, Vol 44, Nov 1995, pg. 839-841

Hoppock, K., Houston, T. The Journal of Family Practice. Availability of Tobacco Products to Minors, Vol 30, 1990, pg. 174

Hu, F., Hedeker, D., Flay, B., et al. American Journal of Preventive Medicine. The Patterns and Predictors of Smokeless Tobacco Onset Among Urban Public School Teenagers, Vol 12, pg. 22

Lisnerski, D., McClary, S., Brown, T., et al. American Journal of Health Promotion. Demographics and Predictive Correlates of Smokeless Tobacco Use in Elementary School Children, Vol 5, July-Aug 1991, pg. 426

Romeis, J., Brownson, R., Davis, J., et al. Morbidity and Mortality Weekly Report. Minors' Access to Tobacco-Missouri, 1992, and Texas, 1993, Vol 42, Feb 1993, pg. 125-128

Zieve, M. Public Health Reports. FDA's proposed regulation of the sale and promotion of tobacco products to minors, Vol 111, 1996, pg. 280-285

The Department of Justice of the State of North Carolina. The General Statutes of North Carolina, Vol 3, 1996, pg. 927

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Detecting Hidden Periodicities in Business Cycles of Fifteen Countries Using Fourier Analysis

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Business cycles reflect fluctuations in national income.Traditionally, business cycles have been examined for amplitude, length, diffusion and utilization rate. Little work has been done on the application of Fourier transforms to business cycles. This paper uses GDP data of fifteen countries to determine the structure of business cycles in the frequency domain. The structure is remarkably similar for all fifteen countries. Inverse transformation reveals that high frequency components are not correlated significantly, while low frequency components show very high cross country correlations.

BACKGROUND

Traditionally, business cycles have been examined for amplitude, length, diffusion and utilization rate. This paper focuses on the length aspect of business cycles. Various authors explored the length of business cycles (Valentine and Ellis, 1991; Diebold, 1993; Diebold and Rudebusch, 1991). None of them have attempted the Fourier analysis of business cycles.

National Bureau of Economic Research (NBER) defines the business cycle from a broader set of indicators of business activity than just the components of aggregate measures such as GDP. Relevant studies use predominantly the NBER definition of business cycles. Diebold (1993) showed that long expansions are followed by short contractions. He postulated that an economy gains an upward momentum during a long expansion and this momentum than mitigates the downturn. Diebold and Ellis (1991) showed that the duration of expansions and recessions in the US has significantly changed after the Second World War. The average length of an expansion increased from 25 to 50 months while the average length of recessions fell from 20 to 10 months. Valentine and Ellis (1991) tabulated the length of American business cycles between 1854 and 1990 and found out that most business cycles last between 3 and 4 years.

The above studies primarily deal with the US economy. They focus on cycles measured from trough. Such analysis assumes that the spectrum of country's business cycle is a horizontal summation of individual cycles marked by expansions and recessions. This paper, however, assumes that country's business cycle is a vertical summation (superposition) of individual sinusoidal cycles marked by different wavelength and amplitude/

METHODS

There is no consensus about how to define the business cycle. The NBER uses a complex definition of the business cycle in terms of various indicators of business activity. More simple definitions use only aggregate measures such as GDP. To obtain business cycles, one can use a decomposition of GDP data into a trend and a cycle or first - differencing method is outlined in Equations 1 through 5, where GDP_T is the trend component C is the cycle component.

$$GDP = (GDP_T)(C) \tag{1}$$

$$ln(GDP) = ln(GDP)_T + ln(C) \tag{2}$$

$$ln(GDP)_{t-1} = \alpha + \beta(t-1) \quad (3)$$

$$ln(GDP)_t = \alpha + \beta t \quad (4)$$

$$ln(C) = ln(GDP_t) - ln(GDP_{t-1}) = \beta \quad (5)$$

Fourier analysis of a time series is a decomposition of the series into a sum of sinusoidal components. For a periodic function f(x) with period 2a, the Fourier transform is given by (6). The right hand side of (6) is called the Fourier transforms of f(x). Coefficient a_n and b_n are called Fourier coefficients.

$$F(x) = a_0 + \sum[a_n\cos(\pi nx/a) + b_n\sin(n\pi x/a)] \quad (6)$$

When dealing with a nonperiodic discrete set of data, one has to adjust the mathematics to account for the nonperiodicity. The discrete Fourier transformation J_j of the data is given by (7). The Fourier frequency f is given by (8). The fast Fourier transformation is an algorithm for calculating the discrete Fourier transformations at all discrete frequencies using relatively few arithmetic operations.

$$J_j = n^{-1}\sum x_t\exp(-if_jt) \quad (7)$$

$$f_j = 2\pi j/n \quad (8)$$

The Fourier transformations can be then normalized with respect to their sum. As a result, percentage importance of each coefficient can be obtained. Finally, one can obtain wavelengths of the sinusoidal waves by inverting the frequency.

Annual GDP per capita data are used. The data are adjusted for inflation and are available for the following fifteen countries : Australia, Austria, Belgium,Britain, Canada, Denmark, Finland, France, Germany, Holland, Italy, Japan, Norway, Sweden and the USA. The economies of all fifteen countries are market based and therefore suitable for comparison. The data cover the period from 1900 to 1987.

Business cycles were obtained using the GDP data for all countries using Equations 1-5. The business cycles were then Fourier transformed. The Fourier coefficients were normalized with respect to their sum. The high frequency coefficients representing sinusoidal waves of short wavelengths were separated from the low frequency coefficients representing sinusoidal waves of long wavelengths. In particular, four categories were established: (1) Sinusoidal waves lasting 2-5 years, (2) 5-10 years, (3) 10-15 years (4) 15 and more years. The Fourier coefficients pertaining to each category were summed. Note that their sum represents the percentage importance of that category. The summations were compared across all fifteen countries.

Next, coefficients pertaining to each category were inverse transformed. The inverse transformations of each category were correlated across the same category for all fifteen countries. Finally, the cross correlations for each category were compared for all countries.

RESULTS

Figure 1 shows a business cycle for the UK and Figure 2 shows its Fourier transformation. Table 1 summarizes the main features of the Fourier transformations of business cycles for all fifteen countries.

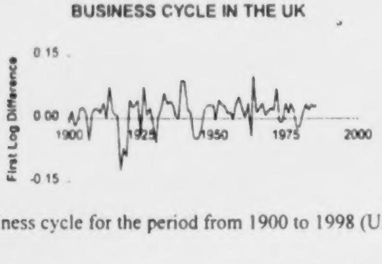

Figure 1: Business cycle for the period from 1900 to 1998 (United Kingdom).

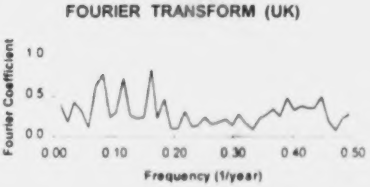

Figure 2: Fourier transform of the UK business cycle (1900-1987).

Table 1 : Percentage importance of sinusoidal components in business cycle structure for various countries.

Country	*2-5 years*	*5-10 years*	*10-15 years*	*15+ years*
Australia	57.3	22.7	10.4	9.6
Austria	42.8	33.3	8.9	14.7
Belgium	56.1	20.7	10.0	13.2
Britain	49.7	26.2	12.8	11.2
Canada	44.5	28.0	13.2	14.3
Denmark	61.8	19.1	8.2	12.0
Finland	53.6	24.1	10.5	11.8
France	55.9	17.0	13.0	14.1
Germany	61.5	21.5	8.9	8.1
Holland	54.6	24.8	9.5	11.1
Italy	50.6	24.9	11.5	13.1
Japan	57.4	18.8	9.3	14.5
Norway	62.4	19.2	7.3	11.0
Sweden	55.4	20.2	8.8	15.6
USA	48.6	29.4	9.1	12.8

CONCLUSION

The importance of sinusoidal components with various wavelengths is as follows: 2-5 years (54%), 5-10 years (23%), 10-15 years (10%) and 15 and more years (13%). These percentage values are averages for all fifteen countries. These results imply that the most important frequency components last between 2-5 years.

The zero lag cross country correlations of business cycles vary between -0.33 and 0.81, with an average of 0.22 and standard deviation of 0.27. However, the zero lag cross country correlations of inverse transformed low frequency components (15 and more years) are extremely high. Their average is 0.93 and their standard deviation is 0.11. In other words, long lasting sinusoidal cycles in the business cycle structure are highly correlated across all fifteen countries.

RECOMMENDATIONS

Alternative methods of deriving business cycles should be used to compare the final results. Also, a rigorous treatment of noise should be performed by filtering the initial GDP data. Finally, the use of wavelet transforms could be explored.

ACKNOWLEDGMENT

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REFERENCES

[1] Bloomfield, Peter.Fourier Analysis of Time Series: An Introduction, John Wiley & Sons, Inc., New York, 1976.

[2] Diebold, Francis X., "Are Long Expansions Followed by Short Contractions?" Business Review, Federal Reserve Bank of Philadelphia, July-August, 1993, pp.3-11

[3] Diebold, Francis X., and Rudebusch, Glenn D., "Shorter Recessions and Longer Expansions", Business Review, Federal Reserve Bank of Philadelphia, November-December, 1991, pp. 13-20.

[4] Powers, David L., Boundary Value Problems, 3rd edition, Harcourt Brace Jovanovich Inc., Orlando, FL, 1987, chapter 1, pp. 44-112.

[5] Valentine, Lloyd M. And Ellis, Dennis F., Business Cycles and Forecasting, 8th edition, South-Western Publishing company, Cincinnati, 1991, Ch.2-4, pp.26-105.

Effects of Foster Care on Perceptions of Family And Family Functioning

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There has been conflicting data about the ability of children who grew up in foster care to function as adults. This study explored the perceptions of family and levels of family functioning of adults, who as children, were in foster care. Significant differences were found in the areas of income and education levels, as well as in perceptions of family.

BACKGROUND

"In a statistical sense, the American family is the most violent social institution in our society" (Olson & DeFrain, 1994, p. 486). This recognition of family violence has led to the creation of laws that are intended to protect our children. For years we have taken children out of unsuitable homes and placed them in substitute foster homes. There was little research on the effects of this family substitution, either short- or long-term. Multiple placements were common for foster children, which created inconsistent views of family. These views, which were carried over into adulthood, had consequences that were not well known.

According to Flynn (1994), some children placed in foster care can become confused about three family-related areas. They can be confused about the nature of a family, about the biological family they left, and about the foster family in which they were placed. This confusion about boundaries and family structure may affect the child's psychological adjustment to foster care and their family relationships. Family environment, which provides the foundation on which future relationships are built, has been correlated to the mental health of children (Kashani, Canfield, Borduin, Soltys, and Reid, 1994). For example, if a child's perception of family support is low, that child is more likely to have behavior problems. Knowing these two things raised the question of how unstable familial foundations and a confused sense of family evolved and affected children in adulthood.

In 1978 Fanshel and Shim found that the quality and frequency of contacts with the natural family were closely correlated with the child's adaptation to foster care (Flynn, 1994) Distorted perceptions of the natural parents were found to occur with children who had infrequent visits with their parents. This was played out in two ways, over idealization of the parents or exaggeration of their parents' problems (Flynn, 1994).

When children rated family functioning of their natural families and foster families, natural parents were rated as healthy 50% of the time, while foster parents were rated healthy 80% of the time (Kufeldt, Armstrong & Dorosh, 1995). In this study, Kufeldt et. al. (1995) found that children do not idealize their parents when there is no contact. In a 1996 study, Gardner found that most of the children in foster care identified their foster family as their "family," instead of their biological family. Gardner's conclusion was that foster families were viewed as similar to biological, intact families in structure and were the ones with which children identified most.

A number of sources suggest that children in foster care have difficulties with psychological maladjustment, although this has been challenged by other studies. Marcus (1991) also suggested that children are at risk for insecure attachments, which may cause ineffective functioning as adults. One of Marcus's findings indicated that the quality of attachment to foster parents was the primary predictor of children's problems rather than their attachment to natural parents. Additional studies have shown that children in foster care had poor academic performance and low self-esteem (Johnson, Yoken & Voss, 1995).

Only a few studies have dealt with adult functioning specifically (Benedict, Zuravin & Stallings, 1996; Gardner, 1996; Mangine, Royse, Wiehe & Nietzel, 1990). Studies by Susser, Lin, Conover & Struening (1991) and Mangine, et. al. (1990) discovered that adults that had been in foster care as children were in the homeless population up to four times as often as in the general population. Susser et. al. (1991) reported that 79% of state hospital patients who had been in foster care as children reported being homeless at some time since the age of 17. Children in foster care run a much greater risk of adult dysfunction and homelessness.

Conflicting reports, however, state that former foster children are very similar to adults raised in natural homes in terms of socioeconomic situations, living conditions and the ability to function independently (Lyman & Bird, 1996). Johnson et. al. (1995) state that children formerly in foster care were able to function adequately as adults and were satisfied with the primary relationships in their lives.

SAMPLE

Participants in this survey were age 19 or older. Those in the foster care group had to be in foster care as a child, and had to respond to an ad in the paper or to posters that were distributed to the University of Nebraska-Kearney campus and two employment agencies. Snowball sampling was also used. Persons who responded to the ads were asked if they knew anyone else who was in foster care as a child. Once this information was obtained, the respondents names were looked up in the phone book. The persons whose names appeared directly above and directly below that name were also sent a survey, thus creating the control group. Mail survey design was used.

Two well-known questionnaires, a modified version of the Family of Origin Scale (Hovestadt, Anderson, Piercy, Cochran, & Fine, 1985) and the FACES II scale (Olson, Bell, & Portner, 1991) were used in this study. The Family of Origin scale was modified to elicit responses that pertained to families in general rather than family of origin. FACES II was used to gain information about current family functioning. Family was defined as anyone that the participant saw as being in their family.

RESULTS

In all, 31 questionnaires were received. Of the 31 respondents, 14 had lived in foster care. The average age of respondents in the foster care group was 30.21 years. The average age of the non-foster care group was 48.25 years. There were very few differences between the two groups in terms of demographics, with the exception of two areas: education level and yearly income.

In terms of yearly income, the foster care group was significantly weighted in the lower income levels. All but three persons in the foster care group earned less than $20,000 annually. No one in this group had an income of $40,000 or above. The non-foster care group had 9 persons in the $40,000+ category. (See Figure 1).

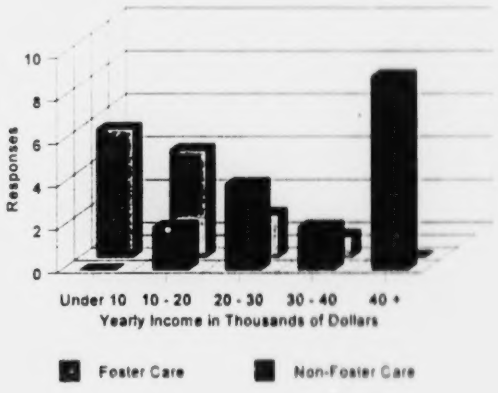

Figure 1: Yearly Income for Foster Care vs. Non-Foster Care Participants

The majority of the participants in the foster care group had graduated from high school or attended some college. The non-foster care group was more evenly distributed along all levels of education. The "didn't graduate from high school" category did not have any responses and the "Ph.D." category had four responses from the non-foster care group. (See Figure 2)

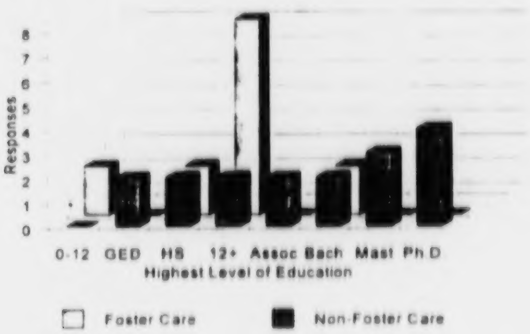

Figure 2: Education Levels for Foster Care vs. Non-Foster Care Participants

The modified Family of Origin Scale, which assessed the perceived health of families in general, showed a significant difference on the Likelihood Ratio of .050. Only five of the 14 persons in foster care viewed families in general as healthy, while 12 of the 17 non-foster care participants viewed the health of families in general as high. Sixty four and three tenths percent (64.3%) of foster care respondents perceived the health of families in general as low compared to 29.4% of non-foster care respondents. (See Table 1).

Table 1: Perceptions of Family in General

	Foster Care	Non-Foster Care	Total
Health Perceived as High	5 35.7%	12 70.6%	17 54.8%
Health Perceived as Low	9 64.3%	5 29.4%	14 45.2%
Total	14 100.0%	17 100.0%	31 100.0%

There was no significant difference between the foster care and non-foster care groups for current family functioning. Both groups were fairly similar in family types. (See Table 2).

Table 2: Levels of Family Functioning

	Foster Care	Non-Foster Care	Total
High Levels of Family Functioning	6 42.9%	8 57.1%	14 50.0%
Low Levels of Family Functioning	8 57.1%	6 42.9%	14 50.0%
Total	14 100.0%	14 100.0%	28 100.0%

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DISCUSSION

There were several limitations to this study. The foster care group was limited in part to those persons who read the paper and were willing to call in response to the ads. This did not give persons who do not read the paper a chance to participate. This study was also not generalizable due to its small size and lack of representation of the population. The parameters of this study extended only to the number of responses received from the advertisements.

One major finding of the study was the significant difference between the income and education levels of the two groups. Foster care participants were less educated and earned less income annually when compared to the non-foster care participants. This finding may support the notion that children who were in foster care were not able to function as well as adults. These differences need to be explored further to confirm their validity. The perception of family scale also showed a significant difference between the two groups, although this difference was slight. There was also no significant difference on the family functioning scale, which indicated that persons in foster care were able to function just as well as those persons who never experienced foster care. Foster care in and of itself was not a predictor of adult family functioning. Further studies on family functioning and perception of family need to be conducted with larger sample sizes that more accurately reflect the population.

REFERENCES

Dubowitz, Howard. Kinship care: suggestions for future research. Child Welfare, v73(5), pp 553-563.

Flynn, Susan M. 1994. Psychological adjustment and family experiences of children in foster care placed with or apart from siblings. Arbor, MI: UMI Dissertation Services.

Gardner, Helen. The concept of family: perceptions of children in family foster care. Child Welfare, v75(2), pp. 161-181.

Hovestadt, Alan J., William T. Anderson, Fred P. Piercy, Samuel W. Cochran, & Marshall Fine. A family of origin scale. Journal of Marital and Family Therapy, v11(3), pp 289-297.

Johnson, Penny Ruff, Carol Yoken, & Ron Voss. Family foster care placement: the child's perspective. Child Welfare, v74(5), pp. 959-973.

Kashani, J., L. Canfield, C. Borduin, S. Soltys, J. Reid. Perceived family and social support: impact on children. Journal of American Academy of Child and Adolescent Psychiatry, v33(6), pp. 819-823.

Kufeldt, Kathleen, James Armstrong & Marshall Dorosh. How children in care view their own and their foster families: a research study. Child Welfare, v74(3), pp. 695-714.

Lyman, S., & Gloria W. Bird. A closer look at self-image in male foster care adolescents. Social Work, v41(1), pp. 85-94.

Mangine, Steven J., David Royse, Vernon Wiehe, & Michael Nietzel. Homelessness among adults raised as foster children: a survey of drop-in center users. Psychological Reports, v67, pp. 739-745.

Marcus, Robert F. March, 1991. The attachments of children in foster care. Genetic, Social and General Psychology Monographs.

Olson, David H., Richard Bell, & Joyce Portner. 1991. FACES II. St. Paul, MN: Family Social Science.

Olson, David J., & DeFrain. 1994. Marriage and the family: diversity and strengths. Mountain View, CA: Mayfield Publishing Company.

Susser, Erza S., Shang P. Lin, Sarah A. Conover, & Elmer L. Struening. Childhood antecedents of homelessness in psychiatric patients. American Journal of Psychiatry, v148(8), pp. 1026-1030.

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Retailer Country Bias Cues:
An Experimental Approach

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A saturated home market is forcing U.S. retailers to look for opportunities abroad. Despite their competitive advantage over foreign counterparts, U.S. retailers have met with limited success. Thus, global retailers are in need of strategies and incite into foreign consumers' perceptions to strengthen their operations abroad. This research examines the effects of the retailer country of origin and merchandise type on Hispanic consumer evaluations utilizing a 2 x 2 between subjects factorial experimental design. The study's results indicate a significant effect for country of origin, with no significance for merchandise type. Specifically, U.S. retailers were evaluated more favorably than Mexican retailers in terms of atmosphere, service and terms of sale.

BACKGROUND

Oversaturated domestic markets are requiring U.S. retailers to look abroad for further opportunities. All major formats, from discount to department stores, are included in this race for global expansion. Yet, many of these retailers are running into obstacles in their ventures abroad (Treadgold, 1991). Major companies such as Woolco, Dillards and JCPenney are withdrawing from foreign markets, often with considerable losses.

Essentially, U.S. retailers require accurate factors upon which they can base their strategic planning (Segal-Horn and Davison, 1992; Treadgold, 1991). A crucial issue is whether to standardize the domestic program or to adapt the program specifically to the foreign market. This decision will be affected by cues such as country of origin upon which consumers base their evaluations of the retailer.

Research related specifically to consumer evaluation cues with respect to retailers is not widely available. Thus, research of international products provides the best foundation for investigating consumer evaluations of global retailers. This product research suggests that a product's country of origin may bias consumer evaluations which is a result of country stereotypes (Bilkey and Nes, 1982; Harris, Garner-Earl, Sprick and Carroll, 1994; Klenosky, Benet and Chadraba, 1996). This resulting bias can be positive or negative in nature depending upon the country image created by the informational cue.

As with products, the global retailer can also be assessed by consumers in terms of country of origin. This research investigates the effect of country of origin and type of merchandise on Hispanic consumers' evaluations of U.S. and foreign retailers. The questions explored in this research are as follows:

> Research Question 1: Does the retailer's country of origin affect the Hispanic consumer's evaluation of the retailer? If so, how are the assessments affected?

600

Research Question 2: Does the merchandise type affect the Hispanic consumer's evaluation of the retailer? If so, how are the assessments affected?

Research Question 3: Is there an interaction between retailer's country of origin and merchandise type on the consumer's evaluation of the retailer?

REVIEW OF LITERATURE

Country of Origin

Country of origin and product evaluation. The country of origin (COO) is an extrinsic product cue, like price or brand (Peterson and Jolibert, 1995). It is the product's source country, noted by the phrase, "Made in (name of country)." The COO is considered an informational cue by researchers, as it provides information to consumers for decision making purposes (Bilkey and Nes, 1982).

Country of origin effects, related to consumers' evaluations of products, have been extensively investigated. The main conclusion of this research is that consumers develop stereotypical images of countries and their products which bias their product evaluations. In 1982, Bilkey and Nes reviewed 25 country of origin studies which support this assertion. Research indicates that this country stereotype can result from a number of factors, including a consumer's experience with a product from a country, the country itself, political beliefs, etc. (Samiee, 1994).

Research suggests that there is a relationship between the country's level of economic development and consumers' product perceptions (Gaedeke, 1973; Kaynak & Cavusgil, 1938; Wang and Lamb, 1983). A product from a more developed country has been found to receive more favorable evaluations than a product from a less developed country (Schooler, 1971; Wang and Lamb, 1983; Cordell, 1992). In illustration, a stereo made in Japan (more developed country) may be evaluated more favorably than an identical stereo produced in Mexico (less developed country).

Similar research also indicates the presence of a "home country bias." This is the consumer's tendency to favor domestically produced goods (Bannister and Saunders, 1978; Lillis and Narayan, 1974; Nagashima, 1970). Studies link this bias to ethnocentrism, nationalism (Han, 1988; Shimp and Sharma, 1987) and a perceived risk in purchasing foreign products (Hampton, 1977).

Country of origin and product type. Country of origin research also suggests that country of origin and product type may combine to impact consumer assessments of products (Samiee, 1994). This result is rooted in the idea that consumers already hold beliefs with respect to product quality from various countries. Consumers regard favorably the product produced in a country with an affinity for the product. Conversely, consumers negatively regard the product originated from a country lacking such an affinity. For example, a favorable evaluation may be elicited for Chinese silk or French wine. In contrast, a poor evaluation may be produced for Mexican silk or Russian wine.

Country of origin and retailers. To date, only one study has been conducted on COO with respect to retailers. General results showed that more developed countries receive more positive evaluations as opposed to less developed countries, with the exception of a more favorable evaluation for less developed countries in terms of pricing (Lascu and Giese, 1995).

This study provided an initial confirmation that retailer country of origin does affect consumer perceptions. However, the country of origin was confounded with the merchandise type. In addition, the use of subjects solely from the United States limited the generalizability of perceptions of cross-country retailers by other cultures.

METHODOLOGY

Procedures

Data was collected from 43 volunteer subjects who were students or employees of a large Southwestern university. Participation criteria included requirements that the subject be of Hispanic descent, have lived at least one year in Mexico and be familiar with retailing in Mexico and the United States. Before completing the questionnaire, subjects were asked if they preferred the Spanish or English version of the measurement instrument. After the choice was given, subjects were asked to read a description of a hypothetical retailer noted by its country of origin (United States/Mexico) and its type of merchandise (denim jeans/handcrafted furniture). Furthermore, the description explained that the retailer would be opening stores in Arizona's metropolitan areas in the summer of 1997. After reading the description, subjects were asked to complete evaluative questions about their perceptions of the retailer's merchandise, service, advertising, etc. In addition, subjects answered several demographic questions pertaining to their age, educational level, etc. Upon completion of the study, subjects were given an offer to enter a one-time prize drawing for $50.00.

Experimental Design

The research encompassed a 2 x 2 between subjects factorial experimental design. The two factors were 1) country of retailer (U.S./Mexico) and 2) type of retail merchandise (denim jeans/handcrafted furniture). Therefore, the experiment included four treatment conditions: U.S./denim jeans; U.S./handcrafted furniture; Mexico/denim jeans; Mexico/handcrafted furniture. Subjects were randomly assigned to one of the four treatment conditions.

Questionnaire Development

Pretests and a focus group were conducted with Mexican consumers to determine which merchandise lines are perceived as favorable for the United States and Mexico and which lines are perceived as unfavorable. Answers indicated that Mexico is positively associated with the production of hand-crafted goods whereas the U.S. is highly regarded as a manufacturer of denim jeans.

In pretesting the measurement instrument, the questionnaire was administered to a small convenience sample of subjects meeting the experimental criteria in an attempt to reveal possible problems in wording, understanding, etc. Corrections were made as deemed necessary.

Two versions of the questionnaire were constructed, i.e., English and Spanish, in order to give subjects their preference of language. The English version of the questionnaire was transposed into Spanish and backtranslated into English to insure a direct, accurate rendering of the instrument.

RESULTS

Data Analysis

The data was analyzed using a Multivariate Analysis of Variance (MANOVA). Testing was conducted in order to assess differences in seven a priori store attribute factors: merchandise, service, atmosphere, terms, promotion, value and convenience. When indicated by a significant MANOVA result, individual Analysis of Variances (ANOVAs) were examined to assess specific differences. Both interaction and main effects were examined.

Interaction effects as well as merchandise line effects were nonsignificant. Thus, the sole significant MANOVA was retailer country of origin. In an examination of the significant country of origin effects, only factors relating to service (U.S. Mean=5.74, Mexico Mean=5.17, $F=3.35$, $p=.07$), atmosphere (U.S. Mean=5.88, Mexico Mean=5.11, $F=5.30$, $p=.03$) and terms (U.S. Mean=5.62, Mexico Mean=4.66, $F=8.98$, $p=.00$) were significantly different for evaluations of U.S. retailers as compared to Mexican retailers. Specifically, U.S. retailers were evaluated more favorably as compared to Mexican retailers with regard to the three retail attributes, i.e., service, atmosphere and terms.

Table 1 MANOVA and ANOVA Results on Retail Attributes by Country of Retailer Origin

	MEANS[1] (S.D.)			
Retail Attributes	U.S. (n=24)	Mexico (n=19)	Univariate F	Multivariate F
				2.68**
Merchandise	5.78 (1.23)	5.25 (1.20)	2.78	
Service	5.74 (1.10)	5.17 (1.24)	3.35***	
Atmosphere	5.88 (1.17)	5.11 (1.30)	5.30**	
Promotion	5.30 (1.51)	4.91 (1.11)	1.07	
Value	5.24 (1.49)	5.30 (.84)	.01	
Convenience	5.48 (1.47)	5.47 (1.12)	.02	
Terms	5.62 (1.15)	4.66 (1.35)	8.98*	

[1] 1= Strongly disagree that retailer possesses attribute
5= Strongly agree that retailer possesses attribute

* p<=.00
** p<=.05
*** p<=.07

CONCLUSION

The findings of this study reveal that stereotypes do exist for retailers based upon their country of origin, regardless of the retailers' merchandise line. As such, those retailers that cross borders should understand consumers' perceptions of their country of origin in order to enhance positive perceptions and negate unfavorable perceptions. For example, in this study, U.S. retailers were perceived to possess a more pleasant store atmosphere as compared to Mexican retailers. This result indicates U.S. retailers should pay careful attention to focusing on this aspect of their business in promotions, etc. On the other hand, U.S. retailers were not evaluated differently with respect to value. This could be quite problematic for U.S. discount retailers which enter the Mexican market emphasizing the "value" aspect of the business. Special campaigns might be needed in order to create a differential between the retailers and their competitors in regard to the value concept.

LITERATURE CITATIONS

Bannister, J.P., & Saunders, J.A. (1978). UK consumers' attitudes towards imports: The measurement of national stereotype image. European Journal of Marketing, 12, 562-570.

Bilkey, W.J., & Nes, E. (1982). Country-of-origin effects on product evaluations. Journal of International Business Studies, 13, 89-99.

Cordell, V.V. (1992). Effects of consumer preferences for foreign sourced products. Journal of International Business Studies, 23, 251-269.

Gaedeke, R. (1973). Consumer attitudes toward products made in developing countries. Journal of Retailing, 49, 13-24.

Hampton, G.M. (1977). Perceived risk in buying products made abroad by American firms. Baylor Business Studies, 53-64.

Han, C.M. (1988). The role of consumer patriotism in the choice of domestic versus foreign products. Journal of Advertising Research, 28, 25-32.

Harris, R.J., Garner-Earl, B., Sprick, S.J., & Carroll, C. (1994). Effects of foreign product names and country-of-origin attributions on advertisement evaluations. Psychology & Marketing, 11, 129-144.

Kaynak, E., & Cavusgil, S.T. (1983). Consumer attitudes toward products of foreign origin: Do they vary across product classes? International Journal of Advertising, 2, 147-157.

Klenosky, D.B., Benet, S.B., & Chadraba, P. (1996). Assessing Czech consumers reactions to western marketing practices: A conjoint approach. Journal of Business Research, 36, 189-198.

Lascu, D., & Giese, T. (1995). Exploring country bias in a retailing environment: Implications of retailer country of origin. Journal of Global Marketing, 9, 41-58.

Lillis, C.M., & Narayana, C.L. (1974). Analysis of made in product images - An exploratory study. Journal of International Business Studies, 119-127.

Nagashima, A. (1970). A comparison of Japanese and U.S. attitudes toward foreign products. Journal of Marketing, 34, 68-74.

Peterson, R.A., & Jolibert, A.J. (1995). A meta-analysis of country-of-origin effects. Journal of International Business Studies, 883-899.

Samiee, S. (1994). Customer evaluation of products in a global market. Journal of International Business Studies, 25, 579-604.

Schooler, R.D. (1971). Bias phenomena attendant to the marketing of foreign goods in the U.S. Journal of International Business Studies, 71-80.

Segal-Horn, S., & Davison, H. (1992). Global markets, the global consumer and international retailing. Journal of Global Marketing, 5, 31-61.

Shimp, T.A., & Sharma, S. (1987). Consumer ethnocentrism: Construction and validation of the CETscale. Journal of Marketing Research, 24, 280-289.

Treadgold, A. (1991). Dixons and Laura Ashley: Different Routes to International Growth. International Journal of Retail & Distribution Management, 19, 13-19.

Wang, C., & Lamb, C.W., Jr. (1983). The impact of selected environmental forces upon consumers' willingness to buy foreign products. Journal of the Academy of Marketing Science, 11, 71-84.

Matching Cultural Value Orientations to Ad Appeals: Exploring the Role of Individualism-Collectivism in the USA Versus Mexico

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Past research suggests that cultural orientation individualism-collectivism should be considered when developing global advertising campaigns. Although numerous studies have examined cultural differences between foreign markets, few studies have measured how inconsistencies in value orientations presented in global advertising messages may affect consumer behavior. In research reported here, examined are how certain aspects of individualism-collectivism may affect attitudes and behaviors toward advertised products within the USA and Mexico. The data provides little support that individualism-collectivism matters across cultures, but it could matter within cultures. Interestingly, product category appears to be an important issue for future research on individualism-collectivism in consumer behavior.

INTRODUCTION

As multinational firms race toward globalization of markets, the issue of standardized versus customized advertising messages remains unresolved. Some marketers believe companies should consider standardizing ads to improve long-term profitability (Szymanski, Bharadwaj, and Varadarajan, 1993). Other researchers suggest that since no two cultures are exactly alike, the most effective ads are those developed for each individual market (Jain 1989; Wills, Samli, and Jacobs 1991). Therefore, the focal point of the research is to investigate the role cultural values may play in cross-cultural advertising.

Cultural values may play an important role in the perception of marketing communications. Studies examining message content indicate that one very important dimension of culture to consider when developing advertising and promotional messages is that of individualism-collectivism (Han, 1990; Kale, 1991; Zandpour, 1994). Past research also suggests that advertising themes that are consistent with cultural values of the target audience are more desirable than ads that reflect values that are inconsistent (Belk, Bryce and Pollay, 1985; Munson & McIntyre, 1978). In summary, consumers who possess collectivist values should favor ads which appeal to collectivist values, while individualist consumers should opt for individual ad appeals.

The Individualism-Collectivism Construct

One dimension of culture that closely relates to social behaviors within a society is individualism versus collectivism. The individualism-collectivism dimension at the cultural level relates to how one values the individual relative to the group. Individualist societies (U.S., U.K., Germany) emphasize values such as achievement, recognition, etc. (McCarty & Hattwick, 1992); collectivist societies (Mexico, Peru and Chile) emphasize values such as family security, responsibility, conformity to societal norms, etc. (Hofstede, 1980). Based on factor analysis, Mezei (1974) found that individualism-collectivism was the most important cultural dimension from a list of values studied by Kluckhohn & Strodtbeck (1961). This suggests that individualism-collectivism may be an important dimension to consider when communicating across cultures.

Although a culture may be largely individualist or collectivist, it is important to note that at the individual level a consumer may exhibit either individualistic or collectivistic tendencies. Prior research examining individualism versus collectivism at the individual level identifies persons who display individualist tendencies (e.g., emphasize personal goals over ingroup goals) as idiocentrics; and persons who display collectivist tendencies (i.e., emphasize ingroup goals over personal goals) as allocentrics (Triandis et al., 1990). American, as well as Mexican, cultural groups contain individuals that display both idiocentric and/or allocentric tendencies, depending on the behavioral context. On the other hand, Mexicans place a strong emphasis on family unity and cohesiveness. Mexicans tend to be more cooperative in interpersonal activities compared to their American counterparts (Diaz-Guerrero, 1982). A recent review of literature by Diaz-Guerrero & Szalay (1991) on Hispanic/Latin family values suggests that Mexican parents place a greater emphasis on parental authority, respect, obedience, affective interdependence and discipline in their children when compared to American parents. Consistent with general findings by Triandis (1989), Diaz-Guerrero (1967) found that Mexicans (as a collectivist society) displayed more unity than Americans (as an individualist society) with respect to the family, and are more willing to subordinate their individual priorities and interests to those of the family ingroup.

HYPOTHESIS

Based on review of the literature examining individualism-collectivism, consumers' cultural value orientations differ across cultures and these differences should affect their advertising preferences. Specifically, the first hypothesis:

> H1: Consumers in an individualist culture (USA) will prefer individualist relative to collectivist ad appeals. For consumers living in a collectivist culture (MEXICO), the reverse will be true. That is, collectivists will prefer collectivist ads compared to individualist ads.

The research examining idiocentrics and allocentrics suggests that irrespective of the overall cultural value orientation, differences in advertising preferences will be most evident when cultural values are considered at the individual level within one's culture. Therefore, consistent with H1:

H2 Idiocentric consumers will prefer individualist relative to collectivist ad appeals. This should be true for both the USA and MEXICAN idiocentrics. For allocentrics, the allocentrics will prefer collectivist ads compared to individualist ads.

METHODOLOGY

One hundred eighty-four undergraduate college students (USA, 112 UTA subjects, MEXICO, 72 Northern Mexico University subjects) were assigned randomly to a treatment. The subjects were then asked to evaluate an ad and complete a questionnaire. The questionnaire contained the following set of measures.

Attitude toward the Advertisement

Ad Attitude component was measured first and was assessed using three 9-point semantic differentials: good/bad; like/dislike; positive/negative. The coefficient of reliability was quite acceptable (alpha USA = .91; alpha MEXICO = .82).

Triandis 16-item scale used to measure individualism-collectivism

Triandis is used to measure individual-level differences across cultures.

Allocentric and Idiocentric Measures

Triandis is also used to examine individual-level differences within cultures.

Translation

The instrument used in this study was first written in English, then translated into Spanish by a native Mexican, fluent in English. The instrument was then backtranslated to English by a translator fluent in both Spanish and English to assure that a proper translation has taken place (Brislin, 1980).

Ad Pretests

The ad appeals were pretested to be certain that individualism-collectivism was in fact manipulated. The ad copy used to manipulate was as follows: There is a company that is building cars Safer for YOU! The copy used to vary collectivism stated: There is a company that is building cars Safer for YOUR FAMILY!

RESULTS

Hypothesis One was tested by examining the culture by ad appeal interaction on a measure of attitude toward the advertisement.

For the auto ad H1 was not supported (F(1,181) = .84, p = .359). Interestingly however, a main effect of culture was found (F(1,181) = 9.31, p = .003). Mexican consumers rated the auto ad more favorable (X = 7.0) than did the USA consumers (X = 6.15).

For the sunscreen ad H1 was also not supported ($F(1,181) = .02$, $p = .875$). Again, there was no evidence that matching the predominant culture orientation (individualism or collectivism) with ad appeal (individual or collective appeal) influences ad liking. Interestingly, however, for the sunscreen ad an ad appeal effect was found ($F(1,181) = 4.75$, $p = .031$). Irrespective of one's cultural value orientation, the collectivist appeal ($X = 7.17$) was preferred to the individualist appeal ($X = 6.65$).

The same approach was used to test H2. Namely, what should occur is an interaction effect to occur between idiocentrics/allocentrics and ad appeal (individual/collective). Also, USA and MEXICAN idiocentrics should like the individualistic ad better than the collectivist ad and, for USA and MEXICAN collectivists the reverse should be true.

First, the USA subjects were considered for the auto ad. H2 was not supported ($F(1,108) = .93$, $p = .336$). No other significant effects occurred. H2 also received no support from the sunscreen ad in the USA ($F(1,108) = .01$. $p = .997$). There was however, some tendency for both idiocentrics and allocentrics to prefer the collectivist sunscreen ad appeal ($X = 7.1$) to the individualistic approach ($X = 6.6$) ($F(1,108) = 2.88$, $p = .092$).

Next, the Mexican subjects were considered for the auto ad. Once again, H2 received little support ($F(1,69) = 1.85$, $p = .178$). No other effects were found. The test of the sunscreen ad like Mexico also rejected H2 ($F(1,69) = .93$, $p = .339$). Some weak evidence does suggest an allocentric/idiocentric effect on advertising preference. Allocentrics liked the sunscreen ad ($X = 7.2$) somewhat more than did idiocentrics ($X = 6.55$) ($F(1,69) = 2.53$, $p = .11$). Also, the pattern of means suggests that allocentrics in Mexico do favor the collectivist ($X = 7.6$) over the individualistic ($X = 6.8$) ad appeal (t = XXX, $p = .07$)

DISCUSSION

The purpose of this study was to examine how certain aspects of individual-collectivism may affect attitudes and behaviors toward advertised products within the USA and Mexico. The following was discovered:

1.) No evidence of individualism/collectivism match-up effect.
2.) Only weak evidence of allocentrics/idiocentrics match in Mexico.
3.) So what does this tell us? Well,
    Individualism/Collectivism may not matter in advertising appeals?
    Individualism/Collectivism is not used to evaluate ads.
    Advertising preference has little to do with Individualism/Collectivism.

4.) Perhaps it would be more interesting to begin to consider why we had differing effects across products. That is, the auto and sunscreen ads did generate different effects -- one showed culture effects; one showed ad appeal effects. Thus, the findings suggests that two very important cultural aspects to be considered when developing international advertisements: the cultural values represented in ads, and the variation in attitudes and behaviors towards ads as moderated by product category.

Future research efforts should continue to examine whether these relationships apply to other cultural domains (e.g., Latin American countries, other collectivist societies). By empirically examining attitudes and behaviors toward advertisements that depict (in)consistency in cultural values, marketers will be better able to evaluate *how* such cultural differences affect consumer behavior.

REFERENCES

Diaz-Guerrero, R. 1967. Sociocultural Premises, Attitudes and Cross-Cultural Research. *International Journal of Psychology*, 2(2): 79-87.

_____ & Lorand B. Szalay. 1991. *Understanding Mexicans and Americans: Cultural Perspectives in Conflict.* New York: Plenum Press.

Han, Sang-Pil & Sharon Shavitt. 1994. "Persuasion and Culture: Advertising Appeals in Individualistic and Collectivistic Societies," *Journal of Experimental Social Psychology*, 30, 326-350.

Hofstede, G. 1980. *Culture's Consequences: International Differences in Work-Related Values.* Sage Publications: Beverly Hills, CA.

Hui, C. H., & Triandis, H. C. 1986. "Individualism-Collectivism: A study of Cross-Cultural Researchers," *Journal of Cross-Cultural Psychology*, 17, 225-248

Jain, Subhash C. 1989. "Standardization of International Marketing Strategy: Some Research Hypotheses," *Journal of Marketing*, 53 (January): 70-79.

Kluckhohn, F. and Fred Strodbeck. 1961. *Variations in Value Orientations.* Evanston: Row, Peterson and Company.

McCarty, J. and Patricia Hattwick. 1992. "Cultural Value Orientations: A Comparison of Magazine Advertisements from the United States and Mexico," in *Advances in Consumer Research*, 19, eds. John F. Sherry, Jr. and Brian Sternthal, Provo, Utah: Association for Consumer Research, 34-38.

Munson, J. Michael and Shelby H. McIntyre. 1978. "Personal Values: A Cross Cultural Assessment of Self Values and Values Attributed to a Distant Cultural Stereotype," in *Advances in Consumer Research*. Ed. Keith Hunt. Ann Arbor, Michigan: Association of Consumer Research: 160-166.

Szymanski, D. M., Sundar G. Bharadwaj, & P. Rajan Varadarajan. 1992. "Standardization versus Adaptation of International Marketing Strategy: An Empirical Investigation," *Journal of Marketing*, 57: 1-17.

Triandis, H.C., K. Leung, M.J. Villareal, & F.L. Clack. 1985. "Allocentric Versus Idiocentric Tendencies: Convergent and Discriminant Validation," *Journal of Research in Personality*, 19: 395-415.

Vertical Integration and Profitability

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Japan has been getting much recognition in recent years for its great economic successes There is theory which suggests that vertical integration, which is witnessed when a company is involved in all steps of the production process, could be the reason for this success This paper examines the effect of vertical integration on profitability for a sample of forty-five United States manufacturing and retail companies Many theories support the idea that vertical integration will have a positive effect on the profitability of a firm. But, there are other factors, such as increased transactions costs and diseconomies of scope, which could outweigh the positive aspects of integration I created a variable which quantifies the degree of vertical integration for each company (TOTAL). After running a least-squares regression, TOTAL was found to hold no significant effect on an American company's profitability This paper discusses in length the structures and laws of the economic structures of the United States and Japan, in order to explain the result

INTRODUCTION

In the early 1980's, the entire world looked towards Japan for what seemed like its great new innovations in the manufacturing process What the international business community slowly discovered was that this was not a new process, but a tradition of production which had come to fruition for the Japanese This "Japanese Miracle", as it has been often called, is based around a system called the *Keiretsu* In Japan, there are "Six Big *Keiretsu*", and it is these six big groups which control the entire manufacturing processes for the nation The purpose of a *Keiretsu* is to have the ability to unite companies at different stages of a single production process through the financing and support of large banks Many have wondered if it is this complete verticality which allows the Japanese firms to be so profitable in comparison to other countries. While the U S does not have a *Keiretsu*-like structure, due to different cultures and legal policies, the question that this paper sets out to answer is whether highly integrated US firms have a profit advantage over less integrated firms

THEORY

The reasons behind a desire to vertically integrate a firm can be separated into two different categories, those that are legal in the US and those which are not On the "legal" side, the first and most obvious advantage to integrating is the technical cost savings involved Often, it is better for a company to be involved in all parts of the production process, due to the economies of scale realized, rather than to let another company create the inputs This leads into the other advantage of vertical integration, transfer pricing. Transfer pricing, which is the price at which a firm transfers an input from "one division of a vertically integrated firm to another" (Shughart, 1996, p. 495), is often a very big factor in the cost of the final product A firm needs to determine if it is able to make this price a reasonable one for the firm, or if it is optimal to "farm out" the production of the product Since the goal of most firms is profit maximization, the outcome must be that the price of the subcontracted product is lower than the marginal cost for the parent company to produce the product in-house Many economists feel that having that ability to have control over each step of the production process is an obvious way to save money The term which best describes this argument is economies of scope These are the economies, or diseconomies which are realized when a firm vertically integrates For some companies, the benefits derived from vertical integration will far outweigh the costs, and that is a case in which the firm is experiencing economies of scope. If so, a vertically integrated firm will be more profitable.

Other reason for vertical integration would be defined as illegal by American courts. A company which has some market power will tend to use vertical integration as a way to get a stronger handle on the market. Through such anti-competitive methods such as foreclosure (squeezing competitors out of the market), price discrimination, and creation of barriers to entry, monopolies can drastically increase the amount of power that they wield in an industry. Though these types of strategies are restricted in the US through anti-competitive monopoly laws, Japan, for its' own reasons, allows such anti-competitive behavior.

How is it possible to find out the effect of vertical integration on profitability? The measure used in this study is TOTAL, which is a variable which is a percentage figure. For example, If a firm had one subsidiary, which gave 75% of its outputs into the parent company as an input, the TOTAL variable for this company would be .75. Why would the percentage of subsidiaries involved in supplying vital inputs be a good measure of vertical integration? First outlining the past attempts that have been made to quantify vertical integration would be helpful. One of the first things that comes to mind when thinking of a possible measure of vertical integration is the ratio of value added to sales. If the ration of value added to sales to high, then that would indicate a high degree of vertical integration. The main problem with using this device is that "it gives misleading comparison when firms or industries are located at varying stages in the stream of economics activity." (Shughart, p. 100). The reason for this is that all things equal, the closer the raw materials are to the end of the production stream, the higher the value added to sales ratio would tend to be. But many economists, in order to find the changes over time in the intensity of integration, have just accepted this limitation.

Livery and Porter introduce another way to measure vertical integration. Their goal was to find the historical increases in vertical integration, and using data which indicated whether the largest manufacturing firms moved into the upstream or downstream production process over the six year time period that they choose. They found that the most important moves towards integration were found in the early parts of the century. Although this measure was not used in a way which would relate to the regression used in this paper's study, it could be. The limitations stem from the inability to determine how widespread the company's involvement in non-manufacturing stages was. An example of this downfall would be a firm like McDonalds, where it could be seen as very integrated into the retail stage, but most of those retail stores are owned and operated by franchisers. Below this study will address the final decisions made in the creation of the TOTAL variable.

DATA

This study uses cross-sectional data, rather than to concentrate on one particular industry. It has been observed by many economists that some industries, such as oil and steel, have an obvious need to vertically integrate. While addition research into this topic could be interesting, a more interesting data set was possible in a cross sectional study. Therefore, the companies included in this data set were taken from a cross-section of the manufacturing industries. Although vertical integration may have an effect on the excluded division, this effect would not be as clear as in the manufacturing division, where an actual physical product was the outcome.

To procure this information, Dunn and Bradstreet's Book of America's Corporate Families was used. This is a book which lists the parent companies, their subsidiaries, and the industries in which they are involved. Also, for the second step of the data-gathering process, the 1978 Benchmark Input-output Accounts Table was used. These tables measure the amount that each separate Standard Industry Classification (SIC) codes inputs into the parent company. Using these sources, and working from a base of one hundred parent companies, the number of subsidiaries and the different SIC industries that each subsidiary was involved in was noted. The reason for obtaining the above data was by determining what SIC codes that the subsidiaries were in, it would then be possible to see if that line of work was an input into the parent company's business. By using the 1987 Input-Output tables, after converting the SIC coded into the coding system the tables used, it was possible to see whether or not the subsidiaries did in fact contribute to the parent company's main business. After determining this, the degree of vertical integration was determined by figuring out the percent of subsidiaries whose output was directly an input into the parent company.

Instead of approaching the measurement of vertical integration by any of the ways outlined in the theory section, the problems that previous economists were eliminated using the methods described below. This study used the percentage of outputs which the subsidiaries were a direct input into the parent company as the final measure. A quick example would be a soda company. The parent company could be involved in the development and production of the actual soda, and the subsidiaries of the parent company would be providing inputs such as the cans they are stored in or the transportation of the final product to market. By using the SIC codes of the parent companies and their subsidiaries, this study was able, through the use of the Input-Output tables to get a stronger measure of vertical integration.

The TOTAL variable was calculated by determining the number of possible combinations of the subsidiaries and the possibility of their outputs becoming an input into the parent company. This approach to explaining the degree of vertical integration experienced by a company is superior to the other previously mentioned methods for many reasons. The ratio of value added-to-sales method is faulty because this is a number which changes from industry to industry. For example, most manufacturing firms add a very large amount of value to the inputs that come into a plant, whereas a retail store may add a small amount, if any. But, that retail company could be vertically integrated with its distribution network, and in other areas which do not have any obvious value, but has the potential to increase profitability. Livery and Porter based their study on historic trends, which is limiting. To make projections about the future using past data is always risky. By taking each company and discovering the exact level of inputs that the subsidiaries have into the parent company, most of the difficulties encountered in the previous methods have been addressed. Also included in the data was such information as Return on Equity, Sales, Beta, Debt to Capital Ratio, and Dividend Payout Ratio. This data was combined with the vertical integration measures to compile the data set used for this study's regressions.

METHODS

To determine the effect of vertical integration on profitability, the regression form of analysis was used. By using this method, the effect of the independent variables (SALES, TOTAL, BETA, DIVISION and DIVIDEND), can be seen on the dependent variable, Return on Equity. The most basic regression run was:

$$\text{ROE} = B_0 + B_1 * \text{BETA} + B_2 * \text{DIVIDEND} + B_3 * \text{TOTAL} + B_4 * \text{DIVISION} + B_5 * \text{SALES} \qquad (1)$$

Table One: Regression Variables

VARIABLES	
ROE (Return on Equity)	It is a measure of rate of return on investment, more specifically, the investment contributed by shareholders
SALES	It is expected that as a firms increases sales, the profitability would go up, therefore creating a positive coefficient
TOTAL	This variable measures the total degree of vertical integration of all of the parent companies subsidiaries.
BETA	Beta is a recognized measure of risk. Since the data is cross sectional, it was necessary to control for the differing risks inherent in each industry represented, It is recognized in the financial field that when a shareholder takes on more risk, it expects to receive a higher reward.
DIVISION	This variable is a dummy for the division each company was in.
DIVIDEND	Although it is rather hard to represent the management techniques, these can sometimes be observed through the dividend payout ratio

RESULTS AND SIGNIFICANCE

These regressions show that none of the variables used in the regression except for BETA turn out be have any significant effect on profitability.

Table Two shows the results of the regression. In this table, the independent variable are listed vertically and the dependent variable of each regression horizontally.

Table Two: Regression Results

	Regression 1 ROE	Regression 2 ROE
Constant	-8.107 (-0.767)	-14.228 (-.2137)
BETA	1.59 (.676)	33.3168 (2.2873)**
DIVIDEND	.000 (0.0736)	
TOTAL	0.069 (0.5639)	-0.1052 (-0.1368)
DIVISION	1.0288 (1.057)	5.7575 (0.9586)
SALES	-0.308 (-1.744)	
DEBTEQUITY		0.0098 (0.1728)

The t-statistics (the variable coefficient divided by the standard error) is shown in parentheses
** denotes variables that are statistically significant at the 5% level

Something to note from this outcome is that the results are not as surprising as one would originally think. There is theory, as indicated before, that suggests the results could be significant, but there is other theory such as the cost of integration theory which indicates that there also might not be any correlation between vertical integration and profitability. There are many reasons that can be held accountable for this. First we must remember the main reason that it is assumed that American firms would be more profitable if they had a higher degree of vertical integration; because it has been observed that Japan, with its high degree of vertical integration has recognized large profits in the last ten years. This could be considered an indication of a system that had finally come together, and therefore something which American companies should consider. Also, the size of the data set and the possibility that the data set did not fully capture the effect of integration are also factors to consider when looking at the insignificance of the results.

KEIRETSU VS VERTICAL INTEGRATION

The technical aspects of the regression are not the only reasons that we may not have found the significance which was expected. Much of the theory in this paper was based upon the assumption that if it works in Japan, why can't it work here? By explaining the structure of Keirestu, some of the major differences in the two countries structure will come to light. This differences are at times major ones, and may explain to a large degree the lack of significance.

Japan has a history of a "centralized and hierarchical government orchestrating the actions of a centralized and hierarchical business sector." (Shughart, p. 63), whereas in he United States, we as a country have seen the welfare losses due to monopolies and acted against them. When the Japanese economy was destroyed after WWII, instead of looking towards smaller, family owned firms to rebuild the economy from the base up, the government came in a directed change. One thing that should be highlighted, is that the government was making these moves at the exact time that the Japanese anti-monopoly laws were put into effect. This shows the obvious lack of support that the government had had for these American imposed laws.

The U.S, by contrast, has seen the damage that the large monopolies can have on not only consumer welfare, but on the freedom and democracy the Americans trust and believe. As the large conglomerates took control over the economy, they also took control over the government, and the public felt as thought they were losing control. The laws that were put into effect were strongly supported by the public, and that is a reason for the difference between the two countries policies.

CONCLUSION

The results of this paper show no relation between vertical integration and profitability for United States manufacturing firms. This suggests that the costs of vertical integration are as great as the benefits in the United States. The steel industry has obvious cost advantages through vertical integration, but a manufacturing firm as the automobile industry may have increased overhead or the increased management costs that make vertical integration unprofitable. While it is true that many firms will see economies of scale, where a larger firm or plant is better, it is the economies of scope argument, which addresses the costs of integration, makes the advantages of integration not universal.

As stated before, this does make some sense. If there was a structure to the economy which guaranteed greater profits, it would seem that the country would have adopted it already. Instead the US has a variety of different forms of economy, ranging from monopoly to small cottage industry.

Japan in contrast has found great success in an extreme form of vertical integration. In Japan, there appears to be some relationship between vertical integration and profitability. In the US there are laws against many of the strategies that a firm would use in its justification of vertically integrating. American anti-trust law forbids foreclosure, price discrimination and entry barriers as "unfair methods of competition in or affecting commerce."(Shughart, p. 43) So, it is possible that the opportunity for the advantages to be realized in the US are fewer than in Japan, where such laws are overlooked in the interest of economic growth.

REFERENCES

Cunningham, Rosemary; Kolb, Robert. *Introduction to investments.* Kolb Publishing Company, 1993.

Dunn and Bradstreet. *America's Corporate Families, Volume II,* 1996.

Greer, Douglas. *Industrial Organization and Public Policy.* Macmillan Publishing Company, 1980.

Martin, Stephen. *Industrial Economics: Economic Analysis and Public Policy.* Macmillan Publishing Company, 1994.

Schmalensee, Richard; Willig, Robert. *Handbook of Industrial Organization: Volume I.* North-Holland, 1989.

Shughart, William. *The Organization of Industry.* Dame Publication, Inc. 1997.

United States Census Bureau. *Survey of Current Business: Benchmark Input-Output Accounts for the US Economy, 1987.* April 1994, Vol. 74, No. 4.

614

NAFTA and Jobs in the United States

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This research project was an investigation of the North American Free Trade Agreement's (NAFTA's) effects on United State's and Mexico's employment trends. The analyzation of government, public, and private citizen organizations' opinions concerning job losses attributed to NAFTA showed that jobs lost through Corporate America's investment in Mexico have not harmed the overall economy of the United States. The Mexican economy, however, has been negatively affected. An examination of the causes of job losses and long–run perspectives also pointed to the idea that the jobs lost attributed to NAFTA are significantly lower in the United States and higher in Mexico than commonly reported. Based on the sources evaluated, NAFTA will most likely cause the United States to become more efficient and increase employment in capital–intensive industries while improving Mexico's economy in the long-run even though there are severe problems in Mexico's current labor conditions.

HYPOTHESIS

The hypothesis this research study attempted to investigate was: Jobs lost in the United States through Corporate America's investment in Mexico through NAFTA do not harm the overall economy of the United States.

METHODOLOGY

A textual analysis of Government documents, books, journals, and Internet publications was employed to address the hypothesis. This study focused on opinions of well–known opponents of the North American Free Trade Agreement and on basic economic principles.

ASSERTIONS OF SOURCES EVALUATED

Author/Organization	1995 Total Job Losses from NAFTA	Description of Arguments
*1 Ross Perot, United We Stand America	300,000+	Low wages cause jobs to move to Mexico and Mexico has no market for US goods
*2 Marcy Kaptor, Byron Dorgan House and Senate	300,000+	The trade deficit will cause Americans to lose jobs
*3 Peter Cooper, Citizens Trade Campaign	470,000-638,000	US Government has not calculated satisfactory estimates

*1 United We Stand America, Inc. "NAFTA Impact Update."
*2 United States Congress. H.R. 2651 and S. 1417.
*3 Cooper, Peter. "Free Trade Reality Check."

ANALYSIS

United We Stand America (UWSA) is an organization that Ross Perot established to inform America of the dangers of NAFTA before it passed in Congress in January of 1994. The issue of jobs is extremely important for almost every American that is of voting age. It is possible that Perot used this as a tool to further his personal interests and to possibly win the presidential election of 1994 as well as attempting to protect the

American people from what he thinks will be a disaster caused by the North American Free Trade Agreement.

In his campaign against NAFTA, Perot asserts that NAFTA will not create jobs in America but it will in fact eliminate jobs by moving them to Mexico. Perot believes this for two main reasons: Firstly, Perot asserts that Corporate America wants to increase profits by paying lower wages to Mexican workers than to American workers. Secondly, he thinks that there will not be a market for American firms in Mexico because Mexicans cannot afford to purchase American goods (Perot, Choate 69). Perot notes the population differences between Mexico and the United States and compares the ability of people in each country to purchase goods. From these observations, Perot determines that the market of over 92,202,000 people in Mexico is not sufficient enough to create jobs in the future for the United States, the United States will lose jobs because of the low costs of labor in Mexico, and that NAFTA has a negative impact on the economy of the United States. When nations and economic factors are involved, the global economy becomes significant.

Perot does not consider the issue of the United States, European countries, and Japan being involved in international labor competition in his analysis of NAFTA. The debate that preceded NAFTA made it appear that this treaty was going to be the cause of the exodus of jobs to Mexico. However, it is conceivable that high wages in the United States are what cause low-skill manufacturing jobs to move to Mexico, not NAFTA. This is something that critics fail, consistently, to see. The benefits of sending jobs to Mexico (because of NAFTA) rather than to Singapore or Malaysia are the geographical proximity and the greater likelihood of Mexican workers to buy American products than workers from any other developing country.

Further, a look at history shows that low-skill manufacturing jobs had started to move south long before NAFTA was under discussion. The Maquiladora Program began in 1965 creating several hundred jobs in Mexico. Accordingly, the Program had grown to nearly 430,000 workers by 1988 (Vargas 1).

Perot's number of over 300,000 lost jobs resulting from NAFTA seems to come from the addition of numbers reported by citizens. The 300,000 plus number should "check" with the number of jobs created in the maquiladora industry. Considering the number of jobs created in Mexico and the idea that for every job created in Mexico a job is lost in the United States, the actual number of job displacements is far fewer than it is commonly reported. By using the number of jobs created in Mexico before NAFTA was implemented, it is possible to estimate how many jobs have been lost in the United States and sent to Mexico.

A recent publication by CIEMEX-WEFA, a private organization that measures activity of the maquiladoras in Mexico, recorded that 546,588 workers were employed in December of 1993. By October of 1995, the number had grown to 689,420 employees (1). This is a change of only 142,832 workers in nearly two years. Representative Kaptur and Senator Dorgan also estimate over 300,000 jobs lost in the United States in November of 1995, inferring that over 157,168 workers were hired by multi-national firms in Mexico in the month of November, 1995.

To calculate the number of jobs gained in Mexican maquiladoras, first take into account that the historical rate of growth in the maquiladora industry is estimated at 18 percent per year (it was 19.7 percent from 1983-1988, and 17.7 percent from 1989 to 1993 with projections for greater consolidation later in the 1990's) (Vargas 1-2). Then 546,588 workers at the beginning of 1994 increased by 18 percent equals 644,974 workers employed in December, 1994. Then 644,974 workers increased by 18 percent equals 761,069 workers by December, 1995. By subtracting the number of workers in December, 1993 from the number of workers in December, 1995, only 214,481 employees remain, leaving less than 215,000 workers in the United States displaced.

This number is, however, an overstatement of the number of jobs that have moved south from January 1994 to December 1995. Adjust the number of jobs created in the maquiladoras for 1994 and 1995, (214,481) to account for the close to 20 percent investment in the maquiladora industry from non-American firms, i.e., European and Japanese firms that moved jobs to Mexico from places other that the United States. The equation 214,481(.8)=171,585 workers, thus shows that the actual number of workers who were displaced in the United States is about 170,000.

Also, by simply adjusting CIEMEX– WEFA's data for the number of workers employed in maquiladoras from December, 1993 to October, 1995 for the 20 percent non–American investment, the equation 142,832(.8) yields 114,266 displaced American workers. Thus actual job losses from NAFTA are from under 115,000 to slightly over 170,000.

According to the NAFTA Office, the process of shifting America's labor–intensive jobs to capital–intensive jobs will "raise incomes and improve the mix of jobs in the economy" in the United States (1). Kelly George and Lori Taylor, economists from the Federal Reserve Bank of Dallas, Texas, attribute the recent growth in high–tech manufacturing in Texas to the increase of Mexican demand and the increase of exporting firms that have relocated to Texas to take advantage of their location at the border. George and Taylor have seen that "Texas has been a major beneficiary of Mexico's trade liberation" because "as employment patterns shift in response to trade, workers can move geographically, as well as occupationally" (22).

Ohio has also seen this shifting occur in its automobile manufacturing industry, however jobs have shifted out of instead of into Ohio. Steven J. Davis of the University of Chicago believes that it is normal to see dislocation in capitalistic economies. He writes, "The phenomenon of large–scale job destruction and creation has been part and parcel of the U.S. economy and other market economies for as long as we have [had] data" (Davis qtd. in Norton 55). Perot's concern with "large–scale job destruction" is that workers have lost their jobs and will not be able to find employment in the future. This will cause the lifestyles of Americans to deteriorate and negatively affect the overall economy of the United States. Although it is difficult to find new jobs, there is assistance available through Unemployment Insurance, the Economic Dislocation and Worker Adjustment Assistance Program, and the Trade Adjustment Assistance Program. These programs allocate temporary income and retraining services to workers who apply and are qualified to receive assistance.

To address Perot's second assertion that Mexico does not provide an adequate market for American goods one must consider Mexico's purchasing history. Since 1988 Mexico has been the third greatest importer of American goods. Exports to Mexico from 1994 to 1995 also show that Mexico, a poor country, is still the third most important customer of the United States (Current Business Survey 70). Further, in per capita terms, Mexicans buy more from the United States than the Japanese. Before NAFTA, Mexico was already an important customer of the United States. Hence, after NAFTA has had time to help transform the Mexican economy, Mexico is likely to become an even more valuable customer of the United States.

One of the greatest concerns of Representative Kaptur and Senator Dorgan is the trade deficit between the United States and Mexico. According to H.R. 2651 and S. 1417, Mexico is supporting its peso with $30 billion in loans from the United States. H.R. 2651 and S. 1417 also point to the devaluation of the peso and how it has "offset tariff reductions and other trade benefits the United States expected to achieve from the agreement" (H.R. 2651 section 2 paragraph 2). Representative Kaptur and Senator Dorgan are referring to the after affects of the "peso crisis."

With time, Mexico will improve its economy. Mexico, in 1992, created a voluntary labor union called the National Accord for Raising Productivity and Quality that "reflects the growing preoccupation of government, employers and belatedly, organized labor with addressing changes needed in a still largely corporatist labor– management relations system (Mexico Labor Trends 1991–1992). With time comes new leaders and with new leaders comes new changes. Time is the key to what Mexico's economy will be with the results from foreign pressure. Major structural changes have already taken place in Mexico's economy. For instance, the reduction of subsidies to inefficient industries, liberalization of laws that regulate foreign direct investment, rising environmental conscience, and other reforms have been undertaken in Mexico.

Representative Kaptur and Senator Dorgan's concern for the United States to eliminate the trade deficit and to lessen its ability to cause Americans to lose jobs is also a matter of time. The trade deficit according to H.R. 2651 and S. 1417 at the end of 1995, is $30 billion. The concept suggested by Kaptur and Dorgan is that if the United States purchases more goods from Mexico, fewer goods will be purchased in the United States and this will cause Americans to lose jobs. Therefore, the trade deficit is presumed to cause Americans to lose jobs. However this is not the case.

The problems with this argument are that a very large percentage of Mexico's exports to the United States are manufactured goods which are produced in plants that are only part of the production processes of American multinational corporations (Vargas 3). The trade deficit results partially from many maquiladoras that ship goods assembled in Mexico with parts from the United States back to the United States. Also various goods purchased from Mexico are not produced in the United States. Among these are handcrafts and oil and other labor-intensive products. Importing goods from Mexico that are not produced in the United States does not cause Americans to lose jobs. This contributes to the trade deficit and therefore does not cause significant job losses in the United States.

Peter Cooper from Citizens Trade Campaign joins Ross Perot, Marcy Kaptur, and Byron Dorgan in his anti-NAFTA position in his article, "Free Trade Reality Check." Cooper alleges that the Government's main NAFTA economist from the Institute for International Economics, Gary Hufbauer, is mistaken about his findings for net job loss due to NAFTA. Cooper asserts that Hufbauer's argument that there is virtual "full employment in the U.S." and that "there can be no net job loss in the economy due to trade with Mexico" is not correct because "plugging the real life U.S. Department of Commerce data on NAFTA trade flows...shows a net U.S. job loss of over 600,000 in 1995 (2)." Cooper believes that this formula is not reliable and should not be taken seriously.

After examining this issue, it became apparent that there is no formula that adequately counts the number of job losses to NAFTA. Thea M. Lee, in a Senate hearing on May 27, 1993, agrees that the Hufbauer and Schott analysis relies on incomplete methodology and makes assumptions that are not appropriate to calculate the total number of job losses or gains from NAFTA (27). The process of developing an equation that includes every industry, every firm, and every detail that is significant in the American economy to yield the exact number of jobs lost because of NAFTA is extremely difficult and cumbersome.

Cooper exposes the inadequacies of the American Government's multipliers and assumptions and proposes that their predictions are not accurate enough to be considered valid. He then leads us to the idea that we must rely on other factors to provide more accuracy to assess the impact of NAFTA on American jobs. Thus, balancing the assumptions with the number of jobs created in Mexico, noting the likelihood that Mexico will develop into a powerful consumer market for American goods, and witnessing the creation of jobs in the United States because of NAFTA would provide more accuracy in determining the number of jobs affected by NAFTA.

With more labor-intensive investment in Mexico, Corporate America's activity will create more productive opportunities for firms in the United States. As Mexico privatizes its sea ports, airports, railroads, and some petrochemicals, foreign direct investment will increase and the consumer market will also expand. When the market expands, more capital-intensive jobs will be created in the United States to supply the increased demand for American goods in Mexico and jobs in the United States will continue to shift. Jobs will shift to capital-intensive industries that have a comparative advantage over Mexico and there will not be mass unemployment in industries were Mexico has a comparative advantage in labor-intensive industries. It has even been suggested that, when the "Baby Boomers" retire, border controls will be loosened to allow Mexican workers to come and work in the United States (Wescott 23 May 1996).

CONCLUSION

The North American Free Trade Agreement is promoting economic integration and trade with Mexico and is forcing changes in the occupations of many Americans. Although the number of job displacements are uncertain, the overall effect of NAFTA on jobs and workers in the United States has been minimal. For reference to the previous calculations, the January, 1996 issue of Employment and Earnings states that the total number of employed workers as of December, 1995, was 114,373,000 (U.S. Dept. of Labor p. 152). As of April, 1996, the number of workers in America was 123,600,000 (Colorado Labor Force Review 2). With job losses from 115,000 to 170,000 and numerous jobs created by NAFTA, it is proven that a minuscule percentage of jobs have been lost in the United States because of NAFTA. The number of jobs lost is lower than commonly reported and does not harm the overall economy of the United States.

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REFERENCES

CIEMEX-WEFA. "Executive Summary" *Monitoring Border and Environmental and Health Conditions TwoYears after NAFTA*. Netscape. Online. <http://www.essential.or.. petrade/borderexec.html>. (18 Jn 1996).

Cooper, Peter. "Free Trade Reality Check." *Citizens Trade Campaign*. Netscape. Online. <http://www.cmf.net/~cr/trade/trade-jobs-0308>. (31 May 1996).

Economics and Statistics Administration. Office of International Macroeconomic Analysis. "FDI and Trade Interlinkages in Latin America." *NAFTA Watch Index*. Jn 1995. Netscape. Online. <http://www.aescon.com/naftam/folkow.htm>.

George, Kelly and Lori Taylor. "The Role of Merchandise Exports in the Pattern of Texas Employment." Economic Review. Federal Reserve Bank of Dallas. First Qtr., 1995: 22.

NAFTA Office. "NAFTA: First Year Snapshot." 17 Feb. 1995. Netscape. Online. <Http://www.i-trade. com/dir05/facts/4003.html>.

Norton, Rob. "Job Destruction/Job Creation." Fortune. 1 Apr. 1996: 55.

Perot, Ross and Pat Choate. Save Your Job, Save Our Country. Why NAFTA Must be Stopped Now! Hyperion. New York. 1993.

Schriner, James A. "Should You Invest in Mexico? Recent Volatility Presents a Dilemma for Managers." Industry Week. 4 Mar. 1996: 61.

United States. Cong. "North American Free Trade Agreement: Are there Jobs for American Workers?" Congressional Hearing. Washington: GPO, 27 May 1993.

—. —. House of Representatives. H.R. 2651 "NAFTA Accountability Act". Washington: GPO, 16 Nov. 1995.

___ ___ Senate. S1417 "NAFTA Accountability Act". Washington: GPO, 16, Nov. 1995.

___. Dept. of Commerce. "Survey of Current Business." Washington: GPO, Apr. 1996: 70.

___. Dept. of Labor. "Mexico Labor Trends 1991-1992." CD-ROM. National Trade Data Base. (3 Oct.1995).

—. —. "Colorado Labor Force Review." Washington: GPO, Apr. 1996: 2.

—. —. "Employment and Earnings." Washington: GPO, Jan. 1996: 152.

—. International Trade Commission. "Chapter 4: U.S. Relations with Major Trading Partners." The Year in Trade. CD-ROM. National Trade Database. (9 Aug. 1995).

United We Stand America. "NAFTA Impact Update." Jan. 1996. Netscape. Online. <Http://www.uswa.org/hey/naftal.html>.

Vargas, Lucinda. "Business Frontier." Federal Reserve Bank of Dallas. El Paso. Sept./Oct. 1994: 1.

Wescott, Jim. Conference. Department of Local Affairs Economic Projection Workshop. Denver. 23 May 1996.

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Gender Differences in Investment Expectations

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There has been a great deal of focus on women investors and as a result brokerage firms are beginning to market their services directly to women. Yet, there has been little evidence of a difference between men and women and their investment behavior or expectations. This paper investigates the existence of gender differences by presenting the results from a survey distributed to more than 500 students taking introductory economics at 10 colleges and universities. In particular, the results indicate that women differ from men in the way in which they (1) rate their understanding of the financial markets, (2) characterize their risk preferences, (3) select the most important resource for investment advice, and (4) estimate the Dow Jones Industrial Average.

INTRODUCTION

Recently there has been some attention by the media and brokerage houses concerning how men and women differ as investors. In particular, there is some concern that women may be reluctant to participate in more risky investment assets and therefore may miss out on the higher returns these assets may generate. Given the focus on the ability of the Social Security system to handle the upcoming retirement of the baby-boomers and recent proposals for privatizing the system, this issue takes on even greater importance. Since women on average earn less than men, their ability to prepare for retirement with contributions to Social Security, other pension plans, and financial assets in general is more limited. Together with the longer life expectancy of women, this may portend a much reduced standard of living for women in comparison to men in the later years (Bajtelsmit and Bernasek, 1996). To compensate for this disadvantage, will women be willing to take on more risk in order to increase the magnitude of their returns?

It has been repeatedly noted from U.S. Census data that income for men and women retirees differs substantially. In 1992, the median income for elderly men was $14,548, whereas for women, median income was $8,189 (U.S. Census Bureau, 1995). This disparity seems certain to continue given the current wage gap between males and females. The Department of Commerce reports that in 1995, median income for year-round, full-time workers was almost $9,000 greater for men than women.

Recent studies by Jianakoplos and Bernasek (1996) and Bajtelsmit, Bernasek, and Jianakoplos (1996) investigate gender differences in investment behavior using the 1989 Survey of Consumer Finances as the source of data on risky asset holdings for individuals. In "Are Women More Risk Averse?" Jianakoplos and Bernasek examine household holdings of risky assets in

620

portfolios to determine whether financial decision making reflects differences between men and women. They find that single women are relatively more risk averse than single men or married couples. Bajtelsmit, Bernasek, and Jianakoplos investigated gender differences in allocating wealth to defined-contribution pensions and found that women are also more conservative in their allocations to pensions implying less financial security for women upon retirement. These studies by Bajtelsmit, Bernasek and Jianakoplos indicate that women follow an investment strategy that on average will produce lower returns and will cause elderly women to be at even a greater income disparity with elderly males. Given the results of this research, our study attempts to determine if a more conservative investment strategy will continue with the next generation.

This project attempts to investigate gender differences in investment expectations among college students by asking students in introductory economics courses about their knowledge of financial markets and their willingness to take on risk. The results indicate that women perceive themselves as less knowledgeable in the market and less willing to take on risky investments. These results have astounding implications for the prosperity of elderly women in the future.

THE SURVEY

This survey involved 576 students taking introductory economics at 10 colleges and universities during the Fall 1996 semester. Of the 576 students, 270 (or 47 percent) were female and 306 (or 53 percent) were male. After collecting information on age, sex, citizenship, and family income, the survey asked the students about their experience with various saving and investment opportunities and to estimate the current value of the Dow Jones Industrial Average (DJIA). The survey then focused on the answers of female and male college students to the following questions:

- How would you rate your understanding of financial markets?
    - very knowledgeable.
    - somewhat knowledgeable.
    - not very knowledgeable.
    - do not understand financial markets at all.
- How would you characterize yourself?
    - willing to take on very risky investments.
    - somewhat willing to take on very risky investments.
    - not very willing to take on very risky investments.
    - wish to avoid risk completely.
- When looking for investment opportunities, what factor would you feel is most important?
    - recommendation by an investment advisor.
    - recommendation by a friend or relative.
    - personal knowledge of company or product.

RESULTS

The results of the survey indicate a statistically significant gender difference in the answers to the questions. In general, men are more willing to estimate the value of the DJIA (56.2 percent versus 28.2 percent for women), are more likely to be correct in estimating the DJIA (25.5 percent versus 11.5 percent), evaluate themselves as somewhat knowledgeable about investments (41.8 percent versus 27.8 percent), and characterize themselves as being somewhat willing to take on very risky investments (47.4 percent versus 28.5 percent). Similarly, women are more likely to respond that they do not understand financial markets at all (12.6 percent versus 4.9 percent for men), characterize themselves as not very willing to take on very risky investments (61.9 percent versus 42.5 percent), and respond that they wish to avoid risk completely (7.8 percent versus 3.3 percent). Finally, men and women differed in their responses about what factor was most important to them when looking for investment opportunities. Men were statistically more likely to respond that personal knowledge of a company or product was more important to them (61.4 percent versus 43.3 percent for women), while women were statistically more likely to respond that a recommendation by an investment advisor was more important (46.3 percent versus 34.3 percent for men) or recommendation by a friend or relative (10.7 percent versus 6.5 percent). The only response to which there was not a significant gender difference was for students responding that they were very knowledgeable about financial markets. Table 1 summarizes the responses to the survey.

Table 1: Survey Response (Sample: All Students)

	Male Students	Female Students	T-Statistic
Percent Responding to DJIA	56.21	28.15	-7.11
Percent Responding Correctly to DJIA	25.49	11.48	-4.43
Percent Responding to Recommendation by an Investment Advisor	34.31	46.30	2.94
Percent Responding to Recommendation by a Friend or Relative	6.54	10.74	1.78
Percent Responding Personal Knowledge of Company or Product	61.44	43.33	-3.29
Percent Responding Very Knowledgeable	1.96	0.74	-1.28
Percent Responding Somewhat Knowledgeable	41.83	27.78	-3.58
Percent Responding Not Very Knowledgeable	49.67	58.15	2.04
Percent Responding Do Not Understand Financial Markets at All	4.90	12.59	3.24
Percent Characterizing Themselves as Willing to Take on Very Risky Investments	4.90	0.37	-3.51
Percent Characterizing Themselves as Somewhat Willing to Take on Very Risky Investments	47.39	28.52	-4.75
Percent Characterizing Themselves as Not Very Willing to Take on Very Risky Investments	42.48	61.85	4.73
Percent Responding Wish to Avoid Risk Completely	3.27	7.78	2.34

To see whether gender differences persist for subsets of the sample, the analysis narrowed to students who responded that they were either very or somewhat knowledgeable about financial markets and who were able to estimate the Dow Jones Industrial Average within 1000 point band. Of the 211 students who responded that they were either very or somewhat knowledgeable about financial markets, there remained a statistically significant difference between male respondents and female respondents of answering the DJIA (67.9 percent for men versus 33.8 percent for women), answering the DJIA correctly (36.6 percent versus 14.3 percent), and willingness to take on very risky investments (8.2 percent versus 0.0 percent). Those results are reported in Table 2.

Table 2: Survey Responses (Sample: Students Responding Very or Somewhat Knowledgeable about Financial Markets)

	Male Students	Female Students	T-Statistic
Percent Responding to DJIA	67.91	33.77	-5.07
Percent Responding Correctly to DJIA	36.57	14.29	-3.85
Percent Characterizing Themselves as Somewhat Willing to Take on Very Risky Investments	8.21	0.00	-3.45

Of the 109 students who were able to estimate the Dow Jones Industrial Average within 1000 point band, there remained a significant statistical gender difference in men characterizing themselves as willing to take on very risky investments (8.9 percent versus 0.0 percent for women), as well as rating their understanding of financial markets as very knowledgeable (6.4 percent versus 0.0 percent), somewhat knowledgeable (56.4 percent versus 35.5 percent), and not very knowledgeable (35.9 percent versus 61.3 percent). Table 3 summarizes those results.

Table 3. Survey Responses (Sample: Students Able to Estimate DJIA Correctly)

	Male Students	Female Students	T-Statistic
Percent Characterizing Themselves as Somewhat Willing to Take on Very Risky Investments	8.97	0.00	-2.76
Percent Responding Very Knowledgeable	6.41	0.00	-2.30
Percent Responding Somewhat Knowledgeable	56.41	35.48	-2.01
Percent Responding Not Very Knowledgeable	35.90	61.29	2.46

CONCLUSION

The survey results show that women are continuing a conservative attitude toward investing which implies low returns on investment strategies for these women in the future. Through this survey, we also discovered that college-aged women are more hesitant to claim knowledge of financial markets or to respond to questions about the Dow Jones Industrial Average. In the survey question that asked participants to estimate the Dow Jones Industrial Average, participants had nothing to lose by taking a guess. Yet, only 28 percent of the female participants wanted to take that chance versus 56 percent of males. Does this lack of confidence in financial markets stem from an actual difference in financial education for men and women or from social behavior differences in which men assume the risk of being more assertive? The answer to this question is more difficult to ascertain, but nonetheless, needs to be studied more heavily, especially given the increasing attention of privatization of pension plans. By determining why investment differences occur, strides toward improving women's participation and success in financial markets can be made which will hopefully lead to greater income equality in the future.

REFERENCES

Bajtelsmit, Vicki L. and Alexandra Bernasek. "Why Do Women Invest Differently Than Men?" Financial Counseling and Planning, forthcoming.

Bajtelsmit, Vickie L., Alexandra Bernasek, and Nancy A. Jianakoplos. "Gender Differences in Pension Investment Allocation Decisions." Colorado State University, Working Papers in Economics and Political Economy, October 1996.

Jianakoplos, Nancy Ammon and Alexandra Bernasek. "Are Women More Risk Averse?" Colorado State University, Working Papers in Economics and Political Economy, March 1996.

U.S. Bureau of the Census (1995). "Income 1995." http://www.census.gov/hhes/income/income95/in95sum.html. (April 8, 1997).

U.S. Department of Commerce (1995). "Sixty-five Plus in the United States." http://www.census.gov/socdemo/www/agebrief.html. (February 20, 1997).

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Do Dollars Make a Difference? The Relationship Between Expenditures and Test Scores in Pennsylvania's Public Schools

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This paper examines standardized test scores from effectively every public school in the state of Pennsylvania to determine what relationship exists between per pupil expenditures and student achievement. The results of this study show that expenditures have virtually no effect on achievement, while the socio-economic backgrounds of a school's students consistently and significantly affect achievement.

INTRODUCTION

In 1983, the National Commission on Excellence in Education released its report "A Nation at Risk." In this report, the commission confirmed what other studies had been indicating for years: U.S. school children were lagging behind students in other industrialized countries in the basic fields of science and mathematics (Burtless, 1996). Also, many people started to believe that contemporary school children were learning less in basic subjects than those of just a generation ago. This seemed to be supported by declining scores on the Scholastic Aptitude Test (SAT) and other similar standardized tests.

This realization of declining educational achievement spurred the implementation of school improvement programs across the country. Most of these programs called for an increase in the amount of funding provided for schools. Implicitly, this holds that expenditures, at least partially, determine the quality of an education system as measured by quantified indicators of student knowledge of basic subjects.

Intuitively, this assumption makes sense. With more money, schools can "buy" more education. Presumably, more funding will allow school districts to hire better teachers, purchase higher quality text books and employ any number of other tactics which should give schools the ability to do their job.

However, it appears as though intuition was wrong in this respect. Before "A Nation at Risk" was published the trend did not lend credence to the assumption that more money leads to better test scores. The period of declining test scores, from the early 1960s through the early 1980s, coincided with a period when expenditures on education were rising in real terms. Per pupil expenditures rose 58 percent in real terms during the 1960s and 27 percent in the 1970s (Sowell, 1993). During the decade after the report, expenditures rose 29 percent, but there was little appreciable improvement. In the 1990s, American 13-year-olds finished last in a test comparing their science and math skills with students from five foreign countries and four Canadian provinces (Will, 1994), and SAT scores had not begun any recovery to the early 1960s level.

Management expert Russ Ackoff has commented that such testing measures are misleading in that cross-generational comparisons are impossible. He has made the point that today's students learn things that would have been impossible for those of a generation ago to learn (Ackoff, 1996). While a comparison of specialized knowledge does seem unfair, there are still grounds to compare the skill levels each generation exhibited in rudimentary subjects such as reading and math. It is doubtful that there have been the cutting-edge knowledge explosions in vocabulary or arithmetic necessary to turn the comparison into one of apples and oranges. And one need not go back to previous generations to witness a decline in these basic skill areas. The National Assessment of Educational Progress's final 1994 Reading Report Card found that there was a significant decline in the proportion of twelfth graders at or above a proficient reading level since 1992 and a significant decline in the proportion of twelfth graders at or above the basic level of reading (Hirni, 1996).

However, even if comparisons, cross-generational and international, are abandoned altogether, there are still practical evaluations of the quality of education that can be made. American Telephone has reported that, on average, 115 out of 117 applicants flunk its employment exam and Motorola has found that 80 percent of its applicants fail its exam which evaluates English skills at the seventh grade level and math skills at the fifth grade level (Will, 1994).

The situation in Pennsylvania's public schools is perhaps worse than that of the nation as a whole. According to the Heritage Foundation, Pennsylvania's students perform worse on the SAT than all but students from six other states. David Hombeck, the superintendent of the Philadelphia school district, the state's largest, was quoted in The Philadelphia Inquirer as saying, "Fewer than 20 percent of our kids can read or do math or do science at what we consider a proficient level (Jones, 1996)." In terms of practical measures of school achievement, there are also indications that Pennsylvania's public schools are deficient. School board members from throughout Chester County, whose districts have consistently scored among the highest in the state on Pennsylvania's educational assessment tests, have testified that employers have often come to them with the complaint that their schools are turning out students who do not even have the skills requisite for entry-level employment (Klick, 1996).

Following the conventional wisdom, many educators have claimed that more funding is necessary to improve the quality of education in the state. In the School District of Philadelphia's plan for improving its schools, "Children Achieving," the ninth stated objective in the Executive Summary is to "Ensure adequate resources and use them effectively." In its explanation of this objective, the plan states "Adequate resources are a commonsense [sic] precondition to virtually all children achieving at high levels . . . additional resources are an absolute prerequisite for dramatically improving student outcomes." In 1994-95, Philadelphia spent $6,261.17 per pupil, just short of the $6,804 per pupil state average which places it higher than the state averages of all but six states.

Given the anecdotal and quantitative evidence that public schools are deficient in providing American students with fundamental skills and in preparing them for the work force, it is reasonable that parents, politicians and educators would want to remedy the system. This desire is obvious enough. However, the means to improvement are not quite so obvious. Conflicting results have been obtained by numerous studies of the relationship between per pupil expenditures and student achievement.

In a survey of studies analyzing the determinants of student performance, Eric Hanushek found that in only 34 percent of 377 studies on the subject were expenditures found to be statistically significant. And, of those where expenditures were found to be significant, 20 percent found that a negative relationship actually existed (Burtless, 1996). Therefore, only 27 percent of these tests found expenditures to have a significantly positive effect on student achievement.

Similarly, in its 1993 Report Card on American Education, the group Empower America, which counts among its leadership former Secretary of Education William Bennett, noted that of the 10 states that consistently rank among the top in various student achievement tests, only one rated in the top 10 in terms of per pupil spending (Wisconsin at No. 8).

This evidence is sufficient to call the assumption that money is the key to quality education into question. However, it is not sufficient to conclude that, because studies of a national scope propound there is no relationship, there is no linkage between expenditures and achievement in a specific geographic area. To do so would be to commit a fallacy of decomposition.

It is the purpose of this study to analyze specifically the schools in the state of Pennsylvania to determine whether or not expenditures play a role in student achievement. Knowledge of this relationship is necessary in order to formulate effective plans to improve the quality of education in the state.

THE MODEL

Beginning in 1992, the Pennsylvania Department of Education began administering the Pennsylvania System of School Assessment (PSSA) test. This test is taken by fifth, eighth and eleventh graders in February or March of every year, and it measures basic reading and math skills. The 1994-95 school year marked the first year every public school in the state participated in the testing.

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Scores on this test were selected as the basis for the dependent variable in this study. This test is particularly well-suited to serve as a proxy for school achievement in that every student must participate in the testing. Unlike the SAT which is taken only by a self-selected group, the PSSA has the potential to measure achievement by all students, not just those who are college bound.

The PSSA is scored on a relative basis. That is, no absolute score is given in terms of percentage of questions answered correctly. Instead, results for schools are related on a basis of the percentage of a school's students whose scores fall within each quartile of the distribution of scores throughout the state. This relative grading provides yet another advantage of using the PSSA as the proxy for school achievement. By using relative scores, an analysis can be made of what determines differences among schools in educational quality.

In order to yield a quantified "score" for each school in this study, a weighting system was developed whereby scores in the fourth quartile received three points, scores in the third quartile received two points, scores in the second quartile received one point and scores in the first quartile received no points. Mathematically, this scoring scheme can be related as follows:

$$\text{Score} = (3 * \%\text{ of students in Q4}) + (2 * \%\text{ of students in Q3}) + (1 * \%\text{ of students in Q2})$$

Effectively, there were nine different analyses performed in this study. Scores on the reading section of the PSSA and scores on the math section of the PSSA were both studied as well as the summation of both. These analyses were carried out at the fifth, eighth and eleventh grade levels. These separate tests were done to examine any differences in the relationship that result from either grade level or subject matter.

The explanatory variables investigated in this study are total expenditures per pupil, percentage of student body coming from low income households, size of school district and occurrence of strikes within the district.

Total expenditures per pupil was measured by dividing total expenditures made by a district by the average daily attendance within that district. These data have been summed for the years 1989-1995. The rationale for this summation is provided by the assumption that education is cumulative; therefore, if expenditures do have an impact on education, it is more useful to look at expenditures over the educational career of a student rather than at expenditures made just in the year the test was taken. While there is a danger in that it is impossible to account for migration between school districts during this time period, it is not beyond reason to assume these changes will randomize out. Presumably, the relationship between expenditures and achievement will be positive.

Percentage of students from low income households (Poor) was chosen as an indication of the social capital available to students (Burtless, 1996). Presumably, poverty will limit the amount of leisure time a parent has to spend with a child in such activities as reading together or doing homework. Also, these data are likely to give an indication of the ability of a household to provide educational resources to a student such as books or computers. Intuitively, the relationship between this variable and achievement will be negative.

The size of a school district is measured by its average daily attendance (ADM). This variable was chosen to examine the effects of economies and diseconomies of scale on the education process. Intuitively, it seems as though there are certain efficiencies that can be gained in larger districts which can eliminate the duplication of administrative tasks, thus freeing more resources for educational purposes. However, on the other end of the spectrum, a district that is too large may not be able to manage its schools effectively and thus will become bureaucratized and wasteful (Sowell, 1993). It is reasonable to assume that ADM will exhibit a quadratic relationship to achievement with a positive relationship turning into a negative relationship after some optimal size is reached.

Lastly, occurrence of strike (strike) was included due to the presence of the claim by the department of education that some districts may not have been able to cover all of the topics tested by the PSSA due to teacher strikes in the districts. This is a fair enough consideration, and it warrants inclusion in the study. Strikes were measured as a dummy variable with one representing the occurrence of a strike in the district and zero denoting the absence of any strikes in the district during the year. Obviously, as noted by the department's concern, a strike is likely to have a negative effect on achievement.

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COMMENT ON FINDINGS

Regarding expenditures, of the 63 different functional forms of the model that contained some expression of expenditures, 22 of those forms showed expenditures to be statistically insignificant at a 0.05 significance level. Of the 41 forms which showed expenditures to have a significant impact upon performance, 16 showed that impact to be negative. That is, when more money is spent per pupil, tests scores actually drop. For those forms which rendered a significantly positive coefficient with the expenditure term, that coefficient, in every case, was so small (generally about 0.000005) that an increase of $100,000 per pupil would be necessary to raise the school's score by 0.5 points. Obviously, this is an impractical scenario.

Of the 90 functional forms of the model that contained "poor" as an explanatory variable, poor's coefficient (generally about -3.0 for total scores) was significantly negative 90 times. As for the effect of a strike on student performance, in no case did strike's coefficient turn out to be statistically significant. Finally, no consistently significant relationship was found between ADM and achievement.

Also, it is interesting to note that the explanatory power of the regressions decreased significantly from the fifth grade scores to the eighth grade scores and again to the eleventh grade scores. The coefficients of determination for the fifth grade scores neared or surpassed 70 percent, while those for the eighth grade scores dropped under 60 percent and those for the eleventh grade scores fell between the 30 and 35 percent range. Even though each area of the study focuses on different groups of students, it is likely that this decline would have been observed in a longitudinal study as well.

One explanation for this observation may be what Chester Finn of Vanderbilt University calls the "9/91" problem. Finn notes that by the time a child reaches the age 18, only nine percent of his time has been spent in schools, while the other 91 percent often subverts what schools attempt to do (Will, 1994). This phenomenon can be applied to this situation because, presumably, the time children of fifth grade age or younger spend away from schools is spent primarily with families which serve an educative purpose as well. However, as children age, separation from families becomes more distinct and outside social influences play more of a role in the individual's development. Almost by definition, these outside influences will be more difficult to specify and nearly impossible to quantify. From this reasoning, it is obvious that the true relationships involving older individuals' achievement will include more of these unspecifiable influences than those of younger students. Therefore, the explanatory powers of a quantified relationship will decrease as age increases.

CONCLUSION

The most clear-cut finding of this study is that dollars definitely do make a difference. But that difference is not necessarily made in the schools; instead it is made in the home. Poverty in the home, without fail, proved to be a significant determinant of whether or not a student will succeed in school. The data could not possibly make this point more clearly. Those schools heavily populated by low income students are unable, on average, to educate those students in fundamental math or reading skills.

The reasons for this linkage are not clear. Perhaps these students come to school initially deficient from lack of significant parental attention in the pre-school years, or maybe these students do not have the proper support system needed to reinforce the skills taught in the schools. This could be the case for a myriad of reasons. Perhaps low income parents do not have the free time to spend with their children. Another possibility might be that poorer children do not have sufficient resources at home to allow for reinforcement of school lessons such as books and computers. One other possibility is that there may be a negative correlation between income and education of parents. This point is in fact made in some economic literature. This speculation would hold that affluent parents are better educated and are, therefore, better able to serve as a resource for their children as teachers in their own right. Perhaps this resource is not readily available to children from low income families.

However, regardless of the reason, family income does make a difference in student achievement. Such a conclusive statement cannot be made for school expenditures. Given this situation, it may be sensible for communities to divert funds from the schools and instead spend them in the community. By improving youth centers by employing educators and purchasing improved educational material, a significant resource may be provided for those students who cannot look to their homes for help. Another option might be to develop a

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mentor program whereby poor youth can be put in contact with a role model who is available to help students achieve.

These options need to be researched because there is no proof that money spent on these programs will be any more effective than the money spent in schools. But, in light of this study, at least in Pennsylvania, an alternative to school spending, which has only, at most, a negligible effect, must be investigated.

The practical question that arises for the schools themselves is, why does money seemingly not make a difference in student achievement? The first possibility would hold that schools are operating in a position of zero marginal or negative marginal benefits of funding. Effectively, the schools are spending too much money.

This conclusion has been used by many affluent districts to fight the claims of poorer districts that the funding system for education (i.e. moneys coming from localized tax bases) creates separate and unequal school systems for the rich and poor. By explaining away this claim in saying that money does not matter but to continue to spend thousands of dollars more than poorer districts, the affluent communities contradict themselves. If money does not make a difference, are there not more productive uses for that tax revenue than just throwing it at the schools? If the conclusion could be made through research that there is a different relationship that exists for affluent and poor districts then there would be grounds for allowing the disparity to continue. In the absence of any such research, it seems reasonable to claim that if the marginal benefit of spending in schools is effectively zero then school expenditures could be reduced at every school without affecting achievement. Thus, a more efficient system is created. Perhaps this could lead to the conclusion that there should be a standard per pupil expenditure throughout the state.

A more plausible explanation would be that schools are not using the money they have effectively. This possibility has been raised by Stanford economist Thomas Sowell. Sowell has cited studies of the Milwaukee and New York City school systems which have shown that less than half of the money spent per high school student in New York or per elementary school student in Milwaukee actually reached the schools (Sowell, 1993). His explanation for this is the growing bureaucratization of the public school establishment. Because of this, funds get eaten up in non-instructional administrative costs.

Or perhaps the schools are using their funds effectively, but their objectives are not the education of students in basic subjects such as reading and math. During the period of declining test scores, there has been a proliferation of non-academic instruction involving courses in sex education, environmental awareness and other social causes that were not popular before the 1960s. This possibility is reasonable if that is what society values. Perhaps, as Ackoff claimed, today's students are learning more in a plurality of subjects. If this is the case, then maybe schools are using their funding effectively.

Currently, Pennsylvania's public schools are in the midst of reforms that claim to be geared toward improving deficiencies in basic subjects such as reading and math. These deficiencies are glaring in the light of standardized test scores and in the context of the complaints of employers that Pennsylvania's high school graduates are not prepared for employment in even entry-level positions. One of the main thrusts of most of these reforms involves dedicating more funding to education. This study should give pause to those reformers. Maybe after some structural changes are initiated in the schools, this added money will be productive, but as things stand now, it is likely that any extra money will not have an appreciable effect on helping students achieve.

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REFERENCES

Ackoff, Russ. Lecture at Villanova University, December 10, 1996.

Burtless, Gary (Editor). Does Money Matter? The Effect of School Resources on Student Achievement and Success. Washington, D.C.: The Brookings Institution, 1996.

Empower America. "Report Card on American Education 1993."

Hirni, James F. "America's Report Card on Reading: A Lesson for Congress and the Taxpayers." F.Y.I. No. 94, The Heritage Foundation: April 10, 1996.

Jones, Richard. "Hornbeck calls school summit unifying." The Philadelphia Inquirer. December 17, 1996.

BEST COPY AVAILABLE

Klick, Jonathan. "IU board approves plan for 95 percent attendance rate." The Daily Local News. May 17, 1996.

Pennsylvania Department of Education. The Pennsylvania System of School Assessment: 1994-95 School-By-School Results, December 1995.

Pennsylvania Department of Education. Selected Expenditure Data for Pennsylvania Public Schools, 1989-90, 1990-91; 1991-92, 1992-93; 1993-94, 1994-95.

School District of Philadelphia, The. "Children Achieving."

Sowell, Thomas. Inside American Education: The Decline, The Deception, The Dogmas. New York: The Free Press, 1993.

Will, George F. The Leveling Wind: Politics, The Culture & Other News 1990-1994. New York: Viking Penguin, 1994.

The Income Distribution Effects of IMF Balance of Payments Stabilization Tools: A Case Study of Monterrey, Mexico

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Abstract. A country can experience a currency crisis after a period of prolonged balance of payments deficits. The International Monetary Fund (IMF) encourages devaluing the domestic currency, reducing the government budget deficit, and slowing the growth of the money supply to stabilize the currency. The IMF examines the macroeconomic effects of these actions, but often ignores their effects on income distribution arising from changes in the inflation rate, rising unemployment, and reduction in benefits for the poor.

This paper presents an analytical framework which allows us to evaluate the social effects of each element of these IMF currency stabilization programs. It includes a discussion of previous literature linking stabilization policies and social outcomes and illustrates these outcomes using price, wage, and unemployment data the author collected in Monterrey, Mexico, including over 50 interviews with Mexican workers and economists. The author concludes that while the overall income distribution effects are difficult to measure, parts of the stabilization policy did appear to adversely affect the poor and were therefore regressive in terms of income distribution.

BACKGROUND TO THE ECONOMIC CRISIS IN MEXICO

The December 1994 peso crisis in Mexico was the culmination of a year of instability in Mexican financial markets. Beginning with the January 1st rebellion in Chiapas, confidence in Mexican markets dwindled as various political crises undermined stability in the country and the high current account deficit began to look unsustainable to foreign investors. The capital-flight pressures and current account balance deficit placed downward pressure on the value of the peso, as peso holders valued other currencies more, either to purchase goods with or to invest with. Foreign currency reserves fell from February to April 1994 as the Bank of Mexico, Mexico's Central Bank, tried to support the value of its peso by trading dollars for pesos to keep the exchange rate within a predetermined band. A sudden capital flight at the beginning of December 1994 led to a loss of $1.5 billion in foreign reserves in three days, and the Bank of Mexico had to adopt a floating exchange rate by the end of the month. The value of the peso plunged from 3.5 to 6 pesos per US dollar and looked to decrease further unless major stabilization measures were undertaken.

To follow were a series of IMF-supported currency stabilization policies proposed by the Mexican government and supported by the Director of the IMF, Stanley Fischer, who stated that the policies should result in "low inflation, renewed economic growth, and a significant strengthening in the balance of payments" (IMF, 1/95). The plan, which included a decrease in government spending, increase in government revenue, and a decrease in the rate of growth of the money supply, was supported by the largest single IMF credit backing in history, both in amount and overall percentage of member country quota. The plan gave priority to maintaining social programs, including increasing the minimum wage by 10% in April and retaining social security benefits. But the cuts in subsidies, increases in revenues (accomplished through increases in user fees for government-provided utilities) and wage increases which failed to keep pace with inflation may have affected different income groups disproportionately, perhaps worsening income distribution.

Were these measures truly responsible economic policies? It is inevitable that a country undergoing a currency crisis will have to undertake drastic, painful measures to exit the crisis. In the case of Mexico, however, it is unclear that each class of citizen bore the burden to the same extent. Evidence gathered in Monterrey, Mexico during the summer of 1996 will be used to analyze the effects of this stabilization package on different income classes.

THEORY SUPPORTING THE IMF PLAN

The IMF policies may be illustrated by IS-LM analysis to predict the effects of the reduction in the budget deficit, the devaluation, and the reduction in money supply growth that the IMF recommends. In this framework, the goals of the package (namely an improvement in the trade balance and controlling the inflation rate) are achievable. The reduction of the budget deficit, whether accomplished through a reduction in government spending or an increase in government income by increasing taxes or user fees, will shift back the aggregate demand curve and lower output. This decrease in aggregate demand will lower interest rates and improve the trade balance by decreasing demand for imports. The currency

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devaluation, by making Mexican goods cheaper relative to other nations' and other nations' goods relatively more expensive, would also improve the trade balance by increasing exports and decreasing imports. A reduction in the growth of the money supply would put upward pressure on the domestic interest rate, reducing inflationary pressures.

According to the standard Keynesian IS-LM analysis, therefore, the currency stabilization policy suggested by the IMF will tend to reduce the trade deficit and curb inflation. These results will most likely come at the cost of some output and thus be recessionary, although the IMF loan would tend to lessen the recessionary effects. Most devaluations are also followed by a temporary increase in the inflation rate, despite attempts to curb inflationary effects. An important question, therefore, is how the costs of the policy are distributed throughout the economy. The IS-LM framework fails to take into account the income distribution changes which may result from changes in relative prices of traded and non-traded goods, increases in user fees, changes in government spending, and the increase in the interest rate. Each element of the stabilization policy will affect different income groups in different ways. It is necessary, therefore, to examine income distribution to determine how the costs associated with the stabilization policy are distributed.

REVIEW OF LITERATURE: STABILIZATION AND INCOME DISTRIBUTION

Demery and Addison provide a theoretical examination of the effects of currency stabilization on income inequality, examining separately devaluation and monetary and fiscal restraint. The net effect of devaluation on income distribution is dependent upon the relative importance of traded and non-traded goods in the consumption basket of different income earners, as the prices of non-tradable goods are not directly affected by the devaluation.

Fiscal restraint achieved by reducing subsidies will adversely affect lower income groups which rely heavily on those subsidies. Similarly, increasing government income by increasing user fees for government services will adversely affect those populations for whom government services represent a large portion of their budget. Monetary restraint will also affect different sectors of the economy. Monetary control instruments will directly affect only the formal banking and monetary sector, in which poor sectors do not often take part.

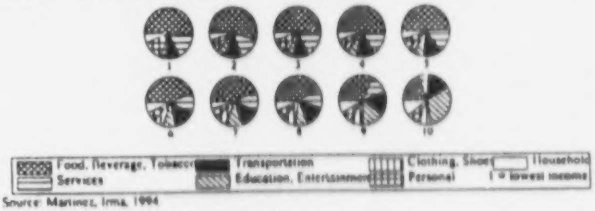
Wage flexibility is an important factor in determining the effects of a decrease in aggregate demand. If the real wage is flexible, firms may be able to maintain employment if workers are willing to take cuts in their real wages. The flexibility of real wages is affected by such factors as unionization and minimum wage legislation. Weaker unions and an unorganized labor force have less ability to bargain and maintain their real wages; this is probably the case in Mexico, where unions are thought to be corrupt and not serve the best interests of workers.

A stabilization policy may initially increase poverty, but in the long run the poor may benefit if the policy leads to sustainable long-term development. The authors call for analysis of empirical evidence to determine whether those who bear the immediate costs of adjustment benefit in the long run.

EMPIRICAL EVIDENCE: PRICES

The data to be analyzed were collected in Monterrey, Mexico during the summer of 1996. Sixty interviews were conducted with workers, plant managers, and economists to determine the effects of the 1994 crisis on small businesses and workers. Monthly price data for 90 products from 1994-1996 and a detailed budget survey of 1000 household heads in Monterrey conducted by the Autonomous University of Nuevo Leon (UANL) were used to calculate price indices for different income groups. Because 1994 was a relatively stable economic year in terms of income and price predictability, the results of the survey will be used to show relatively desirable economic and household budget conditions. It should be noted, however, that income distribution in Monterrey during the time of the survey was not optimal. The poorest quartile of households received 4.73% of total income, while the richest quartile received 55.7%, corresponding to a Gini coefficient of 0.4846. Thus any regressive income or purchasing power effects of the stabilization program will be considered harmful by their worsening of an already undesirable situation.

Figure 1 shows the budget divisions for each decile by household income. The poorest deciles are shown to consume food and services as a large part of their budgets, while transportation and clothing make up a larger part of household budgets as incomes increase.



Source: Martinez, Irma, 1994

Figure 1: Composition of Budget by Income Deciles

Price data were used to price consumer market baskets and create monthly consumer price indices (CPI's) for each decile from 1994 to 1996. Calculated inflation rates are shown in Figure 2 (each two deciles were combined to form 5 quintiles).

Quintile:	1	2	3	4	5
Time Period:					
Jan-May 1994	6.10	6.18	6.10	6.09	6.09
Jan-Aug 1994	8.21	8.34	8.19	8.18	8.17
Jan-Dec 1994	12.53	12.65	12.49	12.46	12.39
Jan-May 1995	6.87	6.89	6.93	6.95	7.05
Jan-Aug 1995	11.04	11.07	11.17	11.22	11.40
Jan-Dec 1995	15.62	15.73	15.89	15.97	16.17

Figure 2: Inflation Rates by Income Quintiles (1 = lowest income)

The differences in CPI's between income groups are negligible. It is also important to note that the CPIs calculated from the Monterrey data are significantly lower than the 35% rates claimed by the government of Mexico. This is most likely from a data inconsistency in certain budget groups, and perhaps from not including debt repayments. The CPI calculations do, however, reflect the impact of price changes on various income groups and are therefore worth analyzing.

Reasons for Differences in Consumer Price Indexes: Food, Beverages, and Tobacco

While the food, beverage, and tobacco division did not experience the highest price increases, the prices of goods in this division continued to increase long after the initial January 1995 shock. Because of the higher proportion of budgets spent on food in the lower income deciles (over 50% of lower income groups' budgets compared with 18-42% in the three highest income deciles), inflation of food prices adversely affected lower-income people. As income increases, a lower proportion of consumers' budgets is spent on milk products, fruits and vegetables, and grains, while consumption of other foods (including imported and domestically produced beverages, processed foods, and tobacco) increases. Middle-income consumers consume the highest proportion of meat products, with consumers on the low and high ends consuming relatively less meat.

Prices of goods in the "other foods" division, which are consumed disproportionately by higher income groups, remained relatively stable throughout the crisis period. Grain prices, although stable during the period immediately following the crisis, experienced high inflation towards the end of 1995 unmatched by a similar increase the preceding year. This also disproportionately affected lower-income groups, who rely more heavily on grain consumption. Food price fluctuations, therefore, adversely affected lower-income consumers through increases in grain and fruit and vegetable prices, and adversely affected middle-income consumers through increases in meat prices. Higher-income people, however, were not disproportionately affected by food price increases because their largest food/beverage/tobacco consumer good, "other goods," did not experience as high an inflation.

Differences in CPI's: Government-Priced Goods and Traded vs. Non-Traded Goods

Figure 3 shows the composition of each decile's budget in terms of government-priced goods (including such services as water and electricity), traded goods, and non-traded goods.

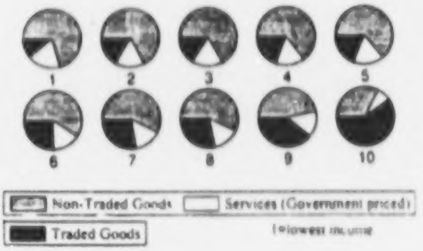


Fig. 3 Composition of Budget, Income Deciles, Monterrey

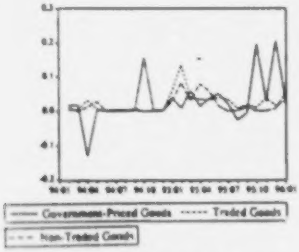


Fig. 4: Rate of Change of Prices Monterrey

(Mexican trade balance data were used to determine whether consumption goods were exported, imported, or not traded.) Although imported-goods prices increased the most immediately following the devaluation, the prices of services and non-traded goods also eventually increased at high rates.

The reliance of lower-income groups on the consumption of services such as telephone, water, electricity, gas, and public transportation makes these groups disproportionately affected by government-induced price increases in user fees for public services. The highest proportion of budget spent on services is represented by the lowest income group, at 16.9%. Proportions decline as income increases, with the 9th decile allotting 12.33% and the highest income only 6.75%. Similarly, lower-income groups are more vulnerable to changes in prices of public transportation (bus or subway). The lowest quintile of income earners in Monterrey spends about 5.5% of its income on public transportation, while the highest spends only 0.68%, concentrating more of its transportation budgets on servicing vehicles they own.

The higher-income groups in Monterrey are shown to be much more dependent on imported goods than lower-income groups. The jump in prices of imports which occurred immediately following the December 1994 devaluation, therefore, adversely affected these import-dependent higher-income groups. Import prices in general increased more than non-traded and government-priced goods during the period immediately following the devaluation, which could be the reason that import-dependent high-income groups experienced the highest increases in their inflation rates during this time.

In the long run, however, import prices began to level out by mid-1995 to match price changes in non-traded goods. Thus the traded vs. non-traded aspect of each consumption good lost importance as prices leveled off. The effects of stabilization on high-income groups, therefore, were concentrated in the short run. As user fees were increased by the government, lower income groups began to see the price of their market baskets increase.

In conclusion, the price and budget data would indicate that high income groups in Monterrey were adversely affected by the devaluation in the short run by their dependence on imports, whose prices increased drastically. In the long run, however, the peso stabilization policy adversely affected low-income groups by increasing the cost of their market basket as the inflation of traded and non-traded goods' prices subsided.

EMPIRICAL EVIDENCE: INTEREST RATES

The effects of interest rates on income distribution during the peso stabilization program are ambiguous. Because the interest rates on credit cards and many bank loans were pegged to the dollar, interest rates increased drastically following the exchange rate devaluation in December 1994, jumping from below 20% to more than 80% in March 1995. Because lower-income groups are not largely directly involved with the formal banking sector in Mexico, the increase in interest rates did not affect them very much. Spending on credit card debt in the lowest quintile is only 0.5% of this quintile's total budget expenditure, and only 1.81% of the second-lowest quintile's budget. The third and fifth quintiles, however, spend 3-4% of their budgets on credit card debt, which increased greatly when interest rates increased drastically in January 1995. Thus middle and high-income consumers were adversely affected by the increase in the interest rate. Inasmuch as the highest income earners are lenders, however, the increase in variable interest rates benefited lenders because debt repayment was not fixed but flexible. The data is insufficient to determine whether high-income groups benefited or lost from the increase in interest rates.

EMPIRICAL EVIDENCE: UNEMPLOYMENT

Data was collected from INEGI (Mexico's national census bureau) and the 60 interviews to determine changes in wages and employment in Monterrey during the economic stabilization program. It should first be noted that unemployment worsened for many months after the initial stabilization program, reaching a peak of 11% in August 1995 from 4% in February. The employment effects of the stabilization program, therefore, lasted at least 8 months. Although employment in all jobs was reduced during the stabilization period, young Monterrey workers, especially men, were disproportionately unemployed. For both men and women, young workers ages 12-25 were more likely to be unemployed than middle-aged workers during the destabilization period. Because young workers are most likely unskilled and poorly paid, these high rates of unemployment were most likely concentrated in the poorer sectors of the population.

Not only was unemployment persisting at a high rate months after the devaluation, but average wages fell until August 1995. Beginning in March 1995, the percentage of Mexican workers employed below the minimum wage or from 1 to 2 times the minimum wage increased, while the percentage of workers employed at more than 2 times the minimum wage decreased. Thus average nominal wages were decreasing and prices were increasing, signifying that the real wage was being eroded.

Interview data with economists and business owners/managers in Monterrey supported the notion that wage increases occur only with minimum wage increases. Most nominal wage increases, which generally occur with minimum wage increases, fall below minimum wage percent increases, regardless of wage level, as is shown in Figure 5.

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Job Type	nom wage as percent of min wage	%change in nom Wage Jan 94-May 96	Inflation Jan/94-May/96	%change in nom wage Jan/95-May/96	Inflation Jan/95-May/96	%change in nom wage May/95-May/96	Inflation May/95-May/96
minimum wage	100.00	72.26	62.39	60.97	55.56	43.76	29.51
driver	129.01	50.00	62.39		55.56		29.51
driver	176.32	10.81	62.39	0.00	55.56	0.00	29.51
qual control (factory)	186.38		62.39		55.56	44.44	29.51
driver	193.55		62.39		55.56	12.50	29.51
factory worker	217.63		62.39	33.16	55.56	33.16	29.51
supervisor (factory)	219.35		62.39	8.51	55.56		29.51
factory worker	240.86	14.29	62.39	7.69	55.56	7.69	29.51
machine operator	295.34	17.71	62.39		55.56		29.51
factory worker	301.08	55.56	62.39	27.27	55.56	27.27	29.51
secretary	362.72	68.67	62.39	30.41	55.56	15.53	29.51
supervisor	369.89		62.39	32.31	55.56		29.51
accountant	376.34		62.39	16.67	55.56	16.67	29.51
mechanic	394.27	39.24	62.39	39.24	55.56	22.22	29.51
messenger	430.11		62.39	14.29	55.56		29.51
supervisor	483.87	50.00	62.39	17.39	55.56	17.39	29.51
secretary	501.79	55.56	62.39		55.56		29.51
maquiladora	(index)	62.72	62.39	43.71	55.56	25.92	29.51

Figure 5. Percent Change in Nominal wages vs. Inflation for Various Jobs, Monterrey

The vast majority of nominal wage increases lie below minimum wage increases regardless of wage amount. Thus there exists an across-the-board general real wage decrease in Mexico which was amplified during the stabilization period due to the high rates of inflation.

CONCLUSIONS

The IMF has recognized that its programs "have not in general been inimical to the goal of improving distribution of income" (Sisson, 36). Its consideration of the effects of policy on the poor is shown by its attention to the maintenance of social security systems and job creation included in its 1995 Mexico plan. But the theory the IMF uses to support its currency stabilization programs fails to include the effects of its policies on income distribution, which we have shown to be influential. The high inflation, slow wage increases, decreases in subsidies, increases in user fees, and skyrocketing interest rates which accompanied the 1995 peso stabilization program, and which often characterize currency stabilization programs, affected different income groups in different ways. The poorest sectors of the population in Monterrey were adversely affected by inflation in food prices and increases in user fees for services because these elements represented a large part of their budgets. Young and unskilled workers were unemployed at higher rates than older, skilled (and most likely higher-paid) workers. These regressive income distribution effects, however, were countered by effects of the policy which adversely affected the middle-and higher-income groups, i.e. the increase in the interest rate and the increase in the prices of imported goods consumed largely by the upper classes.

It is important, therefore, for the IMF to recognize the impact of its programs on different income groups so as not to worsen already poor income distribution. Alternatives to certain aspects of the program proved regressive could be proposed. In Mexico, this might have included slower increases in user fees, fewer subsidy reductions in food staples, and more minimum wage increases to reduce the drop in real wages. While the IMF/Mexican government program did indeed address its social costs, the measures proposed may actually have hurt the people these authorities claimed to want to protect.

BIBLIOGRAPHY

Addison, T. and L. Demery, "Stabilization Policy and Income Distribution in Developing Countries," World Development, 15(12), pp. 1485-1492.

Federal Reserve Bank of Atlanta, "The Mexican Peso Crisis," Bulletin, 81(1),1/96, pp. 1-20.

IMF News Brief, 95/2, 1/3/95.

Jasso, Irma Martinez, Encuesta de Ingreso y Gasto del AMM, 1994, UANL, Monterrey, Mexico.

Sisson, Charles A., "Fund-Supported Programs and Income Distribution LDC's," Finance and Development, 23 (1), 3/86, p. 36.

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Tests of the Induced Innovation
Hypothesis In Indian Agriculture

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Economic theory suggests that technology and innovation are the most important factors explaining productivity and growth. The induced innovation hypothesis suggests that research activity can ensure the efficient allocation of resources towards new technology, thus saving the scarce and relatively more expensive factors of production. The Indian economy presents an extremely good case for tests of induced innovation following the Green Revolution in the early 1970's. This study uses cross-sectional data from 53 districts from the main agricultural areas of the country to test this hypothesis. The results are consistent with the hypothesis, and there is basic support for the contention that relative factor prices influence the direction of technological change in the Indian economy.

INTRODUCTION

Agricultural development which stems from technological change and innovation is one of the most important factors which explain growth and productivity in developing countries. New technology and innovation arise from both public and private research. Research is an activity that is generally expensive. Hence there is an urgent need to allocate research expenditure so as to save the relatively scarce factors of production. The induced innovation hypothesis claims that research activity can ensure the efficient allocation of resources which saves the scarce or more expensive factors of production. For example, an increase in the price of fertilizer will lead to research and innovations that develop new technologies aimed at saving the use of fertilizers. In other words, developing technologies that promote the use of other factors such as land and machinery.

Furthermore, Hayami and Ruttan (1970), who first applied the induced innovation hypothesis, argue that research develops technologies that are consistent with the demand for crops in developing agricultural economies. Since the work of Hayami and Ruttan (1970), various economists have tested the induced innovation hypothesis. These include studies on the United States and Japan by Binswanger (1974) and Binswanger and Ruttan (1978). There are a few studies on developing agricultural economies. These include studies of Egypt by Antle and Crissman (1988) and, Justin Lin's (1991, 1995) papers on China. More recently, Olmstead and Rhode (1993) and Koppel (1995) have questioned whether the induced innovation hypothesis is the right framework for analyzing agricultural development and the diffusion of agricultural technology.

Given these studies, there have been few attempts to look at the link between innovation and agricultural development in the Indian economy. This paper uses the induced innovation hypothesis to examine technological changes in Indian agriculture following the Green Revolution in the early 1970's. The data set is a cross-section of 53 districts in India from the early 1970's for the states of Punjab, Haryana, Tamil Nadu, and Maharashtra.

REVIEW OF INDUCED INNOVATION LITERATURE

Hayami and Ruttan (1970) found that a decrease in the price of land and machinery relative to wages led to the increased substitution of land and power for labor in the United States. Binswanger (1974) found that machinery, labor, and fertilizers were very responsive to changes in factor prices in the United States. Antle and Crissman's (1988) study of Egypt reveals that induced innovation may not be as applicable in the short run as compared to the long run. The reason for this result is that farmers may perceive changes in factor prices to be

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permanent Thus, they may alter their demand for a particular factor more so than if they viewed the factor price change as temporary Olmstead and Rhode (1993) question the validity of the induced innovation hypothesis in examining agricultural development In particular, they emphasize that it is necessary to look at the role of changing crop patterns in explaining the utilization of factors

DATA AND EQUATIONS

This section focuses on capturing technological change in Indian agriculture The four states of Punjab, Haryana, Tamil Nadu, and Maharashtra were chosen because they were more involved in the Green Revolution than most other states The data consist of 53 districts from these states between 1973 and 1975, a time at which the Green Revolution was applied intensively in the Indian economy The aim is to derive a production relationship which includes land, labor, machinery, and fertilizer Since innovations are expected to take time, the equations below introduce a lag structure These relationships can be explained by the following functional forms

$$F/A = a_0 + a_1(PF/PA)_t + a_2(PF/PA)_{t-1} + a_3(PM/PL)_{t-1} + a_4(PA/PL)_{t-1} \quad (1)$$

$$M/L = b_0 + b_1(PM/PL)_t + b_2(PM/PL)_{t-1} + b_3(PF/PA)_{t-1} + b_4(PA/PL)_{t-1} \quad (2)$$

Equations (1) and (2) are tests of the induced innovation hypothesis in which

F/A = ratio of the quantities of fertilizer (F) to the quantities of land (A)
M/L = ratio of the quantities of machinery (M) to the quantities of labor (L)
PF/PA = ratio of the price of fertilizer (PF) to the price of land (PA)
PM/PL = ratio of the price of machinery (PM) to the price of labor (PL)
PA/PL = ratio of the price of land (PA) to the price of labor (PL)

In equation (1), which captures biological technological change, if the price of fertilizer rises relative to the price of land, farmers will use less fertilizer So, we can expect a negative relationship between (F/A) and (PF/PA) If the price of machinery relative to the price of land rises, we can expect farmers to substitute fertilizers for machines Hence, the expected sign between (F/A) and (PM/PL) is positive Finally, if the price of land relative to the price of labor rises, once again we can expect farmers to substitute fertilizer for land We expect similar relationships for equation (2), which captures mechanical technological change

The parameter estimates in equations (1) and (2) may be viewed as the elasticities of substitution for the given set of factors While these equations are an adequate test of the induced innovation hypothesis, they fail to capture the role of research in developing new technologies in agricultural economies Research institutions, both private and public, may allocate resources towards saving the scarce factors and increasing yields in various crops Since rice is one of the main crops in which the Green Revolution was applied intensively, equation (3) is aimed at capturing the relationship between the quantities of rice, the price of rice, research in biological factors, rainfall, research in rice, area of land devoted to rice, and the percentage area under high yielding varieties of rice used in each of the 53 districts Accordingly, equation (3) may be specified as follows

$$QRICE = c_0 + c_1ARICE_t + c_2PHYVRICE_t + c_3RESCHEM_t + c_4RESRICE_{t-1} + c_5RAIN_t + c_6PRICE_t \quad (3)$$

where
QRICE = the quantity of rice
ARICE = the area of land under rice
PHYVRICE = the percentage area under high-yielding varieties of rice used
RESCHEM = research spending in the fertilizer industry
RESRICE = state specific research in rice
RAIN = rainfall
PRICE = the price of rice

Equations (1), (2), and (3) were estimated using ordinary least squares The parameter estimates and results are shown and discussed in the section below

637 BEST COPY AVAILABLE

RESULTS

The results from the induced innovation models, especially equation (1) and (3), are good Table 1 summarizes the results from the biological technological change model where the ratio of the quantity of fertilizer to land (F/A) in each district (for the year 1974) is the dependent variable Given that this data is a cross-section of 53 districts, the R^2 of 0.4366 is particularly good, i e 43.66% of the variation in the quantity of fertilizers to land ratio is explained by the set of independent variables The ratios of the price of fertilizers to the price of land in both 1974 (PF/PA)$_{74}$ and 1973 (PF/PA)$_{73}$ are significant and the effects are quite strong In particular, a 1% increase in the price of the ratios of the price of fertilizers to the price of land (PF/PA)$_{74}$ led to a 0.63% decrease in fertilizer use However, the positive sign for 1973 is surprising Suppose that the price of fertilizer was high in 1973 and that farmers viewed this change in price as temporary If so, they would postpone their purchases of fertilizer until 1974 Such a scenario could explain the positive relationship between (F/A)$_{74}$ and (PF/PA)$_{73}$ This seems to suggest that there is evidence in India to support Antle and Crissman's (1988) hypothesis that farmers understand the notion of temporary and permanent changes in prices The coefficient of the ratio of the price of machinery relative to the price of labor (PM/PL)$_{73}$ was negative, but insignificant at the 5% level as indicated by the t-statistic of 1.84 Again, this result is contrary to expectation If (PM/PL) in 1973 was high, it is possible that farmers bought fertilizer in the 1973 to substitute for the high-priced machines Therefore, they did not need as much fertilizer in 1974 This could explain the negative relationship found between (F/A)$_{74}$ and (PM/PL)$_{73}$ Finally, the coefficient of the ratio of the price of land relative to the price of labor (PA/PL)$_{73}$ was positive as expected, but insignificant

TABLE 1 LAGGED MODEL FOR BIOLOGICAL TECHNOLOGICAL CHANGE
Dependent variable is F/A (Quantity of Fertilizer/Quantity of Land)

Variable	Coefficient	t-statistic
Constant	21.3804	4.2839*
(PF/PA)$_{74}$	-0.6346	-4.0221*
(PF/PA)$_{73}$	0.7039	2.6853*
(PM/PL)$_{73}$	-0.0042	-1.8436
(PA/PL)$_{73}$	0.1386	0.9191
R^2	0.4366	

* significant at 5% level

Table 2 summarizes the results from the mechanical technological change model of induced innovation While the R^2 of 0.5203 indicates a good fit, none of the independent variables is significant Therefore, the results here seem to corroborate the findings from equation (1) that there is a poor link between mechanical change and fertilizer use between 1973 and 1974 in the Indian economy

TABLE 2 LAGGED MODEL FOR MECHANICAL TECHNOLOGICAL CHANGE
Dependent Variable is M/L (Machines/Labor)

Variable	Coefficient	t-statistic
Constant	647.5960	5.3386*
(PM/PL)$_{74}$	-0.0419	-0.6757
(PM/PL)$_{73}$	-0.1409	-1.8638
(PF/PA)$_{73}$	-4.0799	-0.8469
(PA/PL)$_{73}$	1.3168	0.3448
R^2	0.5203	

* significant at 5% level

Research needs to be explicitly considered to test the induced innovation hypothesis effectively since relative prices as in equations (1) and (2) are not the only factors which influence innovation For example, research on fertilizer or high-yielding varieties (HYV) of seeds has been known to increase greatly the yields of various crops throughout the world

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Equation (3), which uses data from each of the 53 districts from 1975, focuses on rice since it is a major crop of India. Two kinds of research variables, (RESCHEM) and (RESRICE), are included in equation (3) along with other important control variables such as the price of rice, rainfall, and percentage area under high yielding varieties of rice. (RESCHEM) measures the research spending by private firms in fertilizers and (RESRICE) is an index of the public research in rice in each of the four states in this analysis. This index includes budget data, expenditures, and publications resulting from research in the area of rice. It is assumed that research in rice takes time to have an effect on yields, but research in fertilizer may not take much time to apply. Hence, in equation (3), (RESCHEM) is viewed contemporaneously while (RESRICE) is introduced with a lag.

For this equation, if the area of land used for rice increases, the quantity of rice will obviously increase. So, there is a positive relationship between (ARICE)$_{75}$ and (QRICE). Similarly, if the percentage of high-yielding varieties of rice used increases, the quantity of rice will increase. So, there is a positive relationship between (PHYVRICE)$_{75}$ and (QRICE). If private research betters the manner in which fertilizers are applied in growing rice, the quantity of rice will increase. Table 3 shows that the quantity of rice (QRICE) is significantly related to the area under rice (ARICE)$_{75}$, the percentage of high yielding varieties under rice (PHYVRICE)$_{75}$, and the private research in fertilizers (RESCHEM)$_{75}$. The model is an extremely good fit with an R^2 of 0.9736. The effect of research in fertilizers (RESCHEM)$_{75}$ is strong. A 1 % increase in expenditure on research increases the quantity of rice produced in each state by 3.37%. Finally, the signs on (RESRICE)$_{74}$ and (RAIN) are negative and, therefore, contrary to expectation. However, they are both insignificant at the 5% level.

TABLE 3 MODEL FOR RICE RESEARCH
Dependent variable is QRICE (the quantity of rice)

Variable	Coefficient	t-statistic
Constant	19.7104	0.2255
ARICE	1.8801	29.3800*
PHYVRICE	57.3099	2.5169*
RESCHEM	3.3718	2.1411*
RESRICE	-4.5823	-0.6327
RAIN	-0.0113	-1.2519
PRICE	-0.1659	-0.7264
R^2	0.9736	

* significant at 5% level

CONCLUSIONS

Since the induced innovation hypothesis claims that relative prices of factors of production affect quantities of these factors, equation (1) supports the induced innovation hypothesis in the Indian economy. From equation (1), we know that relative changes in the ratio of the price of fertilizer to the price of land do affect the quantity of fertilizer used. It is clear, though, that the Indian farmer understands the difference between temporary and permanent changes in price. Also, from equation (3), there is evidence to support the claim that research influences quantities and yields of crops. In particular for the Indian economy, the quantity of rice is significantly influenced by private research in fertilizer use (RESCHEM). While research on high yielding varieties of rice (RESRICE) should significantly affect rice yields, it is difficult to measure and quantify research output from a particular crop. In any case, we expect research on fertilizer to affect yields of most crops positively. The empirical models show basic support for the induced innovation hypothesis. Thus, we can conclude that the induced innovation hypothesis is the correct framework for analyzing agricultural change and development in the Indian economy.

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BEST COPY AVAILABLE

REFERENCES

Antle & Crissman, (1988) "The Market for Innovations and Technological Change Evidence from Egypt," Economic Development and Cultural Change, 30, 669-90

Biswanger, H. P., (1974) "A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution," American Journal of Agricultural Economics, 56, 377-386

Binswanger H. P. & Ruttan V., (1978) Induced Innovation, John Hopkins University Press

Hayami, Y. & Ruttan, V.,(1970) "Factor Prices and Technical Change In Agricultural Development The United States and Japan, 1880-1960," Journal of Political Economy, 1115-1141

Koppel, B.M., (1995) Induced Innovation Theory and International Agricultural Development A Reassessment, John Hopkins University Press, Baltimore

Lin, J. F., (1991) "Public Research Resource Allocation In Chinese Agriculture A Test of the Induced Innovation Hypothesis," Economic Development and Cultural Change, 54-73

Lin, J. F., (1995) "Endowments, Technology, and Factor Markets A Natural Experiment of Induced Institutional Innovation from China's Rural Reform," American Journal of Agricultural Economics, 77, 231-242

Olmstead, A. L. & Rhode, P., (1993) "Induced Innovation in American Agriculture A Reconsideration," Journal of Political Economy, 101, 100-118

A Qualitative Study of The 1994 Voter Turnout In Prince George's County Executive Election

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This study examines the 1994 voter turnout in Prince George's County executive election. The data collected for this study covered the phenomenon in which Prince George's County voters turned out in record numbers to elect their first Black County Executive. The substantive findings from this research suggest hat increased voter turnout was attributed to recently enacted term limitation measures and Black majority poised to elect the first Black County Executive.

INTRODUCTION

Unlike previous studies on voting behavior which concentrated on the national level (e.g.) (Teixeira, 1992; Piven and Cloward, 1988), this study examines such behavior at the local level. The 1994 Prince George's County Executive election brought dramatic change in the county, as an almost unprecedented number of new faces brought into the fray by recently enacted term limits nearly overwhelmed the voters with choices. Throughout Prince George's 1994 election, officials said high voter turnout was something uncommon in off-year elections (i.e. non-presidential election year).

Thus, this study seeks to examine the rate of voter turnout in the 1994 Prince George's County Executive election and why the rate of voter turnout was dramatically high in an off-year election. This election was the culmination of a decade-long march to political power by African Americans in the affluent Washington suburb. The election of Wayne Curry represented the coming of age politically of the black community. Unlike a city like Detroit or Washington DC, Prince George's County is a jurisdiction where there has been a steady growth of the middle class. So,,the major question here is this: Why was there such a tremendous voter turnout for this 1994 County Executive election?

Prince George's County saw in 1994 has seen the most competitive Democratic primary ever campaign since the county began electing County Executives in 1971. With three-term incumbent Parris N. Glendening seeking the governorship, the vacancy in the county's top elected post prompted a power struggle featuring an array of colorful personalities and racial undercurrents (MacGlashan 1994).

Dramatic demographic changes have altered Prince George's in the last two decades. Once a more rural, predominately white jurisdiction, Prince George's has seen it's character and composition change with the influx of middle cases Black families moving from the District of Columbia, prompting some Black leaders to say it is time for an African American County Executive. But the dramatic exodus of African American families from the District into

Prince George's transformed the 1994 campaign into a symbol of racial empowerment and catapulted Curry into office (Mercurio 1994a).

THEORETICAL FRAMEWORK

As stated earlier, this study seeks to understand the phenomena in which Prince George's County voters turned out in record numbers to elect their first Black County Executive. "The election of a Black mayor often represented a hollow victory in the sense that blacks were almost winning, when whites were giving up on the city," said University of Maryland College Park professor Bart Landry, who has done extensive research on the black middle class (The Washington Post, Nov. 13, 1994). The Immediate question then is the following: How can this electoral victory be analyzed systematically? A Theoretical Approach that has shown a great deal of promise in this area is Voting Behavior.

Voting Behavior

As Hertbert Winter and Thomas Bellows (1985) show, the significance of voting varies with the importance of elections in determining winning candidates. Many Western countries report turnouts in excess of 80 percent; on the other hand, United States congressional elections in nonpresidential election years draw between 30.1 percent and 46.1 percent during the past six decades. In order to delineate these determinants, one must investigate a major question: Why do some people vote?

Why Some People Vote

Ethnicity. In the United States, for example, not many decades ago there was a marked difference in the voting patterns of African-Americans and European-Americans; African-American voting rates were much lower. A great deal of this has changed as income and education evels of African-Americans have risen. Also, the Voting Rights Act of 1965 helped in lowering the barriers placed in the way of African-American registration, especially in the South. To encourage African-Americans to register and vote in 1984, the Rev. Jesse Jackson campaigned doggedly for the Democratic nomination, even though he knew he had no chance of winning. Now, nationwide African-American turnout is closer to that of European-Americans. Of particular importance is this development is the fact that African-Americans have learned the value of their votes. Many racist European-American politicians got the message and have become respectful toward their African-American constituents. Chicanos have quickly learned to register and vote.

Income Level and Education (or Class). In the United States, citizens with large incomes are more likely to vote than those who are less affluent. Also, citizens who are well educated are more likely to vote than those who dropped out of secondary or high school. Even though certain voters often combine the two characteristics, the two influence voting in different ways. The former has to dowith having a stake in election outcomes; the latter has to do with the broader question of interest and sophistication.

Age. Young people under the age of 25 typically feel less politically involved compared to those who are older. Consequently, young people tend to vote less. By 1985, about half of the American citizen 18 to 25 years of age, for example, had not registered to vote(Cord et al 1985).

In 1971, the Twenty-sixth Amendment to the United States Constitution lowered the American voting age from 21 to 18. At almost the same time, most other democracies did the same. In all these countries, the results were similar to that of the United States: the newly enfranchised young people did not vote as much as thier elders (Cord et al 1985).

Area of Residence. In most democracies, the fact that citizens living in urban areas tend to vote more than those living in rural areas is hardly surprising. This reflects the easier accessibility of voting booths in the urban areas, where a relatively smaller area (as in New York City) can comprise a voting district with the same population as a rural district of several square miles (as in Alaska).

Gender. In the past, males were more likely to vote than females in almost every Western sociecty. This was due, in large part, to the fact that females had only comparatively recently won the right to vote in these socities. In Switzerland, for example, it was not until suffrage was granted in the United States after a great deal of struggle by women, the gap between male and female voter turnouts has been narrowing precipitously (Cord et al 1985).

ANALYSIS

Ethnicity. Once a more rural, predominantly white jurisdiction, Prince George's has seen its character and composition change with the influx of middle class Black families moving from the District of Columbia, prompting some black leaders to say it is time for an African-American County Executive. It has become a jurisdiction with its first African-American majority since 1860, accounting for 51 percent of the population in the last census. A major finding of a Washington Post survey (Sept.18, 1994) is that race continues to be a major factor in voting patterns in Prince George's County. Roughly 25 percent of those interviewed before the election said it was important that the next County Executive be black. Wayne Curry, a lawyer who epitomizes the County's new breed of African American professionals, considered himself ready. In the democratic primary, Wayne Curry won 54 percent of the African American vote. In a Washington Post poll, nine out of ten black voters cast ballots for one of the Black candidates in the race. And blacks were more than twice as likely as white voters to say that the race of the candidates was an important factor in determining their vote (Washington Post, Sept; 18, 1994). "I feel blacks have more opportunities in Prince George's than the whites," said Wittenhauer, a 44 years old white resident whose company sells computers, fax machines and typewriters. She had hoped Curry will scrap the County's preference program, which allows minorities with slightly higher bids to win contracts (Washington Post, Nov. 13,1994).

Income level and Education. The White majority in Prince George's County of the 1970's is long gone; they moved mostly to the County's south and southeast neighbors, Calvert and Charles Counties. Prince George's 730,000 residents are now 52 percent African American and three percent other nonwhites (Washington Post, Sept. 18, 1994). By all accounts, the new Black majority is more sophisticated, more educated, and more affluent on average than the Whites they replaced. And they are not about to march in lockstep with anybody, Black or White. Their worries mirror the concerns of any middle and upper-middle class community: they want better schools, less crime, and lower taxes. Curry did well with affluent Black voters, claiming 54 percent of the vote among Blacks who earned $50,000 or more, while receiving 21 percent of the vote from whites who earned $50,000 or more. Less than half the voters surveyed (by Washington Post) said growth and development were very important in determining their vote, compared with 86 percent who said crime a was very important determinant. Crime was a the issue Curry repeatedly said was the number one problem facing the county (Washington Post, Sept. 18, 1994).

Age. Wayne Curry, the youngest candidate in the race, ran stron among younger voters, claiming half of all votes cast by those 30 or younger. But among voters over age 60, the only age group where white voters remain a clear majority in the county, Curry won just 29 percent of the vote. The major issue for older voters was tax increases. And the major issue for younger voters was opportunities for the county's growth and development (Washington Post, Sept. 18,1994).

Area of Residence. In the white Republican strongholds of Laurel, Lanham Seabrook and Bowie, Wayne Curry received fewer vote. In the Black democratic strongholds of Landover, Capital Heights, Mitchellville, Oxon Hill, Temple Hills and Fort Washington, Curry received the majority of his votes. Curry was interested in tackling broader social and economic goals, particular encouraging the revitalization of communities close to the District of Columbia. He said such economic redevelopment is critical to addressing the rising crime rate in Prince George's. "We've got most of the expanding crime in the inner Beltway," Curry said, "And it just coincidentally is the same area we ignored in terms of economic growth and opportunity"(Washington Post, Nov. 3, 1994).

Gender. Gender was not a significant variable. The 1994 County Executive election, as most of the votes followed racial lines. Most African American men and women voted Democrat, while most white men and women voted Republican.

CONCLUSION

Based on the Preceding Analysis, a number of Conclusions can be drawn. First, race was a major factor in the 1994 Prince George's County Executive Election. Second, the new Black majority saw Wayne Curry as someone with their similar socio-economic status. Third, the young voters were more likely to vote for Curry than voters over 60. Fourth, as expected, Curry, being a Democrat, did better in Democratic strongholds than Republican strongholds. Finally, Gender was not a significant variable in this election.

Clearly then, the election of the first African American County Executive in Prince George's County was a culmination of a decade-long march to political power by Backs in the affluent Washington suburb. "It is the natural evolution of urban politics in the way American has developed," said Alvin Thornton, a political science professor at Howard University. But while many viewed the county elections as part of a historic power shift towards a new generation of African American professionals, most of the contests were dominated by more specific concerns about curbing crime and improving the quality of education. The increase in voter turnout in the 1994 County Executive election can be attributed to two factors: (1) recently enacted term-limitation measures, which guaranteed that Parris N. Glendening could not seek a fourth term; and (2) a preordained political rite of passage, with the county's new Black majority seemingly was poised to elect the first Black County Executive in Prince George's history.

REFERENCES

Abramowitz, Michael. "Poll Show Tight Race In P.G.; Black Turnout Cited As Crucial factor." Washington Post 24 July. 1994: A1.

Abramowitz, Michael. "P.G. Democrats Chart Varied Campaigns." Washington Post 01 Aug. 1994: B1.

Abramowitz, Michael. " Lawyer Likely to Become 1st Black to Lead Prince George's County." Washington Post 14 Sept. 1994: A1.

Abramowitz, Michael. "Curry Built P.G. Victory On Black Vote." Washington Post 18 Sept. 1994: A1.

Cord, Robert L.; Mediros, James A.; Walter S.; and Roskin, Michael G. (1985). Political Science (2nd ed). Englewood Cliffs, New Jersey: Prentice-Hall, Incorporated.

Dean, Antonio. Interview with the County Executive's Community Liaison. 18 April 1996.

Frances Fox Piven and Richard A Cloward; Why Americans Don't Vote. New York: 1988.

Hill, Retha. " Curry's Victory Caps a Historic Shift Of Power." Washington Post 10 Nov. 1994: A24.

MacGlashan, Stacey. " County Turnout is Heavy." Washington Post 14 Sept. 1994: A1.

Mercurio, John. "Curry Win Tight Race." Prince George's Journal 14 Sept. 1994: A1.

Mercurio, John. "Unified Democrats Behind Him." Prince George's Journal 10 Nov. 1994: A1.

Mercurio, John. " Diverse Coaition Key to Win." Prince George's Journal 10 Nov. 1994: A1.

Prince George's County Government. General Election Summary. Dept. of Elections.

Surock, Tom Interview with the State Board of Elections Public Relation Liaison. 15 April 1996.

Winter, Herbert R. and Bellows, Thomas J. (1985). People and Politics (3rd ed). New York: John Wiley and Sons.

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A Test of the Efficacy of the University of Maryland College Park Affirmative Action Program

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Employing a multiple, time series regression analysis, the study examines the nature of the Benjamin Banneker Affirmative Action Scholarship Program at the University of Maryland College Park and its efficacy. This was necessary because existing works on affirmative action programs are neither guided by sound methodological analysis nor do they offer empirical evidence about the efficacy of such programs. The substantive findings of this study suggest that there is a positive statistical relationship between the Benjamin Banneker program and the retention and graduation rates of African American students enrolled at the University.

INTRODUCTION

The purpose of this essay is to assess the efficacy of the Benjamin Banneker Affirmative Action Scholarship Program at the University of Maryland College Park. This is important because existing works on affirmative action programs are neither guided by any sound theoretical frameworks nor do they provide empirical evidence to demonstrate the efficacy of these programs. Instead, these idiosyncratic studies (Proponents of Affirmative Action--Fisher 1986, Bergmann 1996, Healy 1996, and the U.S. Department of Education 1996, Opponents of Affirmative Action--Gross 1977, Joyner 1977, Coughlin 1995, Jaschik 1995, LaNoue 1995, and Eastland 1996) concentrate on the ideological/political aspects of these programs. Furthermore, as Thurgood Marshall once noted:

> When the Negro child reaches working age, he finds that America offers him significantly less than it offers his white counterpart. For Negro adults, the unemployment rate is twice that of whites, and the unemployment rate of Negro teenagers is nearly three times that of white teenagers. A Negro male who completes four years of college can expect a median annual income of merely $110 more than a white male who has only a high school diploma. Although Negroes represent 11.5% of the population, they are only 1.2% of the lawyers and judges, 2% of the physicians, 2.3% of the dentist, 1.1% of the engineers and 2.6% of the college and university professors (211).

Therefore, the major questions of the research are as follows: (1) What is the nature of the University of Maryland College Park's Affirmative Action Funding Policy? (2) How do African Americans benefit from this policy? These questions are vital because they will help to determine the nature of the program.

RESEARCH METHODOLOGY

The research methodology that guides this study is quantitative. Considering the major questions of this study, the hypotheses of this research are H1: If affirmative action funding increases, then enrollment rates will increase. H2: If affirmative action funding increases, then the number of Banneker scholars will increase. H3: If affirmative action funding increases, then graduation rates will increase. These hypotheses are linear, directional because they indicate that the values of the variables are apt to increase. The affirmative action funding policy is assumed to have an effect on enrollment rates, the number of Banneker scholars, and graduation rates.

The theoretical framework of this research can be diagrammed as follows:

Enrollment Rates
(Dependent Variable)

Affirmative Action
Funding Policy →
(Independent Variable)

Banneker Scholars
(Dependent Variable)

Graduation Rates
(Dependent Variable)

The independent variable in the preceding theoretical framework is the affirmative action funding policy because it is thought to influence, affect, or cause increases in the enrollment rates, the number of Banneker scholars, and graduation rates, the dependent variables. Therefore, there is one basic assumption in this study: a relationship exists between the independent variable and the dependent variables.

The type of research design used for this is a simple time series design. This design is used because it suggests how the affirmative action funding policy could have increased enrollment rates, the number of Banneker scholars, and graduation rates at the University of Maryland College Park from 1980 to 1994. This design can be diagrammatically represented as follows:

$$X\ O_{1980}\ O_{1994} \qquad [1]$$

where O..O represent observations of the outcome of the independent variable, which is the increasing number in enrollment rates, the number of Banneker scholars, and graduation rates (dependent variables) over a given time. The X represents the effect or independent variable, which is the affirmative action funding policy.

The data source for this study comprises the University of Maryland College Park Institutional Studies (1980-1994). Thus, the type of data collection technique used is document analysis.

DATA ANALYSIS

The data for this study were analyzed in two stages: (1) univariate--looking at one variable at a time, and (2) bivariate--examining two variables at a time. The computer package that was used to compute the data is called the GB-STAT. The statistics used at the univariate stage are the mean and standard deviation. The results of the data generated from the computer runs for these statistics are summarized in Table 1.

TABLE 1. MEAN, STANDARD DEVIATION, VARIANCE, AND COEFFICIENT VARIATION OF VARIABLES

Variable Name	Mean	Standard Dev	Variance	Coef. of Var.
AAP	289536.30	331564.80	1.09	1.14
ERT	2184.50	209.10	43723.35	.09
NBS	23.07	6.40	41.14	.27
GRT	352.21	77.77	6049.40	.22

where:
AAP = Affirmative Action Policy Funding
ERT = Enrollment Rates
NBS = Number of Banneker Scholars
GRT = Graduation Rates

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From the preceding table, the mean for the funding of the affirmative action policy (the Banneker Scholarship) is $289,536 per year (i.e. less then one percent of the total University average yearly budget of 21,460,000--*Chronicle of Higher Education*, Almanac Issue, September 1, 1995: 62) for the years 1979-1980 to 1993-1994; the standard deviation is $331,564. This variation is not statistically significant at the .05 level. The mean for the enrollment rates is 2,184 students for the given years; the standard deviation is 209 students. This variation also is not statistically significant at the .05 level. Next, the mean for the number of Banneker scholars is 23 students and the standard deviation is 6 students for the given years. Finally, the mean for the graduation rates is 352 students and the standard deviation is 77 students for the years examined. The variations for these variables also are not statistically significant at the .05 level.

The statistic employed for the bivariate analysis is the correlation coefficient for both correlation and regression analyses. The results from the computer runs for this stage are presented in Tables 2 and 3.

TABLE 2: CORRELATION MATRIX

	AAP	ERT	NBS	GRT
AAP	-----	.52106	.79197**	.84752**
ERT	-----	-------	.74659**	.80425**
NBS	-----	-------	-------	.83839**
		**P<.01	*P<.05	

From Table 2, it can be seen that AAP has no correlation with ERT; however, NBS and GRT has a correlation at the .05 level; GRT has a correlation with NBS and GRT at the .05 level; and NBS has a correlation with GRT at the .05 level. it can be seen that AAP has no correlation with ERT; however, NBS and GRT has a correlation at the .05 level; GRT has a correlation with NBS and GRT at the .05 level; and NBS has a correlation with GRT at the .05 level. The results from the computer runs for this technique appear in Table 3.

TABLE 3: LINEAR REGRESSION CORRELATION COEFFICIENTY=ERT, NBS, AND GRT X=AAP

	ERT	NBS	GRT
Unadjusted R^2	.2715	.6272	.7183
Correlation Coeff.	.5211	.7920	.8475
Avona for Prediction F	4.4719	20.1900	30.5965
Chance Probability P	.0561	.0007	.0001
STD Error of Est.		185.7585	

As shown in Table 3, there is a positive and statistically significant relationship between ERT and AAP at the .05 level. In addition, there are similar relationships between NBS and GRT and AAP. The explained variances for these relationships are 52%, 79%, and 84%, respectively.

CONCLUSION

Based on the preceding analysis, it can be summarized that there are positive and statistically significant relationships between AAP and ERT, NBS, and GRT at the .05 level. From this analysis, it is clear that the original hypotheses of this essay can be accepted.

H_1: If affirmative action funding increases, then enrollment rates will increase.

H_2: If affirmative action funding increases, then the number of Banneker scholars will increase.

H_3: If affirmative action funding increases, then graduation rates will increase.

In essence, as the Rev. Dr. Martin Luther King, Jr. once stated, "We have developed an underclass in this nation. And unless this underclass is made a working class, we are going to continue to have problems" (Riley 1991: 61). Therefore, affirmative action policies/programs are necessary in this society to move the African American from a "permanent underclass" to a "middle/upper class."

REFERENCES

Bergmann, Barbara R. *In Defense of Affirmative Action.* New York: HarperCollins Publishers Inc., 1996.

Coughlin, Ellen K. "The Great Divide: Public Views, Private Thoughts." *The Chronicle of Higher Education* 17 November 1995: A6-A7.

Eastland, Terry. *Ending Affirmative Action: The Case for Colorblind Justice.* New York: HaperCollins Publishers Inc., 1996.

Fisher, John E. *The John F. Slater Fund: A Nineteenth Century Affirmative Action for Negro Education.* Lanham: University Press of America, 1996.

Gross, Barry R. *Reverse Discrimination.* Buffalo, New York: Prometheus Books, 1977.

Healy, Patrick. "Conflicting Court Rulings: 1992 Decision in a Desegregation Case May Help Defend Affirmative Action." *The Chronicle of Higher Education* 10 May 1996: A35, A38.

Jaschik, Scott. "'No' on Black Scholarships." *The Chronicle of Higher Education* 2 June 1995: A25, A29.

Joyner, Nancy Douglas. "Reverse Discrimination in Student Financial Aid for Higher Education: The Flanagan Case in Perspective." *Journal of Law and Education* 6 (1977): 327-348.

Kirwan, William A. *Decision and Report of the University of Maryland at College Park Regarding The Benjamin Banneker Scholarship Program.* College Park: University of Maryland College Park, April 26, 1993.

LaNoue, George R. "Rethinking Affirmative Action on Campuses." *Planning for Higher Education* 24 (1995) 1-8.

Marshall, Thurgood. "Remedies For Past Discrimination." *Taking Sides: Clashing Views on Controversial Political Issues.* 3ed. Eds. George McKenna and Stanley Feingold. Guilford,Connecticut: The Dushkin Publishing Group, Inc., 1983: 208-214.

Maryland Higher Education Commission Factbook SF II 1995. Annapolis, Maryland: Maryland Government Printing Office, 1995.

Office of Student Financial Aid. *The Benjamin Banneker Scholarship Amount.* College Park, Maryland: University of Maryland, 1996.

BEST COPY AVAILABLE

Office of Institutional Studies. *Enrollment Trend and Degree Recipients by Race, Sex, and Type.* College Park, Maryland. University of Maryland, 1996.

Riley, Dorothy Winbush. ed. *My Soul Looks Back, 'Less I Forget: A Collection of Quotation by People of Color.* New York. HarperCollins, 1991.

United States Department of Education. *Enhancing Quality in Higher Education: Affirmative Action and the Distribution of Resources in U.S. Department of Education Programs: 1995.* Washington, D.C. Government Printing Office, 1995.

Walton-Thomas, Patricia. Telephone Interview. 12 November 1996.

From Critique to Consensus: Stephen White's Pursuit of a Postmodern Politics

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ABSTRACT

Through an examination of Stephen White's text, Political Theory and Postmodernism, I wish to explore a pluralist political theory that is informed by postmodernism's commitment to otherness and critique of metanarrative. I will specifically address the capacity of post-structuralist critique to challenge narrative and White's conception of justice which understands both a responsibility to act and a responsibility to the other.

DISCUSSION

Postmodernism is one of the most widely used and most frequently misunderstood concepts in contemporary political discourse. Much of this confusion is caused by the number of competing interpretations, its internal contradictions, and lack of consensus as to its origins and political relevance. Many have dismissed postmodernism because it seems to lack a theory of agency. However, I believe it is important for contemporary pluralist politics because of its commitment to otherness and its critique of metanarrative.

There are two primary concerns which have caused some to be skeptical of postmodern critique. First, postmodernism has a self-reflexive, paradoxical nature that tends to contradict or undermine its central assertions. While calling into question the legitimacy of narrative, postmodernism cannot escape the fact that it is, itself, a narrative. Some argue that postmodernism reifies rather than deconstructs cultural dominants because the postmodern critique is limited to the very language and conventions that it is critiquing. In The Politics of Postmodernism, Linda Hutcheon uses art as an analogy to examine this contradiction:

> "This is the paradox of art forms that want to (or feel they have to) speak to a culture from inside it, that believe this to be the only way to reach that culture and make it question its values and its self-constructing representations. Postmodernism aims to be accessible through its overt and self-conscious parodic, historical, and reflexive forms and thus to be an effective force in our culture. Its complicitous critique, then, situates the postmodern squarely within both economic capitalism and cultural humanism — two of the major dominants of the western world." (Hutcheon 13)

Secondly, the problematics of a political theory based on a purely deconstructionist, "anything goes" postmodernism are obvious. Since every possible position is considered equally valid, every possible position must be equally privileged; the only way equal treatment can be given to the myriad of competing narratives is to reject them all as flawed. They are rendered equal, but equal in their unsuitability to inform political action. While initially this may privilege alternative narratives by rendering them equal to the dominant, in the end every narrative is left deconstructed, decentered, or devalued. Hutcheon describes this problem when she discusses how postmodernism is counterproductive to the interests of special interest groups. She states, using the feminist movement as an example:

> "The many feminist social agendas demand a theory of agency, but such a theory is visibly lacking in postmodernism, caught as it is in a certain negativity that may be inherent in any critique of cultural dominants. It has no theory of positive action on a social level; all feminist positions do. To 'de-doxify' is not to act, even if it might be a step toward action or even a necessary precondition of it." (Hutcheon 22)

Based on these critiques, many have dismissed postmodernism as inherently negative, ironic, and useless in the political arena. However, I would like to argue that certain aspects of postmodernism are applicable to contemporary pluralist theory. At this point, I believe a close reading of Stephen White may be of use.

White acknowledges at the beginning of Political Theory and Postmodernism that there are various interpretations of postmodernism's relationship to modernism, and he states early on his focus on the more oppositional approaches. In his introduction, he summarizes modernism's emphasis on reason and will, and briefly explains how these precondition the emergence of the dominant political institutions of the nineteenth and twentieth centuries: industrial capitalism, the liberal state, and Marxism. He then begins his discussion of postmodernism and its influences in a manner reminiscent of Mark Edmundson.

In his article, "Prophet of a New Postmodernism," Edmundson considers the postmodern moment:

> "Perhaps we live at a moment when many people--not just our artists--feel confident of their powers to sift critically through the postmodern world of clashing signs. They can't find certainty, but maybe (like [Salman] Rushdie) they aren't looking for that. In fact, it's possible that there are those (again, like Rushdie) who find the prolific variety of contemporary culture exhilarating." (Edmundson 65)

Although White is hesitant to allow that the latter half of the twentieth century has moved completely and radically into a new way of thinking about ethical and political issues, he does believe that we have reached a "postmodern modernity," or a state in which "our modernity is riven by phenomena that are not easily comprehended within familiar cognitive and social structures" (White 3). He refers to these phenomena and their challenges to traditional ways of thinking as the "postmodern problematic," and, to illustrate the emergence of an ethical-political context that underscores the modern-postmodern tension, he discusses four issues inherent to this problematic.

First there is an "increasing incredulity towards metanarrative," in which metanarrative is defined as:

> "those foundational interpretive schemes that have constituted the ultimate and unquestioned sources for the justification of the scientific, technologic and political projects of the modern world. Such narratives, focusing on God, nature, progress, and emancipation are the anchors of modern life."[1] (White 5)

White cites several examples of growing skepticism toward dominant modes of thought, including the deconstructionist impulse of some contemporary philosophy, critiques of liberalism based on a rejection of the assumption that there exists a universal common good, critiques of Marxism that find the conceptual foundations of Marxism comparable to those of Western capitalism, and the questioning of the belief that man is a rational, willful, conscious being (White 5-6).

Second, there has also arisen a new awareness of the costs of societal rationalization and Western modernization. As an example, White cites welfare activities of the modern state:

> "However benevolent these activities may be in intention, the discourses and institutions that emerge with them often promote a deep and progressive disempowerment of their clients. [and] there is [sometimes] little reason to believe that any whole cloth alternatives will not blindly reproduce disempowering modes of rationalization under new guises." (White 8)

Because of this, White argues that more emphasis is being put on continual self-assessment and reassessment in order to avoid continuing or recreating "discourses and institutions" that marginalize.

White's third phenomenon is the rapidly expanding "new informational technology" which encompasses all forms of the media that "vastly enhance the circulation of images and information" with "political ambivalence." This technology has given rise to two interpretations of technology: first as a method of empowering the individual through decentralizing cultural dominants and second as a tool of corporate capitalism that "structures the consciousness and self-identity of individuals and groups" (White 8-9). White elaborates:

> "The crucial questions then become how this proliferation is structured, which cognitive and behavioral scripts are privileged, and which segments of society are systematically advantaged or disadvantaged in the process." (White 10)

White's last element of the postmodern problematic is the emergence of new social movements concerned not with economic distribution, equality, or compensation, but rather with the recognition, protection, or elevation of certain ways of life and sets of values:

> "The women's movement, antinuclear movement, radical ecology, ethnic movements, homosexuals, and countercultural groups in general all share, at least to some degree, this status, even if they differ in many substantive ways. They all have a somewhat defensive character, as well as a focus on struggling to gain the ability to construct socially their own collective identity ..." (White 10)

These groups tend to foster skepticism toward metanarrative as the deconstruction of social dominants allows a "cognitive space" in which their own agendas are subject to less competition.

These ethical-political changes are also described by Anthony Giddens who states, "Postmodernism may or may not exist as a distinguishable phenomenon, no one can doubt, however, that profound changes are occurring in the institutions of the developed societies, regardless of whether or not these are in the end best designated as post-modernity" (Giddens 21-2). Giddens

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goes on to summarize the distinction between postmodern culture and sociology that Zygmunt Bauman presents in his text, Intimations of Postmodernity:

> "A post-modern sociology, Bauman argues, should not follow too closely the characteristics of post-modern culture -- in this sense, the aesthetics of post-modernism and the demands of social science are distinct. A sociology which simply mimicked the characteristics of post-modernity would be pluralistic and hermeneutic; it would have no place for what, precisely, is required -- an analysis of the nature of post-modernity itself. As Bauman expresses it, a post-modern sociology can not develop a conception of post-modernity. None the less, sociology has to move away from its "modern" emphasis. It has to become "dialogical", rather than "monological", and it has to recognize its own involvement in the endless reflexivity typical of the post-modern condition." (Giddens 21)

Although White does not directly address Bauman in his text, it is precisely this idea of a postmodern sociology he calls for after discussing these four elements of the postmodern problematic.

In order to develop a pluralist theory that addresses these issues, White cites post-structuralism as the "most prevalent strategy for undermining the status of traditional metanarratives," and uses the debate between traditional structuralist and post-structuralist critiques to develop his understanding of the two senses of responsibility relevant to democratic politics (White 13).

Structuralism's sense of responsibility focuses on action. Based on some criteria, one narrative, perspective, or agenda is chosen over others in order that certain goals may be reached. As White summarizes, this phenomenon, familiar "in our modern, everyday life and implicit in the dominant, Western styles of ethical and political thought...might be called a sense of *responsibility to act* in the world in a justifiable way, a moral-prudential obligation to acquire reliable knowledge and act to achieve practical ends in some defensible manner" (White 20).

Post-structuralism's sense of responsibility, on the other hand, focuses on "the other," i.e. the underprivileged or marginalized. Jacques Derrida notes the Western tendency toward "unquestioned binary options" and shows how privileged narratives are not privileged because of any inherent logic or truthfulness, but because they fulfill someone's ethical-political agenda[2] (White 15). Michel Foucault focuses specifically on history and politics "to show how social institutions give practical force to such discursive distinctions and how such distinctions are reconstituted in radically different ways in different historical periods"[3] (White 17).

When discussing post-structuralism, however, we return to the same problem Linda Hutcheon has with postmodernism: once the subordinate narrative takes on a privileged status because of the deconstruction of competing ones, post-structuralism's responsibility to the other requires its deconstruction as well. Hence, all narratives are rendered equal, but equal only in their invalidity. There can be no ethical-political justification for political action.

This critique only applies, however, if postmodernism is interpreted as synonymous with post-structuralism. White attempts to reduce the distinction between modernism and postmodernism by interpreting the latter as beyond post-structuralist critique and by attacking an either/or approach to the senses of responsibility. He argues that "part of the responsibility to act includes the responsibility to take others into account" (White 29). In other words, he understands Tzvetan Todorov's warning that "we should not so blindly conflate rationalism with dogmatism, nor should we forget that unlimited tolerance does not provide a solution to all our problems" (Todorov 32). White develops this argument further in his treatment of justice, illustrating a way to act politically without dismissing this responsibility to the other.

White focuses on justice because it is an arena in which it is easy to understand why the two senses of responsibility must be integrated. If one commits solely to the modern responsibility to act, one would be required to understand justice as reducible to a predetermined set of policies or principles that would be applicable in any given situation regardless of circumstance or context. If, however, one commits solely to the postmodern responsibility to otherness, the only justice served would be abstract and pragmatic; no action could be taken because there is no mechanism for establishing "just" action. Given these arguments, it becomes apparent that neither approach seems to adequately describe justice, a fusing of the two is required. White offers two possibilities: a rethinking of injustice and an alternative approach to otherness.

White first examines injustice not as a phenomenon secondary to justice, but as a "central and ineliminable feature of the world" because, as Judith Shklar states, "we simply cannot know enough about men or events to fulfill the demands of justice"[4] (White 123). The postmodern skepticism toward totalization is acknowledged as emphasis is placed on the examination of the "power processes" in society that lead to "domination and injustice" and directed away from attempts to find definitive terms for describing justice. However, the modern call to action is not

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forgotten. White relies on Cicero's conception of injustice that condemns remaining passive when another is acting unjustly; the just individual must act in a way that reduces injustice. White calls this "care" and describes it as "adequately expressed by the sensitivity with which one initially comprehends the specific situation of injustice or suffering; and, second, by the alleviation of the particular burdens" (White 125).

In his second and more developed approach to justice, White emphasizes the importance of a discriminate fostering rather than a mere toleration of otherness. He first argues that we must move beyond John Stuart Mill's understanding of diversity as merely a means to some sort of moral or intellectual progress. Mill's diversity, argues White, is too solidly grounded in the responsibility to act; he tolerates otherness only insofar as it leads to the ends he desires:

> "When tolerance is seen in the purely utilitarian way, Mill does not really disturb (although he does not actually endorse) the traditional attitude of considering tolerance as something we *must bear grudgingly* for the sake of something else; but when tolerance begins to have value in itself, then we should in some sense *celebrate or delight in it.*"[5] (White 128-9)

White therefore argues that we must rethink the other, appreciating diversity in and of itself.

Mark Edmundson also develops an understanding of a politics informed by postmodernism which, like White, emphasizes a sensitivity to and a fostering of otherness, the self-aware rethinking which informs social change, and the emergence of a "creative space" in which discourse may flourish. Using Salman Rushdie's Satanic Verses as an example, Edmundson explains:

> "Rushdie's objective is to stand between these two worlds [England and India] and encourage their fusion; he wants to persuade people on both sides to open themselves to each other, though he's not unsophisticated about the risks involved in such an opening." (Edmundson 66)

Similarly, Edmundson's postmodern impulse is one "in which a critique of old stabilities is combined with a drive toward renewal," one in which "homelessness...is understood as humanity's condition--and one, finally, to be affirmed, because it allows for more metamorphosis, change, and the ability (and the need) to be other than one was" (Edmundson 70).

Edmundson cites Richard Rorty as an example of a pragmatic philosopher who successfully treats this positive postmodernism. He sees much value in Rorty's argument that literature "can give us cues for action, fresh ways to orient our lives, and not only our private lives but our public and political lives as well" (Edmundson 66).

Initially, White's "care" seems to echo Richard Rorty's estimation of moral responsibility. White's approach to justice and Rorty's understanding of morality both value the sort of curiosity Foucault describes in "The Masked Philosopher":

> "Curiosity...evokes 'care'; it evokes the care one takes of what exists and what might exist; a sharpened sense of reality, but one that is never immobilized before it; a readiness to find what surrounds us strange and odd; a certain determination to throw off familiar ways of thought and to look at the same things in a different way."[6] (White 91)

Where White calls for a care that requires that "one draw the other into one's own interpretive frame," a "willingness to hold open an intersubjective space in which difference can unfold in its particularity," and "a hesitancy to 'place' the other quickly and firmly within habitual interpretive molds" (White 99-100), Rorty argues in his text, Contingency, Irony, and Solidarity that "curiosity" is the primary virtue:

> "All that is required to act well is to do what artists are good at -- noticing things that most other people take for granted, seeing the momentary iridescence and not just the underlying formal structure....Knowing the good is just sensing what matters to other people, what their image of good is." (Rorty 159)

The parallel breaks down, however, when each attempt to explain how this curiosity or care comes into play in society. Although White may agree with Edmundson's call for positive postmodernism and Rorty's understanding of the importance of curiosity and critique in the political and aesthetic arenas, White believes that Rorty is, in some ways, unrealistic. White develops a politics that subsumes a theory of agency while Rorty believes that "suffering or injustice 'has merely to be noticed to be remedied'" (White 93). Both understand the responsibility to otherness, but only White understands the importance of the responsibility to act.

White is able to appropriate action into his pluralist theory as he does not commit to an "anything goes" acceptance of all forms of otherness; instead he calls for an approach that is both careful and conscientious. Rather than resort to an idealistic aesthetic approach to politics like Rorty, White attempts to work within a realistic social context:

> "Large complex societies will always be heavily constructed around organizational routines and institutional projects, from the perspective of which the appearance of difference will often elicit more irritation than delight. The more the sway of the responsibility to act dominates a situation, the more this will be the case. The real issue is how to relax the pull of this responsibility before,

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> within, and after such routines and projects; how to create slack and space within which the mood of delight can flourish. Part of this task will be to think creatively about when, where and how intersubjective difference can be actively fostered." (White 129)

White addresses this challenge by asserting that "at some point, one must have a way of arguing that not all manifestations of otherness should be fostered; some ought to be constrained." He then asserts that both a "global principle of pluralism" and "more specific procedural principles providing further normative guidelines for situations where plural forms of life come into conflict" are crucial to political discourse (White 133).

He recognizes the skepticism postmodernists have toward globalization and again uses his two senses of responsibility to offer a compromise between traditional narrative and post-structuralist critique. White's universal is the responsibility to otherness. When conflict occurs, White calls for action informed by a commitment to care:

> "The mood and measure of such a lightness of care would, first, sustain a commitment toward fostering otherness, born of a deeper understanding of finitude and the delight in difference emerging therefrom. Correspondingly, it would also sustain a commitment to constraint, since the urge to dominate constitutes a refusal to bear witness to one's limits, a refusal to recognize finitude. Actions that dominate or systematically manifest a failure to respect others are a willful forgetting of an inescapable dimension of human being." (White 139)

White then applies these principles to the liberal state by offering an initial sketch of how such a rethinking can aid the process of "reorienting ourselves to our own finitude and the meaning of otherness" (White 147). White calls for a "'deliberately nonneutral' liberal state" that is committed to

> "maintaining a balance of values within its own tradition: a state that 'fosters associative activities.' Such a state has an obligation to 'endorse and sponsor' groups which are likely 'to provide shapes and purposes congenial to shared values' of the liberal tradition: 'voluntary association, pluralism, toleration, separation, privacy, free speech, career open to talents and so on.'" (White 144)

Although there is much still to be developed regarding how this "postmodern modernity" will manifest specifically in government, politics, and economics, I believe White's argument is of great value for several reasons. He recognizes that there have been important economic and socio-political changes which cannot be ignored or attributed to the modern impulse of fifty years ago. He goes beyond considering whether postmodernism is valid or applicable to politics; rather, he examines its useful elements without resorting to a reactionary condemnation of the modern narrative. He understands both the equalizing potential of the poststructuralist critique and the cultural need for some sort of narrative structure. Furthermore, he is not intimidated by their seeming incongruity. The narrative to which he eventually commits combines both a sensitivity to the other and a theory of agency in a way that I believe invokes the curiosity and care essential to contemporary pluralist politics.

ENDNOTES

[1] White borrows the phrase "incredulity toward metanarratives" and his understanding of metanarrative from Jean-Francois Lyotard's The Postmodern Condition: A Report on Knowledge, trans. by G. Bennington and B. Massumi, 1984, University of Minnesota Press, Minneapolis, p. xxiv.

[2] White cites Jacques Derrida's Positions, 1981, University of Chicago Press, Chicago, pp. 6, 41.

[3] White cites Michel Foucault's Discipline and Punish: The Birth of the Prison, trans. by A. Sheridan, 1977, Random House, New York and The History of Sexuality, Vol. 1, An Introduction, trans. by R. Hurley, 1978, Random House, New York.

[4] White cites Judith Shklar's "Giving Injustice Its Due", Yale Law Journal, Apr 1989, p. 1135.

[5] White cites John Stuart Mill's "On Liberty", Liberty and Other Writings, ed. by S. Collini, 1989, Cambridge University Press, Cambridge, p. 14.

[6] White cites Michel Foucault's "The Masked Philosopher", Politics, Philosophy, Culture: Interviews and Other Writings 1977-1984, ed. L. D. Kritzman, trans. by A. Sheridan et al., 1988, Routledge, Chapman and Hall, New York, p. 328.

REFERENCES

Edmundson, M., "Prophet of a New Postmodernism: The Greater Challenge of Salman Rushdie", Harper's Magazine, Dec 1989.

Giddens, A., "Uprooted Signposts at Century's End", The Higher, Jan 17, 1992.

Hutcheon, L., 1989, The Politics of Postmodernism, Routledge, New York.

Rorty, R., 1989, Contingency, Irony, and Solidarity, Cambridge University Press, Cambridge.

Todorov, T., "A Poetics of Postmodernism: History, Theory, Fiction", The New Republic, May 21, 1990.

White, S. K., 1991, Political Theory and Postmodernism, Cambridge University Press, Cambridge.

A Quantitative Study of the High School Attrition in Prince George's County, Maryland

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The original intent of this study was to examine high school attrition in Prince George's County, Maryland. The independent variables are average income of parents, parents' educational levels, ethnicity, and gender, and the dependent variable is high school dropout rate. However, due to data paucity, the study was limited to testing for a possible relationship between the median income of parents and the high school dropout rate. The data collected and analyzed after the computer runs determined that the hypothesis that the greater the parents' median income in Prince George's County, the lesser the high school dropout rate, is to be rejected.

INTRODUCTION

Following the tradition of earlier studies on attrition and retention (e.g., Bean 1980, Braxton and Hossler 1988, Naylor and Sanford 1982, Pascarella 1980, Terenzini 1987, and Tinto 1975), the original intent of this study was to examine High School Attrition in Prince George's County, Maryland, using the independent variables, average income of parents, parents' educational levels, ethnicity, and gender, and the dependent variable, high school dropout rate. However, due to data paucity, the study was limited to testing for a possible relationship between the median income of parents and the high school dropout rate.

This essay continues with a review of the nature of the problem and identifies specific variables involved, and develops questions which frame the direction, approach, and scope of the study. In the research methodology section, one hypothesis, a design approach are presented to study the relationship held by these variables. Finally, the actual data collected are analyzed at the univariate and bivariate levels.

NATURE OF THE PROBLEM

Every American must energize to transform this country's priorities. The first priority must be children. According to the Children's Defense Fund, each school day 2,255 American teenagers drop out of school. This is an alarming rate. Prince George's County, is included in this tally. Prince George's County youths drop out of school and join together to take part in criminal activities, such as damaging property, destroying community resources, causing fear in people who live in their neighborhoods, drawing graffiti, dealing in drugs, vandalizing, threatening and assaulting individuals with bodily harm, and driving by and shooting innocent citizens. Youth violence grows from common bonds, such as neighborhood and ethnic backgrounds. Youth gangs are formed when people from neighborhoods and communities hang-out together with idle time on their hands. Most of the violence caused by youths is done by males as opposed to females. This is not to say there are not females involved in youth violence, because they are.

There are programs in Prince George's County that are designed to work with youths involved in violence. The Gang Resistance Education and Training program provides a tool through which youths can grow up to be productive citizens. It is a proactive prevention program aimed directly at youths in the County. It provides them with education and equips them to make positive decisions in life.

RESEARCH METHODOLOGY

Employing a quantitative approach, the theoretical framework tested in this study can be diagrammatically represented as follows:

Median Income of Parents	→	High School Dropout Rate
(Independent Var.)		(Dependent Var.)

There is one independent variable in the preceding theoretical framework: median income of parents. This is the independent variable because it is the measure of the phenomenon that is thought to influence, affect, or cause the dropout rate, the dependent variable. Therefore, the basic assumption in this study is that there is a relationship between the median income of parents and the dropout rate of Prince George's County high school students.

There is one hypothesis being examined in this study based on the preceding problem definition and theoretical framework. This hypothesis is as follows: H1: The greater the median income of parents in Prince George's County, the lesser the high school dropout rate. This hypothesis is one-way directional because it suggests that the average income of parents will affect the high school dropout rate in Prince George's County. The level of analysis is micro because parents' median income and the high school dropout rate are being examined for only one county in the United States.

The research design used in this study is a simple time series design because it suggests how average income of parents could have decreased the dropout rate in Prince George's County, Maryland, from 1991 to 1995. This design can be diagrammatically represented
as follows:

$$X\ O\,1989 \ldots O1995 \qquad [1]$$

where O represents the observation of the outcome of the dependent variable, which is the increasing high school dropout rate over time, and the X represents the effect or independent variable, which is the median income of parents.

The data for the high school dropout rate in Prince George's County School System were obtained from the Prince George's County Public Schools Pupil Accounting & School Boundaries Department. The data for the median income of parents were retrieved from the 1995 Maryland School Performance Program Report.

DATA ANALYSIS

In this examination of the high school dropout rate in Prince George's County as it relates to median income, two stages of data analysis are employed in order to process the data completely. In the univariate analysis, each variable is examined independently of each other and specific values are assigned to it. The bivariate analysis assesses the values given to the two variables and makes a determination whether the two correlate or are related with each other. If a correlation is discovered, the nature of the pattern will tell how the variables are related. The statistical package used to accomplish this analysis is GB-STAT.

The statistics used in the univariate analysis are the mean, or average, and the standard deviation. The results generated from the computer runs for these statistics are summarized in Table 1.

TABLE 1: Mean and Standard Deviation

Variable	Mean	Sample Std. Dev.	Sample Variance	Coef. Of Variation
DROPOU	4.20	.32	.10	.07
MEDINC	48,388	3787.61	1.43	.07

DROPOU = High School Dropout Rate
MEDINC = Median Household Income

Table 1 does not show a consistent pattern for the high school dropout rate, the dependent variable, and the independent variable, median income. Also, the mean dropout rate is 4.2 percent and the mean income is $48,388 from 1990 to 1994.

The coefficient of variation for each variable tells us whether or not the variations within them are statistically significant at the .05. It is interesting to note that when examining DROPOU and MEDINC, the coefficients of variation for both is .07, which is not statistically significant at the .05 level.

Table 2 presents the correlation coefficients for the first part of the bivariate analysis. The idea was to test for the strength of the relationship between the two variables.

TABLE 2: Correlation Matrix

	MEDINC
DROPOU	.64186

**p<.01 *p<.05

An analysis of Table 2 demonstrates the type of correlation between the variables. This is correlation is explained as follows with a correlation coefficient of .64, DROPOU is not statistically correlated with MEDINC at the .05 level.

Table 2 sought only to explain the correlation and the strength of that correlation between the two variables. The direction and significance of the relationship is shown by regression analysis. The following table (3) shows the results derived from the computer run for this procedure.

TABLE 3: Explanation for the Variation in DROPOU

Table 3

Linear $Y = \alpha + \beta * X$

$Y = 1.5429 + 5.491193E\text{-}05 * X$

UNADJUSTED R = .412
CORRELATION COEFFICIENT = .6419
ANOVA FOR PREDICTION F = 2.021
CHANCE PROBABILITY P = .243
STD ERROR OF ESTIMATE = .2869
VARIANCE OF ESTIMATE = 0.823
DEGREES OF FREEDOM =1 AND 3

WITH X = MEDINC AND Y = DROPOU

From Table 3, it can be seen that in regards to DROPOU as it relates to MEDINC, there is no relationship which is statistically significant at the .05 level. Also, about 41% of the relationship is explained. Thus, the hypothesis tested in this study, H1: The greater the median income of parents in Prince George's County, the lesser the high school dropout rate, is rejected.

CONCLUSION

This study began by defining the attrition problem of high school students in Prince George's County. Second, the research methodology section entails the theoretical framework which helped to narrow the focus and provided the specificity needed to identify a factor which may define the broad problem of high school attrition in Prince George's County. Then, the hypothesis was suggested that there is a relationship between the independent and the dependent variables. At this point, the research design was drawn to show the time frame that each variable was studied. The data collection section explained from which sources the data used were derived. Finally, the last step analyzed the data collected which determined the hypothesis that the greater the parents' median income in Prince George's County, the lesser the high school dropout rate, is to be rejected.

REFERENCES

Bean, P.J. 1980. "Dropouts and Turnover: The Synthesis and Test of a Causal Model for Student Attrition." Research In Higher Education 12:155-187.

Braxton, J.M. and D. Hossler. 1988. "The Influence of Student Problems on Student Withdrawal Decisions: An Autopsy of Autopsy Studies." Research In Higher Education 28: 241-253.

Naylor, P. D. and T. R. Sanford. 1982. "Institutional Analysis of Student Retention Across Student Levels." College and University 57: 143-159.

Pascarela, E. T. 1980. "Student-Faculty Informal Contact and College Outcomes." Review of Educational Research 50:545-595.

Terenzini, P. T. 1987. "Studying Student Attrition and Retention." J. A. Muffo and G. McLaughlin, EDS. A Primer for Institional Research. Tallahassee, Florida: The Association for Institutional Research.

Tinto, V. 1975. "Dropout From Higher Education: A Theoretical Synthesis of Recent Research." Review of Educational Research 45:89-125.

Race in the Balance:
Case Study of Escambia Treating Company

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Environmental racism has plagued the communities of African Americans, Native Americans, Mexican Americans, and other ethnic communities in the modern era. The historic lack of political power of people of color has left many communities trapped in environments polluted with toxic waste. Race and ethnic discrimination have greatly influenced the location of toxic waste sites. I examined a chemical waste company in Pensacola Florida as a case study. This paper correlates the racial composition of communities and location of toxic sites. In our quest to achieve environmental justice, we must realize the social importance of the race issue.

> More than 15 million African Americans live in communities with one or more toxic waste site; in fact three out of every five African Americans and Hispanic Americans live in communities with uncontrolled toxic waste sites (According to a study of 41 U.S. communities where the highest level of commercial hazardous waste activity is taking place) (Bullard, 1993).
>
> Race proved to be the most significant factor among variables tested in association with the location of commercial hazardous waste facilities. This represents a consistent national pattern (Gerrard, 1994 p.86). Three out of the five largest commercial hazardous waste landfills in the United States are located in predominantly Black or Hispanic communities. These three landfills account for 40 percent of the total estimated commercial landfill capacity in the nation (Bullard 1993).

Racism is a holistic entity affecting people's lives in almost every aspect. Environmental racism as defined by Benjamin Chavis Jr. is

> racial discrimination in environmental policymaking. It is racial discrimination in the deliberate targeting of communities of color for toxic waste disposal and the siting of polluting industries. It is racial discrimination in the history of excluding people of color from mainstream environmental groups, decision making boards, commissions, and regulatory bodies (Bullard, 1993).

Environmental racism not only affect the living environment of people, but it also affects their health and their overall wellbeing. In order to understand the correlation between toxic waste sites and environmental racism, I have focused on the Escambia Treating Company in Pensacola, Florida. In this paper I will demonstrate the devastating consequences that African Americans face from living in a polluted environment. Through this case study I will also analyze one way in which the community has been empowered to fight back.

Located in a poor African American community, the Escambia Treating Company (ETC) manufactures treated poles for sale to telephone and electric utilities. Founded in 1924, the company specializes in

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pentachlorophenol and CCA - treated wood poles and piling. Although the company shut down on October 1, 1982, the people of that community are still feeling the effects of the company. The company shut down because the owners felt it was no longer economically profitable. However, many issues in concerning the company have risen (Wittwer, 1982).

The U.S. Environmental Protection Agency (EPA) is still pursuing a 1988 suit against the owner, Charles A. Soule Jr., alleging that he is responsible for hazardous waste violations. The EPA says Soule should determine the extent of damage, pay for the cleanup, and substantial fines. The most serious alleged environmental violation is the release of hazardous compounds into the soil and groundwater at all locations of the plant. In addition, he is accused of operating hazardous-waste facilities without permits, failing to provide liability insurance, and failing to monitor groundwater (Graybiel, 1990). How a company can exist for over 58 years with such drastic and extreme violations and not have been stopped raises questions about how much this company, and the EPA care for the people in that community.

The existence of this company has presented health problems from the day it opened, threatening the lives of children of the past, and children of the future. In an attempt to find exactly what toxins and how much of those toxins are located in the soil, the EPA has tested the soil where the company once stood. Test results showed that the level of toxins in the soil were beyond safe living conditions for the people in that environment, and for people who use the groundwater. The EPA says it needs more testing for dioxin, but a few analyzed samples showed levels way above the residential standard for dioxin cancer risk. With dioxin, counting only the cancer risk is very misleading because research shows that dioxin is a powerful artificial hormone capable of playing havoc with the endocrine system. Small amounts of dioxin might not cause cancer but still result in birth defects, neurological disorders, and immune system damage. Tests also showed the soil and ground water were contaminated with creosote, pentachlorophenol and other chemicals. Creosote, a wood preservative, is toxic and suspected of causing cancer. By considering contaminants separately ignores the synergistic interactions, often the most damaging health effects of all.

"Nobody can tell me that this place is not killing me," is the response of Alberta Snipes (Myers, 1992). The health hazards for the people of this community are atrocious. After suffering this mistreatment for many years, the people of the community decided to fight back. Led by Margaret Williams the people of this community organized CATE, Citizens Against Toxic Exposure. The people of the community do not want special treatment, only equal treatment. The initial problems that this community faced were about skin color and economics, but ultimately the issue is survival itself. The problems are about innocent adult and children victims. In the words of Sammie Jones, who lives a stone's throw from ETC and suffers from breathing problems, "we're talking about human lives, and you don't get but one chance" (Graybiel, 1995).

There is nothing that can be done to vaccinate these residents against living next to a waste dump and/or living next to the essences of a waste dump. "All around the neighbourhood, people are dying of cancer. It is at epidemic proportions. Someone must be held accountable. These are human beings, not guinea pigs," says John Beck, a frustrated resident of the community

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(Myers, 1992). Residents of these neighbourhoods claim that sixty-four people have died of cancer in the past 10 years. Only nine people in the area died of other causes during that time. Frank Pricket, 55 years old, said 15 to 20 of his neighbours have died of cancer in the past 10 years. The health problems of these residents are so extensive that they indicate a common casual factor.

Initially the EPA failed to acknowledge that their complaints were real. Did the problem stem from people's presenting unreliable information, or was it the result of the EPA not carefully listening. After many meetings and much time, the residents of this community convinced the EPA to begin cleaning up the problems created by ETC. The health complaints of residents have been consistent over many years; however, they soared in October 1991 when EPA officials began excavating the soil to stop groundwater contamination. The EPA proposed that this toxic cleanup site be added to a priority list to receive Superfund status. Superfund sites are hazardous waste areas the EPA has declared priority sites for cleanup. Because of the high levels of toxins, the site has been proposed to be a part of the National Priority List (Basiouny, 1994).

Now that the residents have gotten someone to listen to what they are saying, what is the best solution to the problem? The proposal that CATE suggested was cleaning up the contaminated environment. Well how do you clean such heavily contaminated soil? The approaches that the EPA sought originally were by cleaning or heating the soil. Soil washing treatment is not designed to eliminate contamination, yet it is used to reduce the volume of contaminants in the soil. However, preliminary tests show that cleaning the soil would only eliminate 97 to 98 percent of the pentachlorophenol and 85 to 96 percent of the creosote: enough to past minimal standards, for those toxins. The other method, boiling the soil, would require the soil to be heated at temperatures above 1,800 degrees Fahrenheit. Finally, with the help and agreement of CATE, the EPA decided that the best decision would be to excavate the soil (Lamb, 1992).

Cleanup of the ETC site, began in October 1990. The EPA will spend an estimated $100 million to clean this site. But area residents were concerned that the cleanup would create a greater health problem than leaving it alone (Ashby, 1995). The EPA had to remove over 220,000 cubic yards of contaminated soil. The excavated soil has been put into 20 - to 25-foot mounds that are to be capped. The residents were seemingly not considered in this decision. The only safeguards that were given for the mounds were a 12-foot fence that bears no signs that warn of hazardous waste. The contaminated soil was merely covered by heavy tarps. Accessibility to this soil is unsafe, in fact children have been spotted sliding down the tarp covered pile of toxic waste. Moreover, during the excavation of the soil two residents were relocated because of severe problems with breathing.

As a result of more than four years of dogged persistence and unwavering unity by of the members CATE, the EPA has extended an offer to relocate all families in the area. Although the site has become a part of the Superfund, it could take 2 1/2 to 3 years before the clean will be completed (Bisouny, 1994). In 1996, the EPA announced that in the next year it would move 358 households surrounding the sites for approximately $18 million - one of the largest relocations in Superfund history. The residents of this community will be the first African-American community to be relocated through the U.S. government's Superfund policy, and the site has been selected to serve as a relocation pilot program (Sherrell, 1996).

There are many lasting consequences that ETC has left the city of Pensacola, but the price that the residents of this environment has paid, and will pay is heartbreaking. Money can always be replaced, but health and peace of mind can not be bought. The relocation of these residents also came with many problems. The concerns that are presented by CATE are as follows: 1) One is a proposal to begin demolishing each home as soon as its residents are relocated. The activity could force more contaminants into the air if the soil is disturbed. The residents would prefer that everyone is relocated before buildings and houses are torn down; 2) That officials may simply try and put residents in another low-income, minority areas. How long will it take for the government to realize the severity of every aspect of this situation? Despite the EPA's assurance that things are moving forward, some residents feel they are being stalled because of their color. Myrtle Crowe says, "we got a black face . . if it had been you or your race, you'd been out of here. It's not fair . . . if I'm wrong, I hope God forgives me" (Allman 1997).

Alberta Snipes feels that the proof of a health threat is the white safety suits which cleanup crews wear when working at the site. The proof is in the fact that her skin burned before she was relocated. The cleanup crew has suits, but who or what will protect the residents? How do you repay Shirley Jones' three children who are not allowed to go outside and play? What is to happen to her two-month-old son, whose prenatal exposure forced him to spend 10 days in the hospital after his birth because he could not breathe (Allman, 1997)? What happens to 17-year-old Randy Roberts who has quit the Woodham High School track team because he can't keep up. He doesn't know if it has anything to do with the hazardous cleanup site near his back yard. He just wishes he could run as fast as he used to (Lamb, 1994). Willie Julius Jr. must use his portable oxygen machine and take a wide variety of medications for problems he says can be traced to his exposure to the site (Escobedo, 1996). 75-year-old Robert Lee who has lived in this neighbourhood for 71 years has watched cancer claim his mother, father, stepfather, and uncle (Escobedo, 1996).

Not only have the residents of this community suffered from health problems and must leave their homes, there are also unresolved financial issues. Great amounts of money have been spent on this project: millions of dollars. Unfortunately this project will require many more millions to be successful. The majority of the monies spent have gone toward cleaning the site and not towards the other needs of the residents. For example, Alberta Snipes will receive an estimated $16,000 for her house that was once estimated at a value of $45,000. Are these proper compensations? The residents do not feel that they are. No amount of money can fully compensate the residents for their losses. The community has been fragmented. Many residents run a high risk of no longer being a part of the same community, and children may have to change schools. Fair compensation does not alleviate the loss, but at least it gives the residents a fair starting chance.

In conclusion, we have seen the personal and economic consequences of environmental racism in the case of the Escambia Treating Company's degradation of an African American community in Pensacola. We have also seen how an African American community organized and fought back to repair their health and dignity. I want to close with the challenge which Cornell West offers in his book Race Matters:

In these downbeat times, we need as much hope and

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> courage as we do vision and analysis; we must accent the best of each other even as we point out the vicious effects of our racial divide and the pernicious consequences of our maldistribution of wealth and power. We simply cannot enter the twenty-first century at each other's throats, even as we acknowledge the weighty forces of racism, patriarchy, economic inequality, homophobia, and ecological abuse on our necks. We are at a crucial crossroad in the history of this nation-and we either hang together by combating these forces that divide and degrade us or we hang separately. Do we have the intelligence, humor, imagination, courage, tolerance, love, respect, and will to meet the challenge? Time will tell None of us alone can save the nation or world. But each of us can make a positive difference if we commit ourselves to do so (Cornell West, 1993).

In Pensacola, Margaret Williams and the Citizens Against Toxic Exposure offer you and me such a vision of hope and courage.

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REFERENCES

Allman, J. (1997). "Residents near cleanups await new homes." Pensacola News Journal. 01/08. 1C.

Ashby, C. (1995). "Residents fear cleanup could stir up toxic waste." Pensacola New Journal. 01/10. 1A.

Basiouny, A. (1994). "EPA seeks priority status for toxic escambia site." Pensacola News Journal. 08/24. 1A.

Bullard, R. (1993). Confronting environmental racism. Boston: South End Press.

Escobedo, D. (1996). "EPA gives in, will mow all at toxic sites." Pensacola News Journal. 10/04. 1A, 14A.

Escobedo, D. (1996). "Residents west of sites want in on epa relocation." Pensacola News Journal. 11/13. 1C.

Gerrard, M. (1994). Whose backyard, whose risk fears and fairness in toxic nuclear sitting. Massachusetts: MIT Press.

Graybiel, G. (1990). "Jury order executive to pay employees $2.39 million." Pensacola News Journal. 09/12. 1A, 10A.

Graybiel, G. (1995). "People near toxic sites may be moved." Pensacola News Journal. 04/13. 1C.

Lamb, S. (1992). "Home site spoiled by Creosote." Pensacola New Journal. 11/06. 18A.

Lamb, S. (1994). "Toxic site called unsafe." Pensacola News Journal. 01/03. 4A.

Myers, C. (1992). "County urges relocation of people near toxic site." Pensacola News Journal. 08/12. 1A.

Schonauer, S. (1995). "Residents near plant want fast health study." Pensacola News Journal. 02/02. C.

Sherrell, S. (1996). "Margaret william exemplifies first kwanza principle: 'unity'." Pensacola News Journal. 12/26. 1B, 5B.

Wittwer, C. (1982). "Treating plants shut down." Pensacola News Journal. 10/12. 3D.

West, C. (1993). Race matters. New York: Vintage Books.

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Aid in Transition
Explaining Post Cold-War Trends in House Foreign Aid Voting

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The end of the Cold War has brought about a fierce debate within the House of Representatives over the role that foreign assistance should play in American foreign policy. The demise of Cold War bipartisanship has resulted in an intensified battle that seems to be focused more sharply than ever along ideological and party lines. To explore the trends in aid voting, the hypothesis that ideology and party are the strongest factors in members' voting decisions on foreign aid legislation is tested; the assumption that those two factors have increased in importance since 1989 is also examined. Bivariate analysis and logit regression suggest the conclusion that ideology and party are very important factors, but the analysis reveals a number of other important influences on voting, and it fails to support the notion that ideology and party are increasingly important over time.

INTRODUCTION

From the early years of the Cold War, foreign economic assistance was a vital part of American foreign policy. But, in the late 1980s as the Cold War waned and domestic budget deficits mounted, Congress began to reconsider U.S. foreign aid allocations. By the early 1990s, liberal members seemed to be supporting foreign aid much more fervently than those with conservative views. The politics of foreign assistance seemed to be moving in a more partisan and ideological direction. Since 1994, the Republican-dominated House and Senate have quickly adjusted foreign aid priorities; multilateral aid appropriations for FY1996 were 33.6% lower than those for FY1995, and bilateral development aid funding was cut by 17.0% (Nowels, 1996, p. 7). Total foreign aid budgeting for FY1996 was set at $12.8 billion--$5.2 billion less than the FY1986 budget (Nowels, 1996, p. 1). This paper examines empirically the apparent increase in ideological and partisan voting on foreign aid during the past decade. The central hypothesis of this study is that party and ideology have been the most important factors in explaining House foreign aid voting decisions since the end of the Cold War. A secondary hypothesis posits that these two factors have increased in importance after 1989 (for practical purposes, the end of the Cold War), and especially after the Republican "revolution" in 1994.

LITERATURE REVIEW

Previous researchers have differed largely over whether a single dimension of influences adequately explains voting, or whether decision-making is a more complex process that can only be explained by examining a variety of dimensions. Unidimensionalist studies generally explain congressional voting by ideology, as measured by a simple left-right dimension (Schneider, 1979). By contrast, the much larger body of multidimensional research asserts that voting behavior results from the interaction of more than one factor or influence. Although this two-category model for classifying the existing literature is admittedly an oversimplification, it seems to provide the most interesting and complete context for this research.

A number of political scientists have explored congressional voting from the unidimensional perspective. William Shaffer (1980), examining the hypothesis that Democratic members of Congress are "far more liberal" than Republican members, finds that the House demonstrates "substantial partisan ideological cleavages." He finds strong evidence that the House is divided along ideological lines and that those divisions correspond with the divide between the two major parties (1980, p. 55). Herbert Kritzer (1978), in his study of elite actions, concludes that elites demonstrate ideological motivation in their action, especially in voting behavior. Jerrold

Schneider (1979) provides the classic unidimensional model, finding that a left-right ideological model explains voting across all major policy areas.

The multidimensional category includes a much broader array of studies that share the common finding that more than one factor influences congressional voting. Influences examined in multidimensional studies include constituency interests, executive branch pressures (Kingdon, 1989), other members (Kau and Rubin, 1979), reelection concerns (Arnold, 1990), lobbyists' campaign contributions (Schroedel, 1986) and party affiliation (Cox and McCubbins, 1991), in addition to ideology and party affiliation. Several of the multidimensional researchers have focused on the varying importance of factors by policy area (e.g., Kozak, 1984).

Finally, political scientists have examined congressional voting on foreign affairs issues in particular from both the unidimensionalist and the multidimensionalist perspectives. Schneider finds that voting on foreign affairs issues follows his overall ideological model. Clausen (1973), by contrast, finds that presidential position and constituency interest are stronger influences than ideology. McCormick and Wittkopf provide an analysis that is especially relevant to this study. They examine the change in partisan and ideological foreign affairs voting before and after the Vietnam war; they find support for the expected increase in partisan aid voting, and they also find that "ideology is an especially strong predictor of foreign aid voting in both chambers" of Congress across the time period (1992, p. 46).

This study proceeds from the assumption that the multidimensional view has received more empirical support, and therefore accounts for a variety of possible influences on foreign aid voting in the logit regression analysis. The importance of the contextual, policy-specific analyses is also acknowledged, and that body of research corresponds with an obvious underlying assumption of this study that members behave in specific, unique ways when they vote on foreign aid legislation, thus obligating a policy-specific inquiry.

RESEARCH METHODS

A series of House votes on the Foreign Operations Appropriations Act serves as the dependent variable for this study. The votes span a period of 9 years and were taken in the 100th through the 104th Congresses. The nine roll-calls funded United States foreign assistance for fiscal years 1989-1997. The independent variable of party was also coded as a simple dichotomous variable, Democrat or Republican (0=Republican, 1=Democrat). Independents and vacant seats were entered as missing data. To measure the ideology independent variable, Americans for Democratic Action (ADA) scores for individual members were employed (ADA scores provide an ideological measure of each member based on prior voting). In order to examine the relative influence of party and ideology on voting, an array of other important factors have been included in this study. One of the most important such factors, geographical region (represented in this study by four categories--northeast, south, midwest, and west), seems to be suggested by the overall dispersion of the yes and no votes in the House. To capture the interest of each member's constituency on foreign assistance, the regression analysis includes two indicators that predict the interests of a particular congressional district in foreign aid: the percent of the population that is foreign born (by *state*), and the outcomes of the most recent presidential election (by district). These measures, incorporated into the regression, capture constituency interest in foreign matters and overall constituency ideology, respectively. In an effort to examine the importance of the executive branch position in foreign aid voting, *Congressional Quarterly*'s presidential support scores (index values for the frequency of support for presidential positions) were coded at the ratio level and incorporated them into the regression analysis, noting whether members with a history of support for a given president would follow that pattern in their vote on aid appropriation. As a final possible independent variable, the length of tenure for individual members was examined under the assumption that members with longer tenure are more secure in their reelection and therefore more free to vote on the basis of ideology.

Overall trends in the relationships between the independent and the dependent variables were examined using crosstabulation in most cases. Cramer's V was employed as the measure of association for the asymmetrical tables where ideology was the independent variable. Phi was used as the statistical measure of association in the case of the square tables where party affiliation was the independent variable. Pearson's Chi-square was used in all cases to test statistical significance at the .05 level. To eliminate some of the shortcomings of crosstabulation, t-tests were also performed using the ratio level data for ADA score. The heart of this study's investigation, however, is contained in the logistic regression analysis. Regression was selected as the method for the analysis because it allowed each of the possible independent variables to be

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incorporated, and it indicated the relative importance of each factor in influencing members' voting decisions. Each regression included the ADA score, party, region, tenure, district presidential vote, district foreign-born percentage, and presidential support indicators. The results from the regression runs for each of the nine votes have been analyzed to provide an applicable interpretation of each variable's impact on voting decisions. It is important to note that *only* the variables that were significant at the .05 level were analyzed for each Congress; however, all variables, regardless of significance, were included in the overall equations. Since some votes included many more significant variables than others, the five votes chosen for in-depth analysis (FY1989, FY1990, FY1993, FY1994, and FY1996) had the greatest number of significant variables.

Logit outputs pose some difficulty for clear, accurate interpretation, and a method was used in this study that allows logit to predict the probability that a given congressman will vote "yes" on aid legislation. Four cases that were particularly typical of the liberal Democrat, conservative Republican, moderate Democrat, and moderate Republican, were selected from the data set (chosen specifically for their "typicalness"), and probabilities for yes votes were determined for the five votes with the most significant variables (one vote from each Congress represented in the study). To achieve a basis for comparison across the five Congresses, the values for the same four model members were used to analyze a vote from each Congress.

BIVARIATE ANALYSIS

Crosstabulation and t-test methods were used to obtain an overall picture of the relationships between party and vote, ideology (in five categories) and vote, and region and vote. Although space considerations prevent detailed discussion and presentation of the data here, the general conclusions are worthy of note. The crosstabulations of ADA score and vote seem to suggest a pattern of ideological voting behavior on foreign aid appropriations bills from FY1989-FY1995. Although foreign aid was almost always supported by a majority of members from all locations on the ideological spectrum, ideology served as a reasonably accurate predictor of voting on aid appropriation. In each vote from FY1989-FY1995, the most conservative members were most likely to vote no in significant numbers, while liberals consistently voted most strongly for foreign aid. The measures of association for these years reflect the fact that higher ADA scores (indicating greater liberalism) are a good predictor of vote on foreign aid--when the relationship is examined without regard to other possible influences. Since the crosstabulation method used ADA score value categories (ordinal level) and therefore provided less accuracy than is desirable, t-tests were also performed on members' ADA scores at the ratio level. The t-tests allowed the bivariate relationship between ideology and vote to be explored further. Overall, the results of the t-tests confirmed the pattern of ideological voting suggested by the crosstabs. Members voting against aid were more conservative than members who voted for aid--at least through the FY1995 vote. (As a side note, crosstabulation between ideology and *party* yielded a very strong correlation between the two independent variables--Cramer's V was .71 ($p < .001$) for the aggregate correlation.)

When party is crosstabulated as an independent variable with individual votes as dependent variables, a pattern similar to that of ideology emerges, although the party tables contain weaker associations. On the bills from FY1989 through FY1995 (with the possible exception of FY1990), Democratic affiliation was a weak to moderate predictor of vote. Members with GOP affiliation were more likely than Democrats to vote no, approximately 30% of the Republican party consistently voted against aid appropriations. The pattern completely reversed for FY1996, contradicting the original hypothesis, as discussed above. And, as was the case with the ideology crosstabs, no pattern or relationship between party and vote emerged in the FY1997 vote. Similarly, in the region crosstabs, the apparent voting pattern is relatively clear up to the FY1997 vote. Members from the northeastern states voted consistently for foreign aid appropriations, with only a handful of defectors for each vote. In the midwest, at least three-quarters of members generally favored foreign aid, in fact, the percentage of midwestern members voting against the appropriation bill was usually similar to the percentage of House members in opposition. Western members voted similarly to the whole House in some years, but on several votes--notably FY1994-FY1997--westerners posed greater opposition to aid appropriations. Southerners, while generally providing a majority of their votes for foreign aid, did display a strong and consistent opposition to aid appropriations through FY1996. The regional pattern vanished for the FY1997 appropriation, in which over 80% of representatives from each region supported aid, suggesting that region no longer served as even a weak predictor of how members vote on foreign aid.

Overall, region seems to be functioning as a surrogate for ideological and party differences, as the logit discussion will demonstrate.

LOGIT REGRESSION ANALYSIS

The results of the logit analysis described in the Methods section, while simplified, are perhaps the most clear of the bivariate and multivariate analysis. The very liberal Democrat member showed an extremely high probability of voting yes on foreign aid in all five years, the probability of supporting aid never fell below .97 for the most liberal Democrat. In addition, the voting trend for the liberal member is quite consistent across the five Congresses. The results for the very conservative Republican case are nearly as consistent and conclusive. The conservative's probability of voting for foreign aid hovered around .25 for the five votes, although the probability increased somewhat to .35 for the FY1996 vote. This shift is in accord with the trends observed in the bivariate data for more conservatives to vote for the reconfigured aid appropriation.

Table 1. Probabilities of Yes Votes on Foreign Aid Appropriations
(Based on Logit Regression Analysis)

Member Type	Congress 100th	101st	102d	103d	104th
Liberal Democrat	.99	.99	.99	.97	98
Moderate Democrat	.81	.82	.76	.37	.79
Moderate Republican	.60	95	.66	.69	61
Conserv. Republican	.26	26	.19	.22	35

The moderate Democrat case produced a less consistent pattern of voting, but one that nonetheless strongly suggests a trend for ideologically middle-of-the-road Democrats. Probabilities for the moderate Democrat archetype were around .80 for the FY1989, FY1990, FY1993, and FY1996 votes. Surprisingly, one of the five years shows a notable inconsistency with this pattern--the moderate Democrat had only a .37 probability of voting yes on the FY1994 appropriation, although the probability returned to the .79 level for the FY1996 vote.

The pattern for the moderate Republican archetype displayed a similarly unusual inconsistency in one vote. Overall, the moderate Republican demonstrated about a .60 probability of a yes vote, but in the FY1990 vote, the same congressman had a .95 probability of favoring aid. It seems unusual that moderate Republicans should, for just one vote, exceed the moderate Democrats and approach the liberal Democrats in their likelihood to support aid appropriations.

Despite the two inconsistencies, a pattern that supports the initial hypothesis of this study emerges from the representative case analysis. Liberal Democrats showed very strong support for aid, while conservative Republicans were notable for their low support. The moderates appear to have been influenced by their partisan affiliations--Democrat moderates showed higher levels of support than Republicans of similar ideological persuasion. Explanations for the inconsistency in the trend among moderates may lie in the international situation surrounding the anomalous votes. 1989, when the FY1990 vote was taken, was a heady year for America in the international arena as the Iron Curtain began to show signs of serious weakness. The usually more skeptical Republicans may have been persuaded by the international atmosphere of 1989 to vote for aid. The drop in moderate Democratic support in 1993 is much less easily explained. In fact, one might expect the moderate Democrats to *increase* in likelihood of support in 1993, the first year in the study in which a Democrat held the White House. The puzzling discrepancies should not detract, however, from the overall picture of voting behavior provided by the representative case analysis, especially among the most liberal and most conservative House members.

CONCLUSIONS

The central hypothesis of this study was that ideology and party are the most powerful predictors of House foreign aid voting. The hypothesis posited that more liberal, Democratic members are more likely to vote for aid than their conservative, Republican counterparts. In addition, the central premise included the supposition that House foreign aid voting has become more ideological and partisan since 1989--especially since the 1994 Republican "revolution" in the House. The bivariate and logit roll-call analysis of the nine votes has provided broad support for the assumption that ideology and party are important influences on voting behavior, however, the data fail to support the assumption that ideology and party are the *primary* factors in aid voting decisions. Clearly, the probabilities derived from the logit outputs do not suggest that ideology explains voting completely, and the logit outputs themselves assign high importance to other variables, including executive support scores and tenure. The analysis also fails to support the notion that the voting has become *increasingly* ideological and partisan. In fact, the bivariate analysis in particular suggests that the trend in voting behavior from FY1989 through FY1995 underwent significant (but unclear) changes in the FY1996 and FY1997 votes. It seems logical that conservatives would become more likely to vote for aid in FY1996 and FY1997 because, as was mentioned in the Introduction, the Republicans in Congress revised aid priorities and cutback overall appropriations to suit more conservative views on foreign affairs.

The "representative cases" analysis of the logit model provides the most concise and conclusive interpretation of member's voting decisions. The effect of ideology and party presents itself *only when the analysis considers all of the other factors usually associated with members of a particular ideological and partisan persuasion.* When four members who represent the typical conservative Republican, moderate Republican, moderate Democrat, and liberal Democrat are studied across the five Congresses, the probabilities that each will vote for aid appropriations corresponds quite well to the initial hypothesis that liberal Democrats are more likely to vote for aid than conservative Republicans. This study, then, failed to demonstrate that members vote unidimensionally on foreign aid; it also did not reveal a multidimensional model of voting in which ideology and party are the clearly predominant factors. Instead, the data suggest that members do vote roughly along ideological and party lines when the other factors--especially executive support, tenure, and constituency characteristics--are set at values that are common to members of their ideological and partisan persuasion.

The conclusions of this study fit neatly into the existing body of research. Although the results suggest an important role for ideology, they cannot be construed to coincide with Schneider's findings that ideology is the only salient influence on foreign affairs voting. Rather, they fit into the multidimensionalist and policy-specific paradigms by finding that a variety of influences, including party and ideology, influence voting behavior on foreign aid appropriations in the House of Representatives.

REFERENCES

Arnold, R. Douglas. 1990. *The Logic of Congressional Action.* New Haven, CT.: Yale University Press.

Clausen, Aage R. 1973. *How Congressmen Decide: A Policy Focus.* New York: St. Martin's Press.

Cox, Gary W. and Mathew D. McCubbins. 1991. On the Decline of Party Voting in Congress. *Legislative Studies Quarterly,* 16:547-569.

-----. 1979. Self-Interest, Ideology, and Logrolling in Congressional Voting. *Journal of Law and Economics,* 22:365-384.

Kingdon, John W. 1989. *Congressmen's Voting Decisions,* 3rd ed. Ann Arbor, MI: The University of Michigan Press.

Kozak, David C. 1984. *Contexts of Congressional Decision Behavior.* Lanham, MD: University Press of America.

Kritzer, Herbert M. 1978. Ideology and American Political Elites. *Public Opinion Quarterly,* 42:484-502.

McCormick, James M. and Wittkopf, Eugene R. 1992. At The Water's Edge: the Effects of Party, Ideology, and Issues on Congressional Foreign Policy Voting, 1947 to 1988. *American Politics Quarterly*, 20: 26-53.

Nowels, Larry. 1996. *Foreign Aid Budget and Policy Issues for the 104th Congress.* CRS Report for Congress. 8 May 1996.

Schneider, Jerrold E. 1979. *Ideological Coalitions in Congress.* Westport, CT: Greenwood Press.

Schroedel, Jean Reith. 1986. Campaign Contributions and Legislative Outcomes. *Western Political Quarterly*, 39:371-389.

Shaffer, William R. 1980. *Party and Ideology in the U.S. Congress.* Lanham, MD: University Press of America.

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A Quantitative Study of the Essence of Federalism: Who Does it Benefit:

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This research examines whether there is a relation between federal funding and its residual effects on state institutions, programs, and their spending practices. Additionally, this study seeks to determine if the amount of federal funds to individual States is driven by modern federalism. The data collected for this study provides information regarding the issues of federal funding and its impact on federalism. The empirical findings from this research suggest a significant correlation between federal funding to States and modern federalism.

INTRODUCTION

Federalism has grown into a controversial issue among politically active Americans. Traditionally, conservatives advocate big business and are against federal regulation. Conservatives refute national policies that focus on labor and consumer issues. If it were politically feasible, conservatives would prefer funding without the restraints of regulation. Contrarily, liberals advocate national policy and are against regulations that cater to big business issues. Ideally, liberals' views reflect a society where power is balanced between the states and the federal government. Elaborately, neutral positions are concerned with "(1) decentralized federal field offices; (2) interstate compacts and commissions; (3) rule-making at the federal level, but enforcement at the state level; (4) federal regulation of new facilities, but state regulation for old facilities; and (5) federal policy for air pollution, but state policy for water pollution" (Nagel 1996:499). Subsequently, American ideologies determine their political affiliations.

New Federalism has allowed states to escalate to a "substantial equivalency status" having similar legal authority as many federal agencies to investigate and conciliate complaints, and enforce laws in a federal capacity at the state level. Ultimately, federalism's opponents fear that policy goals are more vulnerable to subversion by state regulated agencies. In other words, opponents fear that shifting enforcement responsibility is the first step of many to irradicate public policies by chipping away at the exterior so that it provides a loop hole to annihilate the core or essence of many public policies. Shifting responsibility may be a clever "political smoke screen" to pursue a more poignant objective (Nagel 1996:506)

Since previous studies on modern federalism (e.g., Hornbostel 1973, Nelson 1982, Barro 1983, Fisher 1987, Dumenil 1990, and McDowell 1995) focused exclusively on the merits of the policy, the main objective of this study is to determine if the flow of federal funds to the states has caused an increase in the number of state employees. In essence this study seeks to examine whether there is a relationship between federal funding and its residual effects on state institutions and programs and their spending practices. This objective is important because the correlation may reflect a bias in the allocation of funds. Clearly, the allocation of federal funds has a direct impact on the diversity and sophistication of technology that is available to states. Therefore, states that receive the most funding are likely to be more prosperous.

In determining the nature of allocation of federal funds to states, two main questions need to be answered: (1) Is there a correlation between funds allocated by the federal government and the number of state employees? (2) If so, do the data infer an increase in the number of state employees?

RESEARCH METHODOLOGY

Using a quantitative methodological approach, the following theoretical framework is designed to graphically identify the two main factors that were independently and dependently manipulated for this research. Scientifically, the independent variable, the flow of federal funding, is the basis for measuring how the dependent variable, the increase in the number of state employees, affects or influences the increase of the number of state employees. Thus, the theoretical framework is represented accordingly:

The Flow of Federal Funding to States		Increase of State Employees
(Independent Variable)	→	(Dependent Variable)

Basically, the assumption is that there is a relationship between an increase of state employees and the amount of federal funding to states. Consequently, the Hypothesis for this study is H_1: If the flow of federal funds to states increases, then the hiring of state employees will increase.

The Simple-Time Series design is the most appropriate design for this study. Diagrammatically, the X represents the flow of federal funds to states; O represents the observation of the number of state employees. This particular design is used to determine whether the distribution of federal funds is responsible for an increase in the number of state employees over time. Subsequently, this design provides the researcher with the necessary basis to adequately collect and analyze the necessary data.

$$X \; O_{1981} \ldots O_{1994}$$

In an effort to accurately conduct this research on a macro level of the entire United States, the convenient sample appeared to be the most feasible means of representation since the data were available. The data were collected from the Census Bureau. The data collection technique chosen was document analysis. The bases for choosing this method included convenience, availability, and feasibility.

DATA ANALYSIS

The data collected were analyzed in two stages: the univariate and bivariate. The statistical package used to conduct this analysis is GB-STAT. Two types of statistics are used for analyzing the data at the univariate stage: the mean and the standard deviation. The results generated form the computer runs for these statistics are presented in Table 1.

TABLE 1: Mean and Standard Deviation of Variables

Variable	Mean	Sample Standard Deviation	Sample Variance	Coefficient of Variation
STAT	1.41	941922.70	8.87	.06
FEDR	125398.70	23172.87	5.36	.18

where:

STAT = number of State employees
FEDR = amount of federal funding to States

Table 1 shows that the average number employees hired per year by the States between 1981 and 1994 is 1.4 billion; the standard deviation from year to year is 941,923. Thus, the variance over time for this variable is not statistically significant at the .05 level. The average amount of federal funding for the states from 1981 to 1994 is $125 million; the standard deviation from year to year is $23 million. Also, the variance for this variable over time is not statistically significant at the .05 level. Subsequently, the sample variance reveals degrees of freedom that measure about 9 for state employees and 5 for federal funding.

Simple correlation and simple regression procedures were used to analyze the data for the bivariate level. Correlation measures the strength of the relationship between the independent variable (federal funding) and dependent variable (increase of state employees); regression measures the direction or the nature of the relationship between the variables. The results generated for these techniques after the computer runs are summarized in Tables 2 and 3.

TABLE 2: Correlation Matrix

	FEDR
STAT	.99052**
**P<.01	*p<.05

From Table 2, It can be seen that STAT significantly correlates with FEDR at the .01 level with a correlation coefficient of .99. Therefore, there is a positive and statistically significant correlation between the number of State employees and federal funding allocated to states between 1981 and 1994.

TABLE 3: Current Regression Summary Table

Dependent Variable = STAT
Standard Deviation Error Estimate = 135695.3
F = 520.0219
(ALPHA) Constant 9138860

Independent Variable	B-Coefficient	Standard Deviation Error (B)	T-Value	Probability
FEDR	40.26238	1.765585	22.80399	<.001

Table 3 shows that the independent and dependent variables have a statistically significant relationship at the .01 level (T-Value = 22.80). Thus, the hypothesis tested in this study, H_1: If the flow of federal funds to states increases, then the hiring of state employees will increase, is accepted.

CONCLUSION

The accepted hypothesis that federal funding allocated for states increases the number of state employees indicates that federal funding has consistently, from 1981 to 1994, helped to place otherwise unemployed citizens in jobs created by states. Although this research reveals a statistically significant relationship, federal funding may not be the sole source for an increase in the number of state employees. Therefore, other researchers may consider exploring other significant variables. A potential researcher might consider examining state hiring practices, various training and follow-up programs, marketing procedures, or other techniques used in state hiring procedures.

On the surface, federal funding and the increase of modern federalism appears harmless; yet, after examining the underlying issues of some social policies it is apparent that politicians at the state level have the propensity to abuse or cloud the initial purpose of federally implemented policies and regulations. Additionally, major political actors have the propensity to inadvertently change the goals of original laws by shifting enforcement responsibilities. Theoretically, shifting responsibilities may perpetuate shifting federal aid from places (state institutions) to people (state leaders).

Since the signing of the Declaration of Independence and the subsequent indoctrination of the Constitution of the United States, there has been an ongoing tug of war for sovereignty between the federal government and states. Conversely, States have fought to obtain an independent existence, yet they have fought to increase government funding for state institutions. Basically, states have criticized the federal government for encroaching their independent and economic growth. Nevertheless, states have also complained that the government funding they do receive is not enough to make a notable difference. Realistically, perfect relationships do not exist. Obviously, the national and state interdependent relationship is not the exception to the rule. Perhaps, federalism presupposes a harmonious relationship properly channeled through the roots of reciprocity.

Clearly, the systems analysis framework is lacking an equally divisive tool to further examine the concrete subsystems. Thus, concrete analyses would provide political scientists with an in-depth examination of the often overlooked subsystems. Perhaps, a closer examination of subsystems would provide a strong preliminary foundation and formative analysis to further examine modern federalism.

REFERENCES

Barro, Stephen M. "Federalism, Equity and the Distribution of Federal Education Grants." RIE November 1993:

Dumenil, Lynne. "The Insatiable Mean of Bureaucracy: Antistatism and Education Reform in the 1920's." *Journal of American History*. May 1991: 499-524

Fisher, Margaret. "Federal State Relations: 55 MPH Speed Limit." January 1988:41-44

Hornbostel, Victor O. " Viable Federalism in School Finance A Local, State, Federal Policy." 1 October 1973

McDowell, Bruce D. The New Federalism: Current Trend in Intergovernmental Relations." July 1996

Nagel, Stuart. "Political Policy Controversies." *Policy Evaluation*. December 1996:14

Nelson, Orville. "How the New Federalism Strikes Home." December 1982:40-41

The Concepts of Community and Individualism in Twentieth-Century Presidential Nomination Acceptance Speeches and Inaugural Addresses

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Beginning in the early 20th century, the institution of the American presidency underwent a fundamental reinterpretation by the both the occupants of the office and the American public. Since that reinterpretation, public expectations of the president's role in government have been raised; and electronic communication has become a means by which presidents communicate directly with the public in attempting to fulfill those roles. Recent scholarly research has examined these changes in the presidency and the increased importance of presidential speech in American politics. This thesis, however, specifically examines the use of the concepts of community and individualism by presidents and candidates in their nomination acceptance speeches and inaugural addresses between 1904 and 1997. This thesis argues that the concepts of community and individualism as they appear in the liberal and republican traditions of early American political thought also appear in the rhetoric of presidents and candidates during the twentieth-century as they define the "public good" on the ceremonial occasions of their nomination acceptances and inaugurations.

THE INSTITUTION OF THE PRESIDENCY AND PRESIDENTIAL RHETORIC

While the United States Constitution requires only one communication from the President each year, the evolution of the office of the presidency, especially in the latter half of the twentieth century, has been such that presidential rhetoric is now not only frequent but central to the duties of the executive office. In fact, once reserved for special occasions or crises, presidential speechmaking increased by almost 500% between 1945 and 1975 (Zernicke, 1994).

Accompanying, or perhaps stemming from, this increase in presidential speechmaking during the twentieth-century has been a re-conceptualization of the institution of the presidency in which rhetoric figures prominently. Since Richard Neustadt argued in 1960 that presidential power is the power to persuade his various constituencies, many political scientists have explored the relationship of rhetoric to the presidency. The subject of the first chapter of the thesis, therefore, is a brief review of some components of this re-conceptualization. Jeffrey Tulis argues in *The Rhetorical Presidency* that the modern presidency draws authority from two "constitutions," the original Constitution and a new "constitution" comprising, in Tulis words, "contemporary presidential and public understanding of the constitutional system and the president's place in it" (Tulis, 1987). Paul Zernicke, drawing on the work of Clinton Rossiter, similarly argues that a changing understanding of the presidency has resulted in increased importance of presidential rhetoric, for the roles a modern president is expected to play are so numerous and the obstacles he encounters so great that speaking to the public is all a president can do to build support for the ideas that will allow him to fulfill those roles (Zernicke, 1994). Finally, Mary Stuckey offers the advent of television and its increasing importance in American society as another explanation for the frequency of modern presidential rhetoric (Stuckey, 1991). The work of some scholars on rhetorical techniques used by presidents and on different genres of presidential speech is also reviewed.

A THEORETICAL FRAMEWORK

Michael Kammen argues in *People of Paradox: An Inquiry into the Origins of American Civilization* that "the push-pull of both wanting to belong and seeking to be free has been the ambivalent condition of life in America, the nurture of a contrapuntal civilization" (Kammen, 1973). In fact, according to Daniel T. Rodgers, government itself in America is based on competing notions of individualism and community as expressed in the two world views of liberalism and republicanism. For liberalism is that individualistic, Lockean frame that sees the world in the private terms of the private self, private property, and a wealth of private accumulation held together by the competitive market. Republicanism, on the other hand, is that frame that sees the world in the public terms of the public good, a distrust of the market, self-restraint, and a commitment to "the commonweal of men called 'virtue'" (Rodgers, 1987).

The second chapter of the thesis comprises a synthesis of Kammen's and others' theories of community and individualism in America with the late-eighteenth and early-nineteenth-century philosophies of liberalism and republicanism into a theoretical framework useful in understanding the speeches studied in the third, and final, chapter. Nomination acceptance speeches and inaugurals addresses are different genres of presidential speech with important similarities, for they are set apart from other genres in that they are ceremonial speeches. Acceptance speeches, as Ritter writes, are "merely a ceremony of acceptance that occurs after the serious work of the convention has concluded," and as Jamieson and Campbell note, inaugural addresses are a ceremony accompanying presidential investiture (Ritter, 1980; Campbell and Jamieson, 1990). Being epideictic, or ceremonial speeches, acceptance speeches and inaugural addresses are a form of rhetoric that praises or blames, invites the audience to evaluate the speaker's performance, recalls the past and speculates about the future. Presidents and candidates achieve these ends in ceremonial addresses by offering for contemplation to their audience a philosophy of government and society, relating to the present both evaluations of the past and visions of the future, and praising the institution of the presidency and the values and form of government of which it is a part (Campbell and Jamieson, 1990). As Ritter suggests, moreover, these speeches function as political jeremiads, for through them presidents and candidates warn the American public that they have deviated from the fundamental principles undergirding the "America dream" and that a return to the national values on which the country was founded is needed to ensure the future security and prosperity of the country. "National values," often defined in terms of community and individualism, are the answer to that question of how to define the "public good" that has so often been answered in ceremonial addresses.

Furthermore, these "national values" reflect what Kammen describes as the biformity in American culture, a conjunction of two concepts without losing the meaning of either concept, encompassing the competing republican and liberal philosophies of the late-eighteenth and early-nineteenth-centuries. It is this biformity that informs presidential use of the concepts of community and individualism in the speeches studied. In fact, the Jeffersonian synthesis of the liberal principles of self-reliance, the cultivation of self-discipline, and cooperation with the republican notions of duty and virtue is an early instance of this biformity in American political thought; and the notions of affective individualism and self-less virtue resulting from this synthesis appear in the nomination acceptance speeches and inaugural addresses of twentieth century presidents and candidates for the presidency.

The language of the speeches examined in this thesis thus contains conceptions of community in what Michael Sandel has called the instrumental, sentimental, and constitutive senses as these conceptions appeared in American culture in the ideas of the liberal tradition in the case of the first two conceptions and the ideas of the republican tradition in the case of the third (Sandel, 1982). Speakers using language indicative of the instrumental or sentimental conceptions assume that the public good arises, as Jefferson stated, from "each individual seeking his own good in his own way" (Curry, 1991). But the sentimental conception differs from the instrumental conception in its view of what comprises that individual good, for the sentimental conception views cooperation as an end in itself while the instrumental conception views such cooperation only as a means to private ends. Both conceptions, however, view self-interest to be the glue holding together communities.

The constitutive conception, however, is not absent from the rhetoric of presidents and candidates on these ceremonial occasions although it does appear far less often than the instrumental and sentimental conceptions. That is, presidents and candidates sometimes depart from their emphasis on the pursuit of individual self-interest to admonish their listeners not to forget the republican virtues of duty, sacrifice, and "love of country." Thus alongside liberal notions of community as the sum of individual pursuit of self-interest there survives in ceremonial rhetoric the republican notion "that what made republics great or ultimately destroyed them was not force of arms, but the character and the spirit of the people" (Shalhope, 1972). In the constitutive conception, men are conceived to be not only egoistic beings but social beings who will pursue ends for the community even if self-interest must be sacrificed in so doing.

CONCLUSION

Having so developed a framework with which to examine the speeches, what conclusions can be drawn from this study of ceremonial rhetoric? The "public good" has largely been defined during the twentieth century in terms of the instrumental and sentimental conceptions of community indicative of the influence of the liberal tradition developed during the latter part of the eighteenth-century. Of the men included in the text of the thesis, fourteen of eighteen exhibit instrumental and sentimental language; these men argue that the interests of the individual are the basis of the national community. Yet the constitutive conception, that conception of community conceiving community to be a part of human nature, appears in the speeches of three men.

One might want to explain this emphasis on the individual in presidential speech as a result of the ascendancy of liberalism over republicanism in the early part of the nineteenth-century; however, a better explanation for this apparent predominance of individualism may be that at least on the two ceremonial occasions considered in this study, the speeches of the presidents examined in this thesis suggest the prevalence of that biformity encompassing both the liberal and republican traditions identified by Kammen. In fact, the appearance of the instrumental, sentimental, and constitutive conceptions of community evidenced by the speeches suggests that Ralph Barton Perry was correct in asserting that "American self-reliance is a plural, collective, self-reliance -- not 'I can' but 'we can'."

Presidents and candidates whose speeches contain appearances of the instrumental and the sentimental conceptions of community speak the language of the individual, and their speeches are replete with references to opportunity and responsibility. When Roosevelt and Reagan, for example, argue that opportunity must be secured for individual Americans, they call on the responsibility of government and voluntary associations respectively. Other speeches contain similar entreaties to collective self-reliance; only through the help of others can the individual reach fulfill his potential in these conceptions.

Appeals, of course, are made to the collective spirit in the few speeches in which appear constitutive conceptions of community as well. Although the language of these speeches includes calls to the "virtuous citizen" of republicanism, it is nevertheless a language similar in some ways to that of the other conceptions. The calls to service by Harding, Stevenson, and Kennedy parallel the calls to responsibility made by Roosevelt, Reagan, and others; and "cooperation" is, in fact, a word used in the language of all three conceptions. In the American biformity, the two major traditions of political thought from the founding era, liberalism and republicanism, are conjoined.

This thesis concludes, therefore, that despite the changes that presidential speechmaking has undergone in the past century, one constant has been the appearance and use of the concepts of community and individualism in the ceremonial rhetoric occasioning nomination acceptances and inaugurations. For as the situation of America has changed from election to election and president to president, the liberal and republican traditions that are the foundation of the American political system endure in the speeches. Whether in time of economic depression, prosperity, peace, or, war, those who hold and those who seek the office of the presidency reach for the familiar instrumental, sentimental, and constitutive conceptions of community when they address the nation. They implore their audiences to recall the past, evaluate the present, and look to the future; and they do this not with the incessant "I can" so typically heard in twentieth-century, but "we can."

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REFERENCES

Campbell, Karlyn Kohrs and Jamieson, Kathleen Hall. Deeds Done in Words: Presidential Rhetoric and the Genres of Governance. Chicago: University of Chicago Press, 1990.

Curry, Richard O. American Chameleon: Individualism in Transnational Context. Kent, OH: Kent State University Press, 1991.

Kammen. People of Paradox: An Inquiry into the Origins of American Civilization. New York: Alfred A. Knopf, 1973.

Ritter, Kurt W. "American Political Rhetoric and the Jeremiadic Tradition: Presidential Nomination Acceptance Addresses, 1960-1976," Central States Journal, Vol. 31 (Fall, 1980), pp. 153-171.

Rodgers, Daniel T. Contested Truths: Key Words in American Politics Since Independence. New York: Basic Books, 1987.

Sandel, Michael. Liberalism and the Limits of Justice. Cambridge: Cambridge University Press, 1982.

Shalhope, Robert E. "Toward a Republican Synthesis: The Emergence of an Understanding of Republicanism in American Historiography," William and Mary Quarterly, 29 (Jan. 1972), pp. 49-80.

Stuckey. The President as Interpreter-in-Chief. Chatam, NJ: Chatam House Publishers, 1991.

Tulis, Jeffrey K. The Rhetorical Presidency. Princeton, NJ: Princeton University Press, 1987.

Zernicke, Paul Haskell. Pitching the Presidency. Westport, CT: Praeger Publishers, 1994.

A Comparative Study of the Levels of Political Socialization of Children in Two New Hampshire Towns.

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Political socialization is the process by which children become aware of politically relevant attitudes and behaviors. Without this socialization, any given political system would continuously become obsolete and be replaced by a new system with each new generation of citizens. In order to prevent the collapse of the political system, every system must offer its young members ways in which to identify with and form an allegiance to the system.

BACKGROUND

The importance of the process of political socialization becomes evident when we note that many political issues involve rules about the exercise of authority. One assumption of political socialization theory is that people tend to seek congruence between their own personal authority experience and their relationship to broader political authority. (Weissberg, 1974) A child's experience with authorities (parents, police, and court officials) has an impact on their political attitudes, especially in different social classes. Negative experience with minor authority figures could lead to a negative attitude towards broader political authority (the government) in adulthood. With maturity and increased political sophistication, new information and experiences modify, but do not replace earlier socialization. (Weissberg, 1974) Since the regime is a fundamental element in all political systems, it is of value to learn if members of society continue through generations to offer sufficient support to the structure of political authority. (Easton and Dennis, 1969) Without a structure of political authority, no political system could endure for long. Every political system is subject to various kinds of stress that threaten to prevent a society from continuing to allocate values authoritatively. Socialization is interpreted as one kind of response through which political systems may be able to ward off certain kinds of stress on the structure of political authority.

Numerous studies in the field of political socialization were conducted from the late 1950s to the early 1970s. Overwhelming evidence points to the fact that children from a very young age have developed ideas about the government and political system. Children can pick up informal political learning subconsciously, it appears, from socialization agents like school, parents, friends, television, media, as well as participation in associations which teach civic responsibility.

In their 1961 study on children, Easton and Dennis outlined four factors through which the child comes to an understanding of membership in the political system. These factors are politicization, personalization, idealization and institutionalization. By measuring responses to questions surrounding these factors, one can discern stages of development in the socialization process, through the measurement of diffuse support, benevolence towards leaders, and awareness of the differences between the public and private spheres.

DATA AND METHODS

Subjects

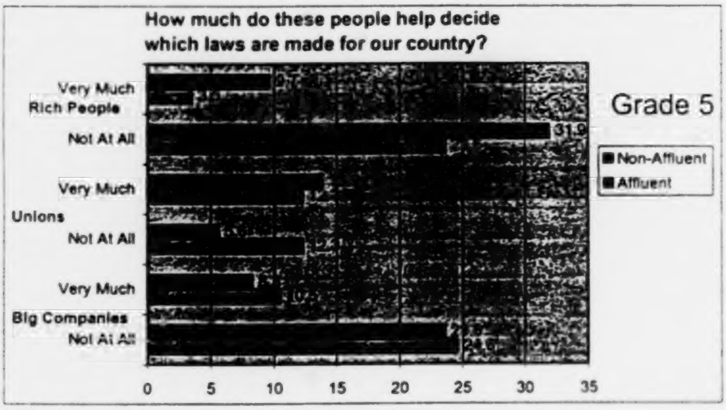
The purpose of the study was to determine if American children today are being trained for future citizenship in a manner, which provides for the continuance of our system of government. Specifically, do children from affluent and non-affluent communities receive the same training for citizenship? Do they possess the same sentiments towards authority figures? The study examined variations in political socialization between younger and older children in an affluent and a non-affluent community. The communities were chosen based on data provided by the New Hampshire Department of Resources and Economic Development. Communities were chosen based on school district size, median income levels, the number of single parent households, and in the case of the non-affluent community, the number of children living below the poverty line. Because researchers agree that the truly formative years of the maturing member of a political system would be the years between three and thirteen, children from three different age groups were surveyed. Three hundred seventy students participated in this study; one hundred ninety two students from an affluent community and one hundred seventy eight students from a non-affluent community.

Design and Procedure

Paper and pencil surveys were administered to children in the second, fifth and eighth grades between May and December, 1996 (the grades being adjusted to third, sixth and ninth grades for the fall term.) Questions from previously administered surveys were used. (see Easton and Dennis) The survey was read aloud to the youngest group by myself, while the older groups worked alone with any questions being answered by an administrator, either a teacher or myself.

RESULTS

Students from the affluent community displayed a greater awareness of political actors and a more realistic view of government. This was evident in their responses to questions measuring benevolence, cognitive development, knowledge and dependability ratings of authority figures. Children from the non-affluent community were less politically mature. However, non-affluent students scored the same for better than affluent students on questions pertaining to general knowledge (Who is the governor of NH?). But, they scored significantly lower than their same age mates on questions pertaining to the roles of political actors (How much do these people help decide which laws are made for our country?). The results suggest that for the affluent students, advantages in these areas are likely to lead to greater efficacy and participation in adulthood.



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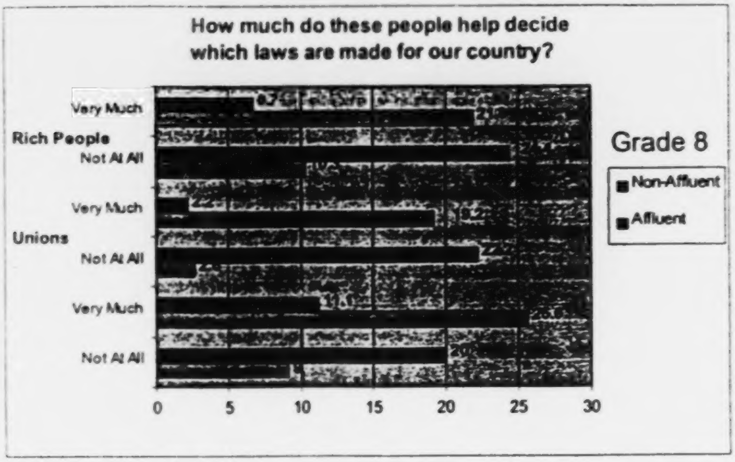
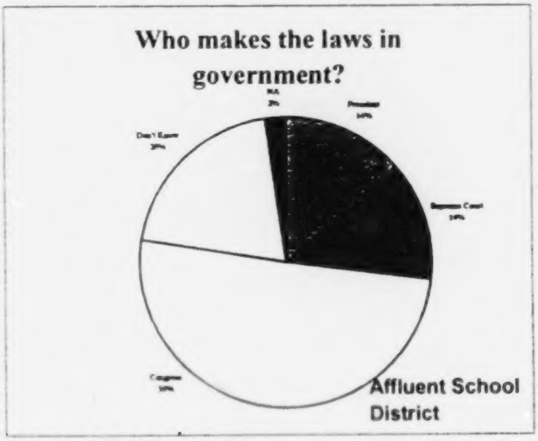


Results also suggest that affluent children are more willing to participate in the political process. On questions pertaining to knowledge (Who makes the laws in government?) non-affluent children were likely to pick "I don't know" or not answer when uncertain, while affluent children were more likely to choose a person or institution. It appears that affluent children feel more comfortable and "knowledgeable" (even if they're not) in the discussion of politics.



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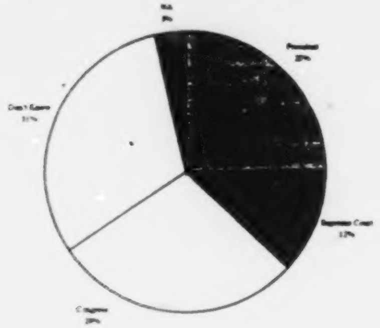
Who makes the laws in government?



Non-Affluent School District

The study did not pinpoint particular social agents as having a specific impact on children in each community, rather differences in social circumstances between the two communities. It is likely that the disparities in education curriculum, levels of parental participation in the political process, extracurricular activities and media exposure all impact the child's socialization to the political arena. These factors taken together suggest that in terms of citizenship, the disparities between affluent and non-affluent children are likely to persist into adulthood.

REFERENCES

Easton, David and Jack Dennis. Children in the Political System. New York: Mc-Graw Hill Co., 1969

Weissberg, Robert. Political Learning, Political Choice, and Democratic Citizenship. New Jersey: Prentice-Hall, 1974.

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A Qualitative Study of Minority-Majority African-American Congressional Districts and African-American Representation in Congress

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This study provides a systematic analysis of the recent redistricting of a majority of the African-American electoral districts in the South and the efficacy of minority representation in the United States Congress. Using a qualitative/simple case study, the non-numerical data collected for this study cover the socio-economic status of the recent redistricted minority-majority African-American congressional districts and the African-American representatives of those districts. The Correspondence Theory of Representation is used as a guide to test the efficacy of each district and its representative. The substantive findings derived from the data analysis suggest that the major propositions examined could not be definitively determined in this study.

INTRODUCTION

The history of redistricting in twentieth century America is well known, and the frequently used practice of redistricting is gerrymandering. Gerrymandering is the manipulation of districts lines for political advantage. Racial Gerrymandering is the manipulation of district lines to enhance or reduce the representation of particular racial groups. The increases in African-American representation in Congress have resulted from racial gerrymandering, the Voting Rights Act of 1965, and the decision of the Supreme Court to enter the political thicket of redistricting. The reasoning for drawing congressional districts to ensure the descriptive representation of African-Americans (minority-majority districts) is openness to African-Americans, and the ability of African-Americans to elect the representatives of their choice who will best address their concerns. Today, changes in redistricting and African-American representation have been very much a function of key court decisions (see for example, Congressional Quarterly Weekly Report, vol.53, no.26, 1996:1944-9).

Thus, employing the Correspondence Theory of Representation as a guide, this study seeks to provide a systematic analysis of the recent redistricting of a majority of the African-American electoral districts in the South and the efficacy of minority representation in the United States Congress. The significance of this study hinges on the fact that pertinent works on the subject are case studies that focus on the threat that redistricting has on minority representation and the constitutionality of racial gerrymanders (Erenhalt 1983, Cohodas 1994, O'Connor and Souter 1994, Raskin 1995, Gruewald 1995, Tabin 1995, Idelson 1995, and Berstein 1996). These studies are greatly opinionated and atheoretical.

THEORETICAL FRAMEWORK

The theory that guides this study is the Correspondence Theory of Representation. This theory emerged in response to the questioning of effective representation. The problem is that even though a representative is able to act as a voice of his/her constituency, he/she could be accused of being unrepresentative on other grounds. This is because most representatives do not share the same social or cultural background of their districts. For instance, most representatives are middle- or upper-class professionals, lawyers, majority male, older than members of their constituencies, and well educated. The best particular phrase that represents the legislature of the United States is "White Anglo-Saxon Protestants" (WASPS) (Bangura 1996:43).

In addition, there are five types of representation that reflect interactions among the central state organs, lower government agencies, and social groups, and they are as follows: Monopolistic, Centralized, Coordinated, Specialized, and Comprehensive. Monopolistic representation refers to the case of a powerful representative who monopolizes the decision-making process, denying lower government agencies and social groups the right to make policies (Bangura 1996:45). Centralized representation exist when representatives in the national government gain dominance over representatives of local political units, such as village assemblies, town council, municipal governments, and provincial administrators (Bangura 1996:45). Coordinated representation refers to a situation where representatives of a single agency formally orchestrate the functional activities of government (Bangura 1996:46). Specialized representation can be found in cases where representatives become both differentiated (specialized) and independent (Bangura 1996:46). Comprehensive representation exists particularly in industrialized societies in which representatives exercise a wide scope of power; that is, they perform a comprehensive variety of activities: system maintenance, construction of an economic infrastructure, and provision of social services to individuals (Bangura 1996:47). This is the type of representation that is performed in these minority-majority congressional districts.

So, the best alternative to answer this problem lies in having a government that corresponds to the characteristics of the state (proportional representation). Since this study examines the United States, let us use it for an example. The United States population is made up of more than just WASPS. It consists of not only males, but also females; not only whites, but also blacks; not only Protestants, but also Catholics and others. The United States is a country of immigrants that represent almost every culture, religion, and race in the world. So, the proposed government in the United States must represent all citizens in proportion to their numbers in the population.

Thus, the formal position taken in this study is that the recent redistricting of minority-majority congressional districts in the South will have an adverse effect on minority representation in Congress. So, the major propositions proffered in this study are the following:

> P1: If all minority-majority congressional districts are considered unconstitutional, then this will have an adverse effect on minority representation in Congress.

P2: If the redistricting of minority-majority congressional districts
increases, then
the democratic stronghold of minority partisanship will dilute.

Given the preceding propositions, the Correspondence Theory of Representation is employed. This is to facilitate a systematic analysis of the available data on gerrymander.

ANALYSIS

After identifying the social makeup of each district that was affected by gerrymandering and the Congressmen/women who represented those districts (see the Congressional Black Caucus of the 104th Congress report of 1995), it became feasible to determine the type of representation which existed in those districts, and to apply the Correspondence Theory of Representation. As stated earlier, there are five types of representation that reflect interactions among the central state organs, lower government agencies, and social groups, and they are as follows: Monopolistic, Centralized, Coordinated, Specialized, and Comprehensive. The one that most characterizes the type of representation in each African-American majority congressional district is Comprehensive representation. This type of representation exists particularly in industrialized societies in which representatives exercise a wide scope of power; that is, they perform a comprehensive variety of activities: system maintenance, construction of an economic infrastructure, and provision of social services to individuals (Bangura 1996:47). It is apparent in each African-American majority congressional district that each congressman/woman performs a comprehensive variety of activities. It is also true that each African-American representative of those districts addresses issues of African-American concern, but their primary concern is that of their constituents. This is shown in their success to effectively address the concerns of their constituents by acting as the voice of those constituents and by securing funds and appropriations to those districts. Their success also refutes the philosophical premise that only minorities benefit from minority-dominant voting districts.

This leads us to the issue of how effective is the Correspondence Theory of Representation in testing these African-American majority congressional districts. It is very effective; however, there are some limitations. To iterate what was stated in the theoretical framework, this theory emerged in response to the fact that even if a representative were able to act as the voice of his/her constituency, she/he could easily be accused of being unrepresentative on other grounds (Bangura 1996:43). This is because most representatives are not at all representative in reflecting the social makeup of their districts, such as class, career, gender, age, education, and ethnicity. For the most part, all of the representatives of African-American majority congressional districts are of middle- or upper-class professionals, who are lawyers and/or former state politicians, much better educated than their constituents, older--with the exception of Cleo Fields, and of African decent. The gender is majority female of the districts that were affected. However, the majority of African-American representatives in Congress are male. A limitation of this theory, therefore, is that there is no method to determine if the representative reflects the social makeup (ethnicity) of the district. For instance, all of the African-American congressional districts were determined to be majority African-American, because of the percentage of African-Americans living in those districts. Finally, it may be true that most representatives are not at all representative in reflecting the social makeup of their districts, but to have a United States legislature that is mostly comprised of white males is not equitable. The reason for this is that a government that corresponds to the characteristics of the general public is a government that could be effective in addressing the concerns and needs of its diverse population.

As stated earlier, the formal position taken in this study is that the recent redistricting of minority-majority congressional districts in the South will have an adverse effect on minority representation in Congress. So, the major propositions suggested can now be assessed.

The first proposition, P1, if all minority-majority congressional districts are considered unconstitutional, then this will have an adverse effect on minority representation in Congress, could not be definitively determined. When the minority-majority African-American congressional districts were considered unconstitutional, they could not be redistricted. The reason for this is that the election process had already taken place in those districts, and redistricting those districts would have violated the legality of the electoral process. As for the second proposition, P2, if the redistricting of minority-majority congressional districts increases, then the democratic stronghold of minority partisanship will dilute, it is apparent that the majority of African-American congressmen and women are democrats. So, if this process of redistricting minority-majority African American congressional districts continues, then the democratic stronghold of minority partisanship will dilute in Congress.

CONCLUSION

As once stated,

> Some time in the past it was necessary to have black faces in Congress to serve as role models for other young people who would aspire to be elected officials, to be at the table so that our voices would be heard, to insure that we were not overlooked. But at some point, we have to question the creation of districts in which the election of a black person is an end with itself. I believe that it is not an end in itself, it's a means to an end, and the end to be accomplished is to win. It takes a majority of the votes, 218, to win in Congress (Swain 1993:212).

Indeed, the purpose of creating minority-majority African-American congressional districts is to win: that is, to obtain the necessary votes to pass appropriate legislation that addresses the concerns and needs of African-Americans and other minorities. Every ethnicity needs to be at the table so that their voices could be heard, and to insure that they are not overlooked. This is why minority-majority African-American congressional districts should not be redistricted.

REFERENCES

Bangura, Abdul K. 1996. Political Behavior. Maryland: University Press of America.

Bernstein, Mark F. 1996. "Racial gerrymandering." Public Interest. (Vol. wntr., No. 122:59-69).

Cohodas, Nadine. 1994. "Electing minorities: Are new methods needed to help minorities get elected?" Congressional Quarterly Researcher. (Vol. 4, No. 30:699).

"Congressional Black Caucus of the 104th Congress." 1995. Washington D.C.: CBC Foundation.

Ehrenhalt, Alan. 1983. "Pulling away from the racial gerrymander." The Civil Rights Quarterly. (Vol. 15, No. 1-2: 33-37).

Gruenwald, Julian. "Court ruling expected to spark more suits (Supreme Court decision in Miller v. Johnson)." Congressional Quarterly Weekly Report. (Vol. 53, No. 26:1947).

Gruenwald, Julian. "Several minority-majority districts still face constitutional challenges." Congressional Quarterly Weekly Report. (Vol. 54, No. 8:456-7).

Idelson, Holly. 1995. "Court pushed closer to setting minority-districts criteria." Congressional Quarterly Weekly Report. (Vol. 53, No. 48:3757).

Idelson, Holly. 1996. "It's back to the drawing board on minority districts." Congressional Quarterly Weekly Report. (Vol. 54, No. 45:3065-7).

O'Connor, Sandra Day and Souter, David H. 1994. "Did North Carolina go too far in drawing congressional districts that favor the election of minority candidates?" CongressionalQuarterly Researcher. (Vol. 4, No. 30:713).

Raskin, Jamin B. 1995 "Supreme Court's double standard: Gerrymander hypocrisy." The Nation. (Vol. 260, No. 5:167).

"Supreme Court rules against race-based redistricting (Transcript)." 1996. Congressional Quarterly Weekly Report. (Vol. 53, No. 26:1944-9).

Swain, Carol M. 1993. Black Faces, Black Interest. The Representation of African- Americans in Congress. Mass.: Harvard University Press, pp. 212.

Tabin, Barrie. 1995. "Supreme Court says race-based electoral districts violate Constitution." Nation's Cities Weekly. (Vol. 18, No. 30:12).

A Quantitative Study of the Longevity of Vietnam-Era Disabled Veterans

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This essay tests for a relationship between the predicted influence of the effect of longevity to those veterans who are disabled, and from the Vietnam-era. It is hypothesized that the more veterans benefits a disabled Vietnam-era veteran receives, the longer the lifespan will be for that veteran. The more effective research method for this type of study was time series. This allowed for the analysis of the change that took place in the relationship between the independent and dependent variables over time. The final analysis showed that veterans benefits to disabled Vietnam-era veterans did have some positive and statistically significant relationship with longevity.

INTRODUCTION

Studies on the Vietnam era and veterans are concentrated on these veterans' readjustment counseling programs (see, for example, Washington 1985, Browne 1973). Given the nature of their studies, the authors do not seek to examine the plausible relationships between veterans benefits to disabled Vietnam-era veterans and longevity. Instead, these authors concentrate exclusively on the issue of readjustment counseling programs. Thus, this essay attempts to test for whether there is a relationship between the predicted influence of veterans benefits and the longevity of those disabled veterans from the Vietnam era. It is suggested that the more veterans benefits a disabled Vietnam-era veteran receives, the longer the lifespan will be for that veteran. Thus, the major question of this research is as follows: Can a disabled Vietnam-era Veteran without veterans benefits have a long life, lacking the assistance of those benefits? This is important because the benefits veterans receive, regardless of their status, are very important for their sustenance. This study covers the period from 1990 to 1995 because it is the timeframe for which pertinent data on the topic are available.

RESEARCH METHODOLOGY

The research methodology employed for this study is quantitative. The theoretical framework used is presented below. In that framework, the independent variable is veteran benefits to disabled Vietnam-era veterans. The dependent variable is longevity. The basic assumption from the theoretical framework is as follows: There is a relationship between veteran benefits of disabled Vietnam-era veterans and their longevity.

Veterans Benefits to
Disabled Vietnam-Era Veterans → Longevity
(Independent Variable) (Dependent Variable)

Consequently, the hypothesis for this research is H1: The more veterans benefits a disabled Vietnam-era veteran receives, the longer the lifespan will be for that veteran. This study is therefore a micro level analysis, meaning that data for the measurements were taken from a microcosm of the total veteran population. The data were derived from reports prepared by the Department of Veterans Affairs, c/o Laboratory Services; Paralyzed Veterans of America, c/o Baltimore Service Office; and The National Center for Veteran Analysis and Statistics Service, c/o Robert E. Klein, Ph.D., and Janet M. Somers. Therefore, the type of data collection technique used was document analysis because the data already existed. These documents are running records covering a long period of time.

The research design employed in this study is a simple time series design because it suggests how veteran benefits to disabled Vietnam-era veterans affect their longevity from 1990 to 1995. This design can be diagrammatically represented as follows:

$$X \quad O_{1990} \ldots O_{1995} \qquad [1]$$

In the preceding design, X represents the effect of veterans benefits to disabled Vietnam-era veterans and O represents observations of the outcome, longevity, over time.

DATA ANALYSIS

The data for this research were analyzed in two stages: univariate and bivariate. The statistical package used to compute the data was GB-STAT. The statistics used at the univariate stage are the mean and standard deviation. The results of the data generated from the computer run for these statistics are summarized in Table 1.

The results in Table 1 show that from 1990 to 1995, the mean veterans benefits to disabled Vietnam-era veterans (VBDV) is $2.9 million and the standard deviation is $3.7 million, and not statistically significant at the .05 level. The mean for longevity (LONG) is 50.16 years and the standard deviation is 1.47 years and, thus, statistically significant at the .05 level. The procedures used for analyzing the data at the bivariate stage are correlation (which measures the strength of the relationship between the independent and dependent variables), and regression (which shows the nature of the relationship between them). Tables 2 and Table 3 are tabular representations of the results after the computer runs for the bivariate analysis.

TABLE 1: Mean and Standard Deviation

VAR	MEAN	SAMPLE STD. DEV.	SAMPLE VARIANCE	COEF OF VAR.
VBDV	2.968742E+08	3.725916E+07	1.388245E+15	.1255
LONG	50.16667	1.47196	2.16667	.02934

TABLE 2: Correlation Matrix

	LONG
VBDV	.97605**

* * PROBABILITY < .01 * PROBABILITY < .05

As Table 2 reveals, the correlation coefficient of .97605 shows that statistically, there is a positive and significant correlation between veterans benefits to disabled Vietnam-era veterans and longevity at the .01 level. The results generated after the computer runs for the regression equation are summarized in Table 3.

TABLE 3: Explanation for the Variation in Longevity

Linear Y = A + B * X
Linear Y = 38.7191 + 3.856037E-08 * X

UnAdjusted R^2 = .9527
Correlation Coefficient = .9761
Anova for Prediction F = 80.5276
Chance Probability P = .ooo9
STD> Error of Estimate = .3578
Variance of Estimate = .128
Degree of Freedom = 1 and 4
With = VBDV and Y = LONG

As Table 3 shows, a regression coefficient of .9761 means that there is a statistically significant relationship between longevity and veteran benefits to disabled Vietnam-era veterans at the .01 level. Therefore, the hypothesis examined in this study, H1: The more veterans benefits a disabled Vietnam-era veteran receives, the longer the lifespan will be for that veteran, is accepted.

CONCLUSION

This study was originally based on the premise that longevity is dependent upon the veterans benefits a disabled Vietnam-era veteran receives. As such, the study of the relationship among these variables addresses real-world actions. The most effective research method for this type of study is that of a time series. This allows for the analysis of the change that took place in the relationship between the independent and dependent variables over time. The final analysis showed that veterans benefits to disabled Vietnam-era veterans did have some positive and statistically significant relationship with longevity. For future research, different independent variables could be used to explore other plausible explanations for the longevity of these veterans.

REFERENCES

Department of Veteran Affairs. *Annual Data Reports (RCS 20-0236) from September 1990-1994.* Washington, DC: Analysis and Statistics Service (008C11), April 09, 1996.

Browne, Corrine. *Body Shop: Recuperating from Vietnam.* New York: Stein and Day, 1973.

Klein, Robert E. *National Center for Veteran Analysis and Statistics.* Washington DC: Department of Veterans Affairs, March 14, 1996.

Paralyzed Veterans of America. *Geographic Distribution of VA Expenditures for Fiscal Year 1994: Summary of Expenditures by States.* Baltimore, Maryland: Baltimore Service Office, March 20, 1996.

Paralyzed Veterans of America. *A Basic Guide to Special Monthly Compensation Rating Under 38USC1114 (Fourth Edition).* Washington, DC: Veterans Benefits Department, 1994.

Solotaroff, Paul. *House of Purple Hearts: Stories of Vietnam Vets Who Find Their Way Back.* New York, NY: Harper Collins. 1995.

Washington, William H. *Vietnam-Era Veterans Readjustment Counseling Program.* Washington, DC: Vietnam Veterans Outreach Center, Rev. Feb. 1985.

The 1996 Albanian Elections:
Corruption? Or a Catalyst for Democracy?

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Since the fall of Communism in 1990, Eastern Europe has been in transition to democracy. The transition has been rather rocky in many countries, with irregularities in their electoral processes. This essay is a case study of electoral problems in Albania. The 1996 Albanian elections, which were marked by irregularities, helped cause the crisis of 1997.

INTRODUCTION

For the third time since the end of communism in 1990, the citizens of Albania elected a President on May 26, 1996. The election was marked by irregularities perpetrated by the ruling Democratic Party and its leader: President Sali Berisha. In this essay, the electoral process and the results of the 1996 Albanian elections will be discussed. The current crisis in Albania will also be analyzed.

THE POLITICAL PARTIES

In order to be able to understand the context of the elections, one needs to look at the political parties in Albania. Albania has a multi-party system. But in the 1996 election cycle, the two main parties dominated. Minor parties formed coalitions with the main parties. For each of the two main political parties, who leads them and who their are aligned with and supported by will be described, beginning with the incumbent Democratic Party.

The Democratic Party, which claims to be oriented toward democracy and right-wing on the ideological spectrum, is led by Sali Berisha, who was first elected president of Albania in the country's second post-communist elections in 1992 ("Who's Who in the Election," 5-27-96). President Berisha, a former communist and a heart surgeon, helped to lead the 1990 revolution which toppled communism ("Who's Who in the Election," 5-27-96). The main issue Democrats ran on was how they defeated Communism in 1990 (Gerencser, Steven, 9-27-96).

During the 1996 Democratic Party convention, President Berisha made a "Union for Democracy," a coalition with other right-wing and centrist parties in Albania ("Democrats Call to Prevent Return of Former Communists," 4-8-96). This coalition was made in an attempt to gain a big enough majority to prevent the Socialists from gaining power ("Democrats Call to Prevent Return of Former Communists," 4-8-96).

Berisha also brought in leaders from different Western European countries to campaign with him. Michel Pericard, who is the Parliamentary head of France's ruling Rally for the Republic Party publicly campaigned with Berisha as did Klaus Buehler, representative in the Council of Europe for German Chancellor Helmut Kohl's conservative party ("Rights Group Protests Foreign Interference," 5-6-96). Italian President Oscar Luigi Scalfaro and former German President Richard von Weiszaecker also made campaign appearances with Berisha ("Rights Group Protests Foreign Interference," 5-6-96).

Berisha had help from the Roman Catholic Church in Albania, which issued a statement, signed by clergy, that indirectly supported Berisha ("Roman Catholic Leaders Urge Albanians to Vote," 5-20-96). The statement read in part, "We...pray to God that through the benefit of voting...real Democracy can win once and for all for the honour and glory of God and the benefit of the whole nation" ("Roman Catholic Leaders Urge Albanians to Vote," 5-20-96).

The Socialists, or the former communists, were led by Fatos Nano who was an economist in the former Institute for Marxist-Leninist Studies during the regime of communist leader Enver Hoxha ("Who's Who in the Election," 5-27-96). He was arrested in 1993 and jailed in 1994 for embezzlement in an Italian aid scandal ("Who's Who in the Election," 5-27-

96). Many human rights groups criticized his imprisonment as being unjust ("Who's Who in the Election," 5-27-96). He escaped from prison during the 1997 crisis (Puto, Arben, 4-22-97).

In an effort to gain a majority and win the election, the Socialists made an alliance like the Democrats ("Socialists to Join Forces With Other Leftists," 4-29-96). At their party's convention, the Socialists announced a coalition with five other left-wing and centrist parties that would give them an electoral victory, or at the very least, a working majority in the parliament ("Socialists to Join Forces With Other Leftists," 4-29-96).

Because of the economic conditions in Albania, tensions in the electorate were high, and the ruling coalition under Berisha was fearful of losing support. It is not surprising that irregularities began to emerge during the campaign process.

IRREGULARITIES

One type of irregularities in the Albanian electoral process was when laws were misused to unfairly benefit or harm one party over another. An example of this was Albanian Law that prevented former communists and their secret police from running for office until 2002 ("Albanian Elections Set For May 26," 4-15-96). This prevented the Socialists from running many of their candidates even though Sali Berisha himself was a communist ("Albanian Elections Set For May 26," 4-15-96).

Another way the Democrats misused law to unfairly benefit themselves and harm their opponents was how they controlled Albanian television (Gerencser, Steven, 9-29-96). The government controls television news (Gerencser, Steven, 9-29-96). So the news coverage was tilted in favor of the Democrats and against the Socialists (Gerencser, Steven, 9-29-96).

The Democrats also broke election law. An example of this is although there is a law which prohibits non-Albanian citizens from running an election campaign, Berisha brought in several Western European diplomats who helped campaign for he and the Democrats ("Rights Group Protests Foreign Interference," 5-6-96).

Many instances of police harassment occurred against opposition candidates and newspapers. In Albania there is no independent press, with newspapers tilted in favor of a party (Gerencser, Steven, 9-29-96). So the police would go into an opposition newspaper office, detaining the editors for questioning (Gerencser, Steven, 9-29-96). They would claim to be investigating a supposed libelous news report out of that newspaper (Gerencser, Steven, 9-29-96). This would effectively shut them down for the day so that they would be unable to print that day's newspaper (Gerencser, Steven, 9-29-96). It can also be argued that such investigations by the police were a form of indirect censorship, because it made newspapers less likely to publish certain articles against the government in fear of being harassed (Gerencser, Steven, 9-29-96).

Another way the police harassed opposition candidates was by breaking into their offices ("Police Disrupts Opposition Campaign, Daily Says," 5-6-96). In one report, the police stormed into a Socialist Party office, ripped down the pictures, flags, banners, tearing the place apart ("Police Disrupts Opposition Campaign, Daily Says," 5-6-96). Police also detained the workers, questioning them as to whether they were running a libelous campaign ("Police Disrupts Opposition Campaign, Daily Says," 5-6-96).

The police weren't the only ones guilty of harassing the opposition. Four days before the election in Durres, Albania, Democratic supporters disrupted a legal Socialist rally by assaulting vehicles carrying Socialist Party members and cutting off power to the rally, canceling it ("Police Arrests Suspected Rally Killers," 5-27-96).

One of the most blatant examples of harassment of the opposition occurred in Shkroder, Albania, which is a rural area in the north. Dr. Steven Gerencser, an election observer, and other American observers traveled to the city to view a Socialist rally which was planned there (Gerencser, Steven, 9-29-96). They were on the only road leading in to Shkroder when they hit a traffic jam and stopped (Gerencser, Steven, 9-29-96). Because the area was so rural, a traffic jam seemed strange, and the observers got out of their car to investigate what was happening (Gerencser, Steven, 9-29-96). The observers continued up the road and saw a semi-truck parked sideways on the road, blocking both lanes of traffic (Gerencser, Steven, 9-29-96). The truck had a Democratic Party banner on it, and Democratic Party supporters held a rally on the road (Gerencser, Steven, 9-29-96). The Americans talked with the police at he sight, who offered to clear a path for them to go through (Gerencser, Steven, 9-29-96). Dr. Gerencser said that although they were offered to be allowed to go through, it was clear that the police were not willing to break up the Democratic rally (Gerencser, Steven, 9-29-96). The

American observers turned around, going to the nearest city to talk with the Socialists (Gerencser, Steven, 9-29-96). The Socialists were prevented from being able to take the road into Shkroder, and had to cancel their rally (Gerencser, Steven, 9-29-96).

Just as Socialist candidates were harassed, Albanian voters were harassed too. Dr Gerencser saw that during voter registration, citizens who were believed to be pro-Socialist had a difficult time registering (Gerencser, Steven, 9-29-96). They either had the validity of their forms of identification questioned, or had to provide more than one form of ID to vote (Gerencser, Steven, 9-29-96). On the other hand, voters who were thought to be pro-Democrat were able to register very easily (Gerencser, Steven, 9-29-96). Some were able to register family members who weren't even with them (Gerencser, Steven, 9-29-96). Voters were also intimidated when they entered the polls, because armed policemen and secret police were present ("Two Monitoring Groups Call Albania Vote Marred," 5-30-96).

In addition to voter intimidation, actual vote fraud took place. Several locations reported unsecured ballot boxes (ballot boxes that were unlocked or not guarded) ("Two Monitoring Groups Call Albania Vote Marred," 5-30-96). There were also reports of altered votes and ballot boxes which were stuffed with illegal ballots ("Two Monitoring Groups Call Albania Vote Marred," 5-30-96).

These irregularities heightened the mistrust of the government by the people, and would set the stage for things to come.

ELECTION DAY AND ITS AFTERMATH

In the days and weeks before the election, many people believed that the race between the Democrats and the Socialists would be very close, within about five points (Gerencser, Steven, 9-29-96). But by the middle of election day, the Socialists pulled out of the election, citing the many irregularities which took place (Gerencser, Steven, 9-29-96). The Democrats won with more than 67% of the vote, while the Socialists had less than 25% of the vote ("Riot Police Beat and Arrest Albanian Election Protesters," 5-29-96).

Although President Berisha was declared the winner in the Albanian elections, he still banned an opposition rally to be held the day after the elections ("Riot Police Beat and Arrest Albanian Election Protesters," 5-29-96). In what many experienced election observers said was the most violent aftermath of any election in Eastern Europe since the fall of communism in 1990, many Socialists demonstrated against the government and were beaten and jailed by the police. ("Riot Police Beat and Arrest Albanian Election Protesters," 5-29-96).

REACTIONS TO THE ELECTION

Forty out of 53 O.S.C.E. observers said they witnessed irregularities and basic electoral corruption at the polls ("Riot Police Beat and Arrest Albanian Election Protesters," 5-29-96). More than a dozen of the observers signed a statement saying the election did not meet "international standards for free and fair elections" ("Riot Police Beat and Arrest Albanian Election Protesters," 5-29-96). They also reported that in many cases "the number of ballots cast exceeded the number of signatures on voter lists" ("Eleven OSCE Observers Criticize Elections," 6-3-96). And they called for a second round of elections to be held in districts where the most blatant examples of irregularities were found ("Eleven OSCE Observers Criticize Elections," 6-3-96). In The O.S.C.E.'s final report on the May 26 Albanian elections, its members found that 32 Albanian election laws out of 79 were broken ("Eleven OSCE Observers Criticize Elections," 6-3-96).

Human Rights Watch, a New York based organization, also criticized the election, calling on the United States and European governments to declare the Albanian elections invalid ("Albania's Reformer Turns Autocrat," 6-1-96). The European Union called on Berisha to hold a new election in some districts, with France and the U.S. agreeing ("Albania's Reformer Turns Autocrat," 6-1-96).

Because of the criticism of the May 26 elections, polling was re-run in 17 districts ("Foreign Observers Say Albania Poll Rerun Was Fair," 6-24-96). This second polling was considered free and fair by international observers ("Foreign Observers Say Albania Poll Rerun Was Fair," 6-24-96). It was interesting, because the Democrats won in all 17 districts with huge majorities ("Foreign Observers Say Albania Poll Rerun Was Fair," 6-24-96).

CONCLUSION

The current crisis in Albania began in January 1997. After losing about $1.5 billion in

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"pyramid schemes," the citizens of Albania began violent protests against the government ("Rebel Albanian Port Prepares to Repel Attack," 3-9-97). Pyramid schemes are fraudulent investments where early investors are paid high interest from the contributions of later investors, with operators of the schemes taking a high percentage of the investments for themselves ("Violent Protests of Pyramid Schemes Spread in Albania," 1-27-97). When no new investors can be found, the scheme goes bankrupt ("Violent Protests of Pyramid Schemes Spread in Albania," 1-27-97). Albanian citizens earn only $60-$80 a week, which makes the pyramid schemes so attractive ("Violent Protests of Pyramid Schemes Spread in Albania," 1-27-97). To invest in the pyramid schemes, many Albanians sold their homes, livestock and other assets ("Violent Protests of Pyramid Schemes Spread in Albania," 1-27-97). Almost every family in Albania had some money in a pyramid scheme (Puto, Arben, 4-22-97). These schemes were allowed to take place, because there were no regulations against them.

Because so many people lost so much money, and because Albanians are so poor, violent protests occurred ("Violent Protests of Pyramid Schemes Spread in Albania," 1-27-97). Albanians protested because they blamed President Berisha for allowing the schemes to take place ("Violent Protests of Pyramid Schemes Spread in Albania," 1-27-97). In fact, leaders of opposition parties say, that money from some of the pyramid schemes went to finance the Democratic Party's 1996 campaign ("Albanians Clash in Pyramid-Scheme Protest," 1-20-97). While Berisha denies this, there is evidence that the government knowingly allowed the schemes to take place and was friendly towards their operators. In fact, some of the biggest funds endorsed Berisha and held functions for members of the Democratic Party ("Albania Calls An Emergency As Chaos Rises," 3-3-97). Some Democrats even had insignias from the funds on their campaign posters ("Albania Calls An Emergency As Chaos Rises," 3-3-97). Even though officials from the World Bank, the International Monetary Fund, and the United States warned Berisha of problems with the pyramid schemes, they were not stopped until after most of them went bankrupt ("Albania Calls An Emergency As Chaos Rises," 3-3-97). All of this, along with previous electoral irregularities, has caused a loss of confidence in the government by the people.

During this crisis, Berisha is refusing to step down as President. A new coalition government was formed, with Berisha as President and members of the Socialist Party and the Democratic Party in his cabinet (Puto, Arben, 4-22-97). Berisha also had himself appointed to another five year term ("Albania Chief Tightens Grip In Crackdown on Protests," 3-4-97). These actions seem to suggest the demise of democratic government in Albania. However, Berisha has agreed to new elections to be held in June 1997 (Puto, Arben, 4-22-97).

Whether or not these elections will take place is uncertain. It is hoped that demonstrations will stop as the elections approach. The UN has sent troops to Albania for three months to oversee the distribution of aid (Puto, Arben, 4-22-97). With troops in Albania during the month the elections take place, there is a chance that they might be able to create stability. But what really needs to happen is to have the coalition government sit down and formalize a new constitution. Currently, there is only an interim constitution in Albania. This means that a free and independent press is not guaranteed, nor is the right to assemble and form oneself into interest groups. Until these fundamental rights are guaranteed, there is little chance of legitimate support from the people or-Albania becoming truly democratic. If President Berisha wants to be credible in his country and around the world, he must allow these fundamental reforms to take place.

REFERENCES

"Albanian Elections Set for May 26." *Albanian Times.*
http://www.worldweb.net/~ww1054/times/04_15_96.html (18 Sep. 1996)

"Albanians Clash in Pyramid-Scheme Protest." *New York Times.* 20 Jan. 1997. A8.

"Democrats Call to Prevent Return of Former Communists." *Albanian Times.*
http://www.worldweb.net/~ww1054/times/04_08_96.html (18 Sep. 1996)

"Eleven OSCE Observers Criticize Elections." *Albanian Times.*
http://www.worldweb.net/~ww1054/times/06_03_96.html (18 Sep. 1996)

"Foreign Observers Say Albania Poll Rerun Was Fair." *Albanian Times.* http://www.worldweb.net/~ww1054/times/06_24_96.html (18 Sep. 1996)

Gerencser, Dr. Steven. Personal Interview. 29 Sep. 1996.

Perlez, Jane. "Albania Calls An Emergency As Chaos Rises." *New York Times.* 3 March 1997. A1-A4.

Perlez, Jane. "Albania Chief Tightens Grip In Crackdown on Protests." *New York Times.* 4 March 1997: A6.

Perlez, Jane. "Albania's Reformer Turns Autocrat." *New York Times.* 1 Jun. 1996: A5.

Perlez, Jane. "Rebel Albanian Port Prepares to Repel Attack." *New York Times.* 9 March 1997: 6.

Perlez, Jane. "Riot Police Beat and Arrest Albania Election Protesters." *New York Times.* 29 May 1996: A6.

Perlez, Jane. "Two Monitoring Groups Call Albania Vote Marred." *New York Times.* 30 May 1996: A5.

"Police Arrests Suspected Rally Killers." *Albanian Times.* http://www.worldweb.net/~ww1054/times/05_27_96.html#boycott (18 Sep. 1996)

"Police Disrupts Opposition Campaign, Daily Says." *Albanian Times.* http://www.worldweb.net/~ww1054/times/05_06_96.html (18 Sep. 1996)

Puto, Arben. Personal Interview. 22 Apr. 1997.

"Rights Group Protests Foreign Interference." *Albanian Times.* http://www.worldweb.net/~ww1054/times/05_06_96.html (18 Sep. 1996)

"Roman Catholic Leaders Urge Albanians to Vote." *Albanian Times.* http://www.worldweb.net/~ww1054/times/05_20_96.html (18 Sep. 1996)

"Socialists to Join Forces with Other Leftists." *Albanian Times.* http://www.worldweb.net/~ww1054/times/04_29_96.html (18 Sep. 1996)

"Violent Protests of Pyramid Schemes Spread in Albania." *New York Times.* 27 Jan. 1997: A3.

"Who's Who in the Election." *Albanian Times.* http://www.worldweb.net/~ww1054/times/05_27_96.html#boycott (18 Sep. 1996)

The Role of the International Law of the Non-Navigational Uses of International Watercourses in Resolving the Disputes Over Access to Freshwater in the Middle East

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Relationships among countries of the Middle East were, and continue to be significantly affected by and played out in the use of water and the policies that surround their use. While many methods exist by which to deal with the water issue, the most universal one is that of international law. Although international law exists to deal with problems such as this, its effectiveness is questionable. This will be discussed in conjunction with two case studies: the groundwater in the West Bank, and the Euphrates River.

There are several reasons why people have failed to consider water as a major force in the Middle East. The main reason is that when someone looks at the Earth, one sees it is covered mostly by water and are left with the impression that there is plenty of water to go around. What one fails to realize is that the only drinkable water is freshwater, and that only accounts for approximately 2 percent of the world's water supply. Of this 2 percent, 87 percent is embedded in ice caps and glaciers, buried deep underground, or contained in the atmosphere. In fact, of all the freshwater in the world, only about one-third of 1 percent is available for human consumption and survival (Starr 1993). Now add to that equation the fact that the minuscule amount left is spread out unevenly all over the world, and not according to need. Only after realizing all of this can one begin to grasp exactly how scarce water, the element essential for all life, really is.

Just how governments will deal with water is the concern. While States may chose to continue their current policies without concern for water issues, time will catch up with them. To allow the status quo to continue will make the problems more explosive and pressing in the future. The Middle East is a volatile enough area without adding to the problems.

There are then two possibilities for action, either unilaterally, or multilaterally. Acting unilaterally is of course better than no action at all. Yet it too is problematic. There are times and issues when a State acting on its own can resolve a problem, or diffuse a situation by a change in domestic policy or even by acting alone on the international level. However, the issue of water rights and international rivers, by their very nature can not be resolved by a single actor working alone. In addition, by acting on its own a State, in almost all cases, will fail to take into consideration the needs of its neighbors. It will focus solely on its own concerns, plans, and potential for exploiting a given resource, in this case water. The resolution of disputes over rights to international rivers will require a collective effort. It is international law that can function as a mediator between disputing states. However, international law is a course of action that lacks a universal enforcement mechanism. This calls the ability of international law to function successfully into question. It is exactly because of its questionable status that one must ask the question: is the international law on the non-navigational uses of water capable of providing realistic solutions to the disputes over freshwater in the Middle East?

WEST BANK CASE STUDY

Israel's water is transported through a system of pipes and aquifers called the National Water Carrier. The National Water Carrier is made up primarily of three aquifers. Two of these, the "Mountain" and "Western" are located in what Israel calls Judea and Samaria, and what the Arabs call the West Bank. Only one aquifer, the "Coastal" aquifer is located in the original 1948 borders. This system is vital to the delivery of water within the country and the security of the carrier is viewed by many, especially the government, as an essential part of national security. The location of these aquifers is very important and it sheds some light on why Israel is so reluctant to give up the West Bank.

The West Bank has an annual water supply that varies depending on the rainfall in the region. Exactly how much water is in the West Bank Israel refuses to comment on and the Palestinians to this point have been unable to come up with any figures of their own. However, it is known that Israel takes 85 percent of the water from the western aquifer, and gets between 30-40 percent of its total water supply from the West Bank, (Stutz 1994). If the West Bank water is so important to Israel, is peace a possibility? It has become clear that water is an essential variable in any peace equation, but can all parties agree on a division of the water?

APLLICATION OF DRAFT ARTICLES TO WEST BANK GROUNDWATER

The application of international law to the groundwater in the West Bank is an interesting situation. The problem is the fact that the West Bank is an occupied territory and as such would more likely fall under the laws concerning belligerent occupation than the draft articles. Additionally, The Palestinians are not considered a state in the strict legal sense, and as a result would not be considered party to the draft articles. With this case study however the intention is not to determine what current allocations should be, but to determine if allocations should change from their current level given the existence of a Palestinian state in the West Bank. For that to take place, the draft articles must be applied to the situation at hand.

The application of international water law was helped when the Israeli government for the first time officially recognized Palestinian rights to West Bank water in accords signed in September of 1995 (Reuters 1996). Additionally, both sides have agreed that the water issue should be resolved through the principle of equitable utilization (Elmusa 1996). Equitable utilization is the basis of the International Law Commission's draft articles. While all 33 of the articles are important in their own right the focus will only be on articles 5, 6, 7, and 21.

The first article of importance is Article 5. This article establishes that states should utilize an international watercourse in an equitable fashion. Article 5 sets out the fundamental rights and duties of States with regard to the utilization of international watercourses for purposes other than navigation (ILC 1994). Thus a watercourse State has both the right to utilize an international watercourse in an equitable and reasonable manner and the obligation not to exceed its right to equitable utilization or, in somewhat different terms, not to deprive other watercourse States of their right to equitable utilization (ILC 1994). This does not establish a rule that states should have an equal amount of water, instead, it establishes equality of rights to utilize the water. But what is equitable utilization? Jonathan Wenig argues that, "to the extent that existing allocations satisfy existing demands, they are judged as equitable, (Wenig 1995)." It is very apparent that the current apportionment of the West Bank water does not satisfy existing demand. To an extent however this is hard to measure due to the military occupation and governance of the territory. This artificially restricts the Palestinian demand for water due to external restrictions places on agriculture and industry. Although optimal utilization has an inherent bias towards existing uses of water, when inequalities still exist, the focus shifts towards redistribution (Wenig 1995). Not only do inequalities exist, there is also appreciable harm cased by these regulations on the Palestinian people. A use that causes appreciable harm is inherently inequitable (Wenig 1995). As a result of these impediments to the Palestinians (as discussed above) a the West Bank water needs to be re-allocated.

While it is easy to say that the waters should be re-allocated, that hard part is in determining how equitable utilization should be determined. It is at this point that Article 6 enters the picture. Article 6 lists factors relevant to equitable and reasonable utilization. This section includes such factors such as the social and economic needs of the watercourse states, the population dependent on the watercourse, and geographic or hydrographic factors among others. Sharif Elmusa argues that the relevant factors "boils down to the socially and economically based water needs and the relative ability of the two sides to tap alternative water sources, (Elmusa 1996)." These two factors justify a re-allocation in favor of the Palestinians. The aquifers of the West Bank are the sole water source for the Palestinians. Although they border the Jordan River, they are prevented from utilizing it as a result of the military occupation. The Palestinians also have neither the capital or technology to tap alternative sources of water. The Israelis however are world leaders in water efficient technology and have both the capital and technology for desalination plants. Israel is capable of harnessing nonconventional resources that could provide it with substantial amounts of water. In fact, it announced in 1995 a long-term water desalination program that will produce about one-and-a-half times the amount of water of the entire mountain aquifer by the year 2040 (Elmusa 1996).

Article 7 brings up another factor to be considered in redistributing the waters, that of the obligation to not cause significant harm. While this can easily be applied to the case in favor of the Palestinians, it can also be utilized on behalf of Israel. As noted above, Israel is currently very dependent on the West Bank water. It is very easy to argue that a re-allocation would cause them significant harm. However, in the context of the articles as a whole, Article 7 favors a redistribution favorable to the Palestinians. It does however place limits on that redistribution and obligates those who will in the end determine specific amounts to still consider the Israelis when the aquifers are divided.

The final important article is Article 21. This article is designed to prevent, reduce, and control pollution. Pollution is defined as, "any detrimental alteration in the composition or quality of the waters of an international watercourse which results directly or indirectly from human conduct, (ILC 1994)." A reduction in quality or the increase in saline levels in the aquifer would constitute pollution under the draft articles. Only in considering pollutive actions does the principle of "no appreciable harm" supersede that of equitable utilization (Wenig 1995). This is important because if the overuse of an aquifer results in increasing the salinity of the aquifer, then such a use cannot be allowed to continue, even if it constitutes equitable utilization. In other words, the Palestinians must be careful once they acquire autonomy to not overpump the West Bank water (a major Israeli fear) and increase the salt water intrusion into the aquifers. If they were to do so, the Israelis would have the right to prevent such actions.

Looking over the draft articles it is quite easy to see that they endorse a redistribution of the West Bank groundwater in favor of the Palestinians. Such a division can only be seen as finally establishing equitable utilization and reversing the harms and restriction placed on them by thirty years of Israeli occupation. The draft article however should not be seen as a blank check to the Palestinians to engage in whatever water policies they deem fit. The draft articles do place some restrictions on them. These are found in Articles 7 and 21, the obligation not to cause significant harm and to prevent pollution, in this case from salt water intrusion due to overpumping the aquifers.

EUPHRATES CASE STUDY

The primary conflict over the use of the Euphrates River is the Turkish GAP project and its implications for downstream states. The GAP stands for "Guneydogu Anadolu Projesi" or translated from Turkish, the Southeast Anatolia Project. It is a giant $32 Billion project of 21 dams, 19 hydropower plants, and irrigation canals for the southeastern region of Turkey (Washington Times 1996). The rural southeast region of Turkey is populated mostly by Kurds, who have always harbored separatist dreams. A central political premise on which the GAP initiative is predicated is that as long as the rural Kurdish areas remain poor, the locals will be susceptible to Marxist and nationalistic ideas. Conversely, a thriving economy with many job opportunities would strongly inhibit the inhabitants from toying with such destabilizing ideas (Faure 1993). In essence, GAP seeks to buy off the Kurdish population and at the same time significantly decrease the appeal, effect, and importance of Kurdish independence movements such as the PKK.

At the same time though, GAP is a project that can provide immense benefits to Turkey through the increased electrical output, increased irrigation and agricultural output there by producing export income, as well as incredible economic growth. GAP will also serve as a means of flood control for downstream riparians at no cost to them and water storage is most effective done near the headwaters for flood control and to lessen evaporation

(Green 1993). The principle part of GAP is the Ataturk Dam, which has the capacity of nearly 49 billion cubic meters (greater than that of the entire yearly output of the Euphrates) and, when finished, will be the fourth largest construction in the world. The canals draining out from the reservoir will be able to irrigate 143,000 hectares of land, making the region a sort of Eden, capable of producing three harvests a year (Allan 1995). GAP should not be viewed solely as a means of placating the Kurds, but also as a project with tremendous national importance for the country as a whole.

Syria and Iraq are very concerned about the GAP project. Once completed, it would have a drastic impact on the flow of the Euphrates they receive. A fully functioning GAP could cut Syria's permanent share of the Euphrates by up to 40 percent and Iraq's by 80 percent (Cohen 1991).

APPLICATION OF DRAFT ARTICLES TO EUPHRATES RIVER

Article 5 establishing the need for equitable utilization is the fundamental basis of the draft articles. Within the commentary to Article 5 is found the statement that "there is no doubt that a watercourse State is entitled to make use of the waters of an international watercourse within its territory. This right is an attribute of sovereignty and is enjoyed by every State whose territory is traversed or bordered by an international watercourse, (ILC 1994)." This provides the basis of the Turkish claim to be able to do with the Euphrates while it is within its borders as it sees fit. Wenig's point that, "to the extent that existing allocations satisfy existing demands, they are judged as equitable, (Wenig 1995)" is once again very important to the discussion. As long as Syria and Iraq's needs are met, Turkey does not violate international law with the continuation of the GAP. It is questionable however if Syria has enough. Although the majority of their hydropower and dam problems can be attributed to poor planning (dams that were designed for Siberia, not Syria), and Turkey cannot be expected to compensate Syria for poor planning by increasing the flow of the Euphrates into Syria, Syria could be justified in asking for an increase to satisfy irrigation needs and increases in population.

In Article 6 are found the factors to use in order to determine equitable utilization. Looking at the relevant factors such as climate, geography, and hydrology, it is very possible to assert that Turkey is entitled to a large portion of the Euphrates. Turkey not only contributes almost all the water to the Euphrates but also has a large share in the area of its drainage basin and portion in the river channel (Kliot 1994). This is consistent with the current situation. As long as the other riparian needs have been met, the remainder, and what should be a majority, of the Euphrates water can be utilized by Turkey.

Article 7 obligates States to not cause other riparians significant harm. A use that causes harm is inherently inequitable (Wenig 1995). While the current use does not engage in significant harm to any of the riparians, this is a clause to bear in mind for the future. As noted previously, a completed and fully operational GAP will have a drastic affect on Syria and Iraq. This would, by any stretch of the imagination, constitute the significant harm that the draft articles seek to prevent. The impact of this is that that GAP project will have to be re-evaluated, or at least some agreed upon method of compensation for the lower riparians will have to be developed. The likelihood of that if very slim considering the importance of the Euphrates to both Syria and Iraq. Equally unlikely is the prospect that Syria and Iraq will give their permission for the construction of a completed GAP.

All of this of course assumes that Turkey will be willing to implement the draft articles. A consideration that can only be considered a guess at this point. If Turkey remains adamant in their claims that the Tigris and Euphrates Rivers are not international watercourses, as they have been in the recent past, then they will not consider themselves bound by the draft articles. To accept the draft articles would mean turning their back on GAP, a prospect they are completely unwilling to do. Turkey is in a relative position of strength. As the upper riparian, its water supply is not controlled by either Syria or Iraq. As a result of this, it is Turkey that will decide if the draft articles are to be successfully applied to the Euphrates River. Most importantly though, it is protected from repercussion by the state of international law. No effective mechanism exists to force states to comply with international law. The dispute resolution mechanism of the draft articles itself fail to provide

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a solution either. Article 33 on dispute resolution assumes that all parties want to reach a solution. The Article assumes a situation that rarely exists in the real world.

CONCLUSION

International law is capable of providing a means by which an equitable solution can be reached. As the case studies point out, international law can work successfully if its application is agreed on by all parties. Without that agreement, situations such as the Euphrates case study will be the norm. This can be explained by the lack of an effective enforcement mechanism. While the direct application of international law could be labeled as suspect, it does provide indirect benefits. The discussion and formulation of international law serves to shape state practice. It is questionable that the Israelis and the Palestinians would agree to equitable utilization of their waters (the primary principle of the ILC draft articles) without the continuing formulation of those principles by the international law community.

REFERENCES

Allan, J.A., and Chibli Mallat, eds. Water in the Middle East: Legal, Political, and Commercial Implications. I. B. Tauris Publishers. London. 1995.

Chenevert, Donald J. Jr.. "Application of the Draft Articles on the Non-Navigational Uses of International Watercourses to the Water Disputes Involving the Nile River and the Jordan River." Emory International Law Review. Vol. 6. 1992: 495-575.

Cohen, Jonathan. "International Law and the Water Politics of the Euphrates." New York University Journal of International Law & Politics. Vol. 24. 1991: 503-556.

Elmusa, Sharif. Negotiating Water: Israel and the Palestinians. Institute for Palestine Studies. Washington D.C. 1996.

Evans, Eddie. "Shrinking Water Supply Adds to World Tension-Study." Reuters. Sept. 14, 1996.

Faure, Guy Oliver, and Jeffrey Z. Rubin, eds. Culture and Negotiation. Sage Publications. London. 1993.

Green, Elizabeth. Hydropolitics in the Middle East and U.S. Policy. US Naval War College. Newport, Rhode Island. 1993.

Kaplan, Refet. "Water-Rights Dispute Divides Syria, Turkey." The Washington Times. March 25, 1996: 19.

Kliot, Nurit. Water Resources and Conflict in the Middle East. Routledge. New York. 1994.

Moore, James. "Parting the Waters: Calculating Israeli and Palestinian Entitlements to the West Bank Aquifers and the Jordan River Basin." Middle East Policy. Vol. 3 n 2. 1994: 91-108.

Starr, Joyce R. "The Quest for Water: From Biblical Times to the Present." Environmental Science and Technology. 27 (1993): 1264-1267.

Stutz, Bruce. "Water & Peace: in the Middle East, Where Water is as Precious as Oil, the Jordan River is a Pawn in a Complicated Diplomatic Game." Audubon. Sept- Oct. 1994: 64-79.

International Law Commission. Report of the International Law Commission on the Work of its forty-sixth Session. United Nations. New York. 1994.

Wenig, Jonathan M. "Water and Peace: the Past, the Present, and the Future of the Jordan River Watercourse: an International Law Analysis." New York University Journal of International Law & Politics. Vol. 27. 1995: 331-366.

Trends in the Eisenhower Administration:
A study of Inflation, Unemployment, and Presidential Popularity

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A strong approval rating for a President allows that President to exercise a large amount of political power, both within his party and outside of it. What most affects Presidential popularity? How can a President ensure that his popularity will not decline beyond a point of no repair?

Recent elections (since the 1980's) have shown that an incumbent (either President or party) with a strong economy will win (Reagan in 1984, the Republican Party in 1988, Clinton in 1996). On the same note, an incumbent struggling with the economy (Bush in 1992, the Democratic Party in the 1994 Congressional elections) will suffer in an election. The results of recent elections strongly suggest that the economy is one of the foremost factors in determining a President's popularity and influence.

This project examines the relationship between Presidential Popularity and economic indicators, specifically inflation and unemployment.

Eisenhower is an ideal President to study in dealing with inflation, unemployment, and popularity. Eisenhower's term of office was calm: he was not forced to deal with any major international crises and the economy was relatively stable. Eisenhower was the first President to effectively use Keynes' notion of counter-cyclical planning in managing the economy. As a result, under the Eisenhower Administration, the nation experienced three business cycles, each of a relatively "normal" nature. Table 1 shows the U.S. Business Cycles from the close of 1854 to March 1991.

Eisenhower entered office in the midst of a forty-five month period of expansion, and the economy peaked in July 1953. This peak was followed by a ten month period of contraction, and Eisenhower's first trough occurred in May 1954. The economy rose again, peaking in August 1957 (after 39 months of expansion), and, over the next eight months, fell to a second trough under Eisenhower in April 1958. The final peak in the economy during the Eisenhower Administration occurred two years (24 months) later, in April 1960 (Lindeen, *Governing the Economy*, 1994).

The measures by which one can measure the state of the economy are numerous, so it was necessary to study two or three indicators against which Presidential Popularity could be compared. Inflation and unemployment were selected. The choice was not random: according to Kiwiet in *Macroeconomics and Micropolitics*, inflation (the substantial rise of prices caused by an undue expansion in paper money or bank credit) and unemployment are the most watched economic indicators. Kiwiet further contends that the inflation rate is generally used by Republicans to judge the state of the economy, while Democrats tend to use the unemployment rate to judge the state of the economy.

BUSINESS CYCLE REFERENCE DATES		DURATION (IN MONTHS)	
		CONTRACTION	EXPANSION
TROUGH	PEAK	(trough from previous peak)	(trough to peak)
December 1854	June 1857	-	30
December 1858	October 1860	18	22
June 1861	April 1865	8	46
December 1867	June 1869	32	18
December 1870	October 1873	18	34
March 1879	March 1882	65	36
May 1885	March 1887	38	22
April 1886	July 1890	13	27
May 1891	January 1893	10	20
June 1894	December 1895	17	18
June 1897	June 1899	18	24
December 1900	September 1902	18	21
August 1904	May 1907	23	33
June 1908	January 1910	13	19
January 1912	January 1913	24	12
December 1914	August 1918	23	44
March 1919	January 1920	7	10
July 1921	May 1923	18	22
July 1924	October 1926	14	27
November 1927	August 1929	13	21
March 1933	May 1937	43	50
June 1938	February 1945	13	80
October 1945	November 1948	8	37
October 1949	July 1953	11	45
May 1954	August 1957	10	39
April 1958	April 1960	8	24
February 1961	December 1969	10	106
November 1970	November 1973	11	36
March 1975	January 1980	16	58
July 1980	July 1981	6	12
November 1982	July 1990	16	91
March 1991		8	--

Note Numbers in bold face indicate periods of expansion or contraction that occurred during wartime
Source National Bureau of Economic Research, Cambridge MA

Table 1: U.S. Business Cycles

The hypothesis on which the research was based stated that fluctuations in unemployment and inflation would lead corresponding changes in Presidential popularity. Increases in the unemployment rate or the inflation rate would precede a drop in Presidential popularity, while drops in the economic indicators would precede a rise in popularity. The lead time for the indicators should be about one month.

The data to be studied was collected from three sources. Statistics on inflation were from the U.S. Department of Commerce, while the monthly unemployment rate was supplied by the U.S. Bureau of Labor Statistics. Presidential popularity figures came from the Gallop Poll Archives. Presidential popularity is a variation of approval rating: the presidential popularity was obtained by eliminating the "no opinion" category and readjusting the approval rating to be out of 100%.

$$\frac{\text{Approval rating}}{100\% - \%\text{ with no opinion}} \times 100\% = \text{Presidential Popularity}$$

Equation 1: Conversion of Approval Rating to Presidential Popularity

For example: in January 1953, the Gallop Poll reported that the President's approval rating was 78%. Twelve percent of those surveyed did not approve of Eisenhower's actions in office, and ten percent did not have an opinion about the Eisenhower Administration. The ten percent without an opinion were eliminated from the study, and Presidential popularity was then determined by reproportioning the approval rating: [78% / (100%-10%)] x 100% = 87% Presidential Popularity.

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Comparison of the economic indicators and Presidential popularity was done through multiple time series regression analysis. The first analysis, comparing the numbers without any lead or lag time produced a 44.0% correlation with inflation, a 65.0% correlation with unemployment, and a 69.5% correlation with both indicators. Scattergram analysis of the numbers, however, suggested that a relationship between the numbers could be found with lead or lag times. The following diagrams show the analysis used to determine the appropriate lead/lag time for inflation and unemployment:

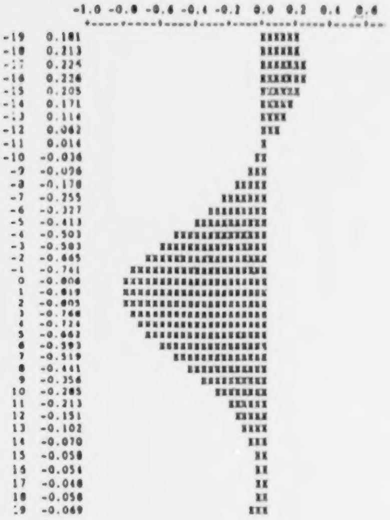

Figure 1: Unemployment
Analysis Data

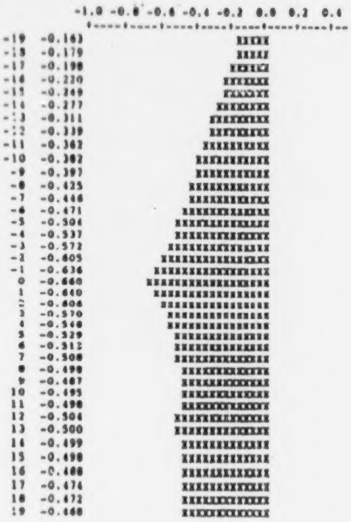

Figure 2: Inflation Rate
Analysis Data

The regression analysis suggested a one month lag for the unemployment rate (the peak is at -0.819, positive one), and no lead or lag for inflation (the peak is at -0.660, zero). With the one month lag in unemployment, the scattergram diagram indicated a tighter relationship between unemployment and Presidential popularity:

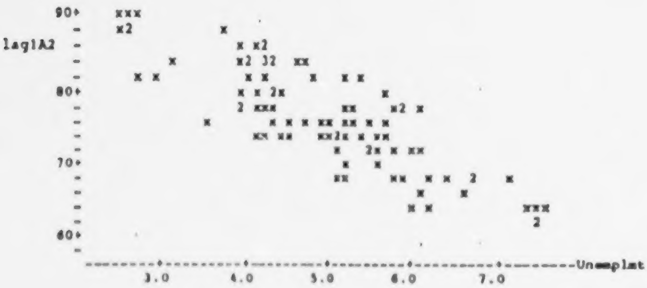

Figure 3: Scattergram Analysis of Unemployment-Presidential Popularity (1 month lag)

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The final analysis of the figures took into account the suggested lag. The result of the final analysis showed a 73.2% correlation.

While one cannot expect a perfect correlation between figures in the social sciences, two factors could have lowered the actual correlation between the Presidential Popularity and the economic indicators. Both inconsistencies in the reporting of Gallop Poll data and current issues would influence the approval rating of the President. Gallop Poll did not report a Presidential Popularity figure for every month. During twenty-four months (25%) of the Eisenhower Administration, the Gallop Poll did not release popularity figures. This forced a "fudge factor" into the equation: for the months missing data, the preceding popularity figure was inserted. Current and domestic issues cause fluctuations in Presidential Popularity for which economic indicators cannot account. No tangible way exists to gauge the effects of current events and the amount they impact the President's popularity in a given month. Major issues that most likely artificially inflated or deflated President Eisenhower's popularity are the end of the Korean War, the sending of the National Guard to Little Rock to force the desegregation of schools, and the sending of troops to Lebanon.

Although the two sources of inconsistencies may skew the data on a month-to-month basis, the overall correlation of inflation and unemployment with Presidential popularity indicates that the two economic factors play a dominant role in a President's approval rating. The correlation was stronger than expected. The lag time for unemployment was expected, but the lack of a lag time for the correlation between inflation and Presidential popularity was not. In retrospect, the lack of a time lag makes sense: although monthly reports regarding the inflation rate and the unemployment rate are issued with a one month lag, an individual would have a better grasp on the current inflation rate because it affects their day-to-day lives. While an individual may not be able to state the inflation rate, he could tell you if it is rising or falling by increase or decrease in prices around him. An individual would have a harder time identifying with the unemployment rate unless he or she was actually unemployed; even so, an individual would have to rely on monthly reports for information about the unemployment rate.

A study of the modern Presidents, starting with Reagan (the other two-term President before Clinton was re-elected in 1996), may suggest a very different result. With the modern press and its coverage of the Presidency being much more extensive than it was at the time of Eisenhower's Presidency, Presidential popularity will probably deviate more frequently from the cycle resulting from a combination of inflation and unemployment.

It would not be surprising if a study of the most recent Presidents (Reagan, Bush, and Clinton) showed a lead time for presidential popularity as opposed to the lag discovered in this study of Eisenhower. Today experts are able to fairly accurately predict the state of the economy more than a month in advance, and it is this outlook, rather than the actual month's data, upon which the public today forms its opinion.

Regardless of the lead or lag time associated with presidential popularity and the inflation and unemployment rates, the fact that they are very closely tied cannot be ignored. While the 73.2% correlation that existed at the time of the Eisenhower administration may not exist today, a strong correlation between popularity and the economic factors can still be expected. To what extent, and exactly how the figures are related, are the questions that only further research can answer. This research reflects a preliminary stage in a much larger project.

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Strategizing Advocacy: Theoretical Frameworks in Grass Roots Social Organization

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"This country with its institutions, belongs to the people who inhabit it. Whenever they shall grow weary of the existing government, they can exercise their constitutional right of amending it, or their revolutionary right to dismember or overthrow it." Abraham Lincoln's First Inaugural

This paper seeks to educate those interested in advocacy and social movements about items related to the optimum time for movements to succeed, what elements must be present within an organization's mission including the dangers to be avoided and why it is so vitally important for our society to support and empower communities in their efforts toward positive social change. The focus of this paper is on the the common characteristics that resonate within all successful social movements. In May a summit headed by Colin Powell to include all of the living former presidents (Reagan will be represented by his wife), state and local officials, volunteers and young people will team up with corporate America to develop strategies for stimulating physical involvement and acitvism on the community level. It is at this level of society that social change truly happens, with a small group of people organizing and gaining power through empowering and bringing hope to the their communities. I intend to stress the importance of strategizing in order to maximize efforts and avoid the most common mistakes in advocacy by using the latest social organization theories and examples from a variety of social movements.

KEEPING DEMOCRACY ALIVE

In 1835 Alexis de Tocqueville's Democracy in America warned us of the dangers in a democracy if the people serve only the token position of voting for their representatives:

> It is vain to summon a people, which has been rendered so dependent on the central power, to choose from to time the representatives of that power; this rare and brief exercise of their free choice, however important it may be, will not prevent them from gradually losing the faculties of thinking, feeling and acting for themselves and thus gradually falling below the level of humanity . . . It is indeed, difficult to conceive how men who have entirely given up the habit of self-government should succeed in making a proper choice of those by whom they are to be governed; and no one will ever believe that a liberal, wise and energetic government can spring from the suffrages of a subservient people.

Tocqueville understood the importance of local community involvement and the price that a democracy will pay if the participants become disenfranchised from the people and policies that they are voting on. It has been said that one of the things'that sets us apart from the rest of the animal kingdom is our ability to hope. Tocqueville foresaw that lack of involvement will eventually result in apathy, a state of hopelessness.

The book The Quickening of America: Rebuilding our Nation, Remaking Our Lives by Francis Moore Lappe and Paul DuBois (1994) chronicles people from various demographies, (mostly working class, middle or low income) and their involvement in everything from labor organizations to environmental and educational causes and puts forth the idea of a new democracy in which the process of democracy becomes a core value and way of life. Women and men report a feeling of personal empowerment and both tangible and perceived improvement in the quality of their lives as a result. Lappe and DuBois assert that community involvement and the connectedness it brings fulfills natural social needs in our being producing a ripple effect of positive change spanning across the community and into our personal lives. Specifically improvements are reported in their book as an increase in confidence, job satisfaction (often the result of new or different employment), communication skills , and interpersonal relationships, perhaps most importantly relationships with their children. The authors explain the new democracy as an excitement and energy that is contagious in nature and thus sweeping across the nation in every corner of America . Involvement appears to bring hope, and with it the realization of power and personal satisfaction that permeates their lives.

Similarly, much has been said in recent years as to the positive affects of gardening. It seems that the process involved; preparing the soil, planting the seeds, adding water and fertilizer, tending to the upkeep and then being able to revel in the tiny agricultural miracle that results invokes a spirit of connectedness in those who participate in it and is now being used in schools nationwide. Studies involving the use of community or personal gardens have also been done in the poverty stricken inner city projects with one of the results being a decrease in violence and crime. When people have something that they are responsible for and something for them to be involved in, it breathes life into their community giving them the connection and commitment that apathy destroys. For when a community, defined here as any group of people with a common belief, cause or physical proximity, comes together and is able to function together as a more cohesive unit, they are then more effective at tackling issues and facilitating change on the global level. If people do not feel sufficiently involved in the democratic process and view it more as something outside of their lives, then their support for the process is going to be lacking as well. In being involved at some level of activism intermittently for the past ten years, I have found that those people participating in some kind community, civic, educational or political organization and working toward change feel much more empowered as a rule compared to those who have no involvement in the making of decisions that affect them. Apathetic comments like "It doesn't matter anyway" or "nothing *we* can do about it" are mere statements of powerlessness.

We have all heard the popular green phrase "Think Globally, Act Locally" which is indeed applicable to every area of advocacy. In my experience with a chapter of the National Organization of Women (NOW) and with starting a Young Democrats in northern California I saw that when young women became involved in these organizations a spark emerged that lit up a part of them they had not yet been in touch with. When young people begin to educate themselves and in turn begin to educate others on issues affecting them they stop feeling like things are happening *to them* and start believing that they *have the power to change* what is happening. Chapters of NOW have been holding an event for over twenty years called "Take Back the Night" while the venue varies across the country generally there is a march where women and children (men are now welcome as well) walk through the streets, parks and neighborhoods that are particularly dangerous in terms of rapes and assualts. Participants chant, sing and proclaim that the streets belong to them and they will not tolerate being victims of these crimes. One of the reasons for this is undoubtedly psychological. It is a known fact that rape is about power and generally a rapist carefully picks a victim based on someone they percieve as being powerless. By marching in Take Back the Night the women report a feeling of empowerment that becomes a part of who they are and lends itself to all aspects of their life. The march is particulary effective because it is a nationwide effort; communites create their own unique event raging from speakers in the community and law enforcement, self defense workshops and education about womens issues, but the global effect is the collective consciousness Take Back the Night creates.

Saul Alinsky addresses another aspect of this issue in the 1946 classic Reville for Radicals. Alinsky asserts that it is an ancient fallacy to assume that the laws make the men rather than the men make the laws (41.) A prime example according to Alinski is prohibition. When laws or policies are enacted that are contrary to the thinking of the majority of the people and/or are not supported by the majority of the people the process becomes vulnerable to failure, "The structure will always be no more than a reflection of its substance (40.)" Laws exist prohibiting sexual and physical assualt yet unless a community comes together to collectively take a firm stand against these atrocities and unless we educate and empower our communities to protect themselves the laws are not going to alleviate the problem.

GETTING STARTED

In looking at social causes over the past 100 years it is clear that there are certain movements that succeeded, gained momentum, sympathy for the cause or were simply set in motion due to some characteristic windows of opportunity that made the time for framing and/or executing efforts optimum. In his article "Culture and Social Movements" from the book New Social Movements (1995), Doug McAdam lists them as the following:

Ideological or Cultural Contradictions

Whenever a commonly held cultural belief is at odds with a widespread cultural practice and an event occurs to dramatize this discrepancy, this can serve to legitimize an otherwise non-tolerated protest activity. McAdam cites Sara Evans' (1980) belief that it is this climate that fueled the feminist movement of the 1960's and 1970's (40.)

Suddenly Imposed Grievances

Edward Walsh (1981) coined the phrase that is used by McAdam to explain the phenomena that follows in the wake of "dramatic, highly publicized and generally unexpected events-human made disasters, major court decisions, official violence-that increase public awareness of and opposition to previously accepted societal conditions." Prime contempoary examples of this phenomona would be what the Anita Hill testimony did for sexual harassment in the workplace and the rise in level of consciousness regarding spousal abuse in the wake of the Nicole Brown Simpson murder trial.

Dramatizations of System Vulnerability

Another culturally framed opportunity is any event or combination of events or processes that "highlight the vulnerability of one's political opponents." The *Brown v. Board of Education* US Supreme Court decision to ban racial segregation is used by McAdam as an example to how the civil rights movement was able to capitalize on the legal and political vulnerability of the system of southern segregation and accelerate the civil rights movement nationwide (41.)

The Availability of Master Frames

This cultural phenomena supports the ideas set forth earlier by Lappe and DuBois regarding the contagious nature of activism. McAdam asserts that "movements tend to cluster in time and space precisely because they are not independent of each other (McAdam and Rucht 1993)." McAdam goes on to theorize that in the 1960's there existed a "master protest frame" based in the momentum of the civil rights movements of which all others could be considered sub-groups. Applying the same theory today with regards to activism across college and university campuses, labor movements and grass roots efforts world wide I believe the current *human rights* movement to be the contemporary nucleus of the"master protest frame."

ORGANIZATION OF POWER

One of the most overlooked items in the framework of a grass roots organizing is the absence of an effective strategy, a business plan if you will that will serve as the organizations blueprint for success. Without a steadfast plan energies are wasted, efforts scattered and it is easy to deviate from the groups mission, that is if an effective mission could be established in the absence of a succinct strategy.

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When definite strategies are not adopted it is easy for an organization to fall into a position of defense rather than the more desirable and powerful position of offense. When working primarily from the defense, a group is following someone else's agenda and is unable to take pro-active steps toward empowerment and realization of long-term goals. It is undoubtedly sometimes necessary to have a strong defense but for the most part defensive measures require short term fixes and thus gives rise to an organizations exhaustive state of "putting out fires". Whereas the strategy and implementation of a fire prevention program is long term and empowering for its constituents.

The development and implementation of an effective offensive strategy requires the organization to agree that the application and generation of power needs to "be controlled and applied for the attainment of the program or goal" (Alinsky 77.) In other words battles must be chosen wisely. Many grass roots organizations fall into a pattern of being unwilling to give up any part of its agenda in exchange for accomplishing bigger wins, because they do not want to give up anything to the "enemy." However, being flexible with regards to choosing what is the most important part of the ultimate mission provides bargaining power and leverage toward attaining a more significant victory. Also if an organization is unwillilng to compromise without a fight (which always drains precious resources) they are deemed not only unduly difficult but also less credible. Staying flexible allows for alternate and perhaps more feasible solutions that are not possible if a group is unwilling to participate at the proverbial or literal bargaining table while also building working relationships with those that they have the most to gain from.

It is not suggested however that something need always be given up nor does it mean to blindly accept compromises once an organization has built a working relationship with public officials, administrators, etc. In his book The Activists Handbook (1996), Randy Shaw address a powerful framework for dealing with elected officials, which can be applied to whomever an organization is working against, called the "fear and loathing approach (45.)" The technique is based on statements from Ernesto Cortez, Jr. of the Texas based Communities Organized for Public Service, regarding COPS's relationship to the local elected public officials;

> It's unfortunate that fear is the only way to get some positions to respect your power. They refuse to give you respect. They don't recognize your dignity. So we have to act in ways to get their attention. In some areas, what we have going is the amount of fear we can generate. We got where we are because people fear and loathe us (45.)"

This does not mean that it is not important to have any kind of working relationship with the officials. On the contrary, it means that when a relationship is developed it is important not to give up the power that the organization has gained by seeing these people as allies who are to be trusted and given blind concessions. Shaw points out that this is extremely critical in the case of a liberal or progressive official. If an organization begins to consider the official an ally or friend to the cause, the dangerous tendency is to not hold the person as accountable as an official who is non-sympathetic to the issues. This generally manifests into making excuses for the official (ie:"they are doing the best they can"), extending deadlines and no longer feeling comfortable with flexing the necessary political muscle so as not to offend the "ally." Having and adhering to a clear strategy will allow an organization to engage in dialogue and remain flexible while not compromising or deterring from the ultimate goals of the cause.

This same framework can be applied to fellow oranizations seen as allies. In a start up student political organization I was once a part of we had the opportunity as the associated student body to own a business that could have meant an incredible long term financial base for our organization and the many student clubs and organizations we would be giving financial assistance to. It so happened that one of these clubs was also interested in having the business. Problems arose for the student goverment when some members became very close to members of said club and felt that they did not want to step on anybody's toes or create any negative energy by putting the ultimate control of the business in the hands of the student goverment (who would then be able to filter any profit to all of the student clubs equally.) This resulted because there was not a clear agenda layed out as to our organizations financial goals and our responsibilties as the administrative body overseeing all student clubs and organizations. The result was not only a missed business opportunity but also a severe blow to the stregnth and credibility of our organization as a result of the internal power struggles that ensued. Again, problems that could have been easily avoided with a proper strategy from the onset.

CONCLUSION

The world is now at the dawning of a new century, experiencing technological and medical advances that never seemed possible one hundred years ago. Unfortunately our evolution in terms of compassion and activism is lacking in comparison. With the knowledge and technology currently available it seems incomprehensible that there are children still going to bed hungry and homeless; educational, economic or humanistic opportunities could be limited due to ones sex, ethnicity or religion; that natural resources including air and water are being destroyed and corrupted; and the list goes on. The hope for the new century lies in the activism of grass roots and community based social organizations and therefore in the awakening of the human spirit to feel individual power and responsibility to the delicate balance of all life on the planet. Saul Alinski said,"Logic tells us, "We'll believe it when we see it." But there is also the converse, faith. Faith, or belief in the people tells us, "*We'll see it when we believe it*" (235.)" It is not hard for people to become empowered for it is intrinsically inside all of us. Knowing when to get started, and what to do to make the most of available resources is the key. In closing I offer a quote from Randy Shaw, "By acting proactively and with tactical and strategic wisdom, social change activists can bring a degree of social and economic justice to the next century that has for too long been deferred (279.)"

REFERENCES

Alinsky, Saul D. (1946) Reveille for Radicals (vintage ed.). New York: Vintage Books.

Alinsky, Saul D. (1971) Rules for Radicals: A Prgamatic Primer for Realistic Radicals. New York: Viontage Books.

Bettencourt, B.A. (Spring 1996) Grassroots Organizations: Recurrent Themes and Research Approaches. Journal of Social Issues, v52, n1, 207(14)

Brief, D.E. , Collins, B.E. & Miller, A. G. (Fall 1995) Perspectives on obedience to Authority: the Legacy of the Milgran Experiments. Journal of Social Issues, v51, n3, 1(19)

Chaiken, Miriam S. & Fleuret, Anne K. (1990.) Social Change and Applied Anthropology : Essays in Honor of David W. Brokensha. Boulder: Westview Press.

Darnovsky, M., Epstein, B., & Flacks, R. (Eds.) (1995) Cultural Politics and Social Movements. Philadelphia: Temple University Press.

DuBois, Paul M. & Lappe, Francis M. (1994) The Quickening of America: Rebuilding our Nation, Remaking Our Lives. San Francisco: Jossey Bass.

Fetterman, David M. (1993). Speaking the Language of Power : Communication, Collaboration, and Advocacy:Translating Ethnography Into Action. Washington, D.C.: Falmer Press.

Gans, Herbert J. (1985). The War Against The Poor: The Underclass and Antipoverty. New York: Basic Books.

Goldschmidt, Walter (ed.). Anthropology and public policy : A Dialogue Washington, D.C.:American Anthropological Association

Gusfield, J., Jonston, H., & Larana, H. (Eds.) (1994) New Social Movements: From Ideology to Identity. Philadelphia: Temple University Press.

Fenno, Richard F., Jr. (1990) Watching Politicians: Essays on Participant Observation. Berkeley: Institute of Government Studies Press.

Hurley, Susan & Shute, Steven. (Eds.) (1993) On Human Rights: The Oxford Amnesty Lectures. New York: Basic Books.

Shaw, Randy. (1996) The Activists Handbook. Berkeley: University of California Press.

712

Peering into the success of peer feedback: Understanding how feedback works in elementary-aged writers

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Peer feedback is an effective tool in the revision process of elementary school writers. Past research credited Piaget's theory of egocentrism for this success. It had been suggested that receiving feedback informs the writer. However, Vygotsky contends that children learn through developing inner-speech. Accordingly, the act of giving feedback is the instructional element of peer feedback. Participants included 77 fifth grade students at a suburban school. Students rewrote according to one of four peer feedback conditions (giving feedback/getting feedback, giving feedback/not getting feedback, not giving feedback/getting feedback, not giving feedback/not getting feedback). While statistical significance was not reached, students giving feedback/not getting feedback showed greater overall improvement.

BACKGROUND

Children work for years learning and practicing writing skills in an effort to gain writing proficiency. The process of writing is no doubt demanding of the young child who is still trying to master small motor skills and spelling (Berninger et al., 1992; Bereiter & Scardamalia, 1987). Teachers have addressed these limitations by allowing students to record their stories on tape or tell their stories to someone who transcribes them. Some teachers encourage inventive spelling to remedy the limitations of beginning spelling skills. Many children go on to become proficient writers; others seem stuck in this beginning stage. The remedial activities above may motivate children to write, but what facilitates development beyond these starter skills?

Barrs (1983) believes that it is important to view children as writers but to acknowledge the problems they encounter in writing as unique to their age. Olson (1990), in agreement with Barrs, identifies these problems as stages in development. Olson views one problem to be the inability of the young writer to understand audience awareness. While providing tools such as inventive spelling to aid the writer's restricted language skills, educators have also used techniques of revision to promote student understanding of the written language. These techniques include several types of feedback: teacher conferencing, teacher written comments, peer conferencing, self-monitoring and computer-generated feedback. Studies by Freedman (1987) and Olson found peer feedback to be the most effective method. It is not yet understood why this is true.

Researchers such as Olson (1990), who study peer feedback, point to Piaget's concept of egocentrism to help explain the limitations of student writing. Olson believes that peer feedback works because the child gains a sense of audience awareness from the other student. However researchers Liva, Fijalkow and Fijalkow (1994), studying the success of student task completion, found that children who verbally explain a task are more able to complete it. This test of Vygotsky's inner-speech theory suggest that learning comes from within the child rather than from an audience effect. Researchers who support Piaget's theory believe that the information given through feedback informs the writer. Yet, applying Vygotsky's theory of inner-speech to the process of revision, peer feedback is successful because the child, in giving feedback, learns inner-speech which will regulate revision.

Peer feedback is recognized as an effective tool in teaching writing skills to elementary-aged children. It is the intent of this study to determine why feedback works. It is proposed that in giving feedback, the student learns inner-speech prompts about writing. These prompts inform the student about his or her own writing ambiguities. Based on Vygotsky's theory that learning language occurs through inner-speech development, it is predicted that students who give feedback will show greater improvement in writing than students who do not give feedback.

METHODS

Participants

Seventy-seven suburban grade school students, aged ten to eleven, participated in this project. The students were in one of four fifth grade Language Arts classes. The classes were randomly assigned to one of four groups. Permission to work with the students and collect data was obtained from the school and parents.

Materials

Instruction of all students included reading the folktale Strega Nona. A web sheet was provided for each student to help organize the story. Editing was modeled on an overhead projector.

Design and Procedure

Classes were randomly assigned to one of four conditions. One class of students, assigned to the exchange group, gave and received feedback from a peer before rewriting. A second class of students assigned to the giving group gave feedback to other students but rewrote their stories without receiving feedback. A third group of students assigned to the receiving group got feedback from other students but did not give feedback before rewriting. A fourth group of Students assigned to the control group neither gave or received feedback before rewriting.

All students received 45 minutes of writing instruction, three times a week for two weeks. Instruction included information about writing. The information discussed was the same for each group with the exception of references to peer feedback during editing. Students in the control group received the same information regarding the kinds of questions asked during editing, but instruction did not specifically address peer questioning as a component of editing. Class discussion and modeling provided a base for the writing. The day before the data was collected, students were told that they would be writing about an event in their own lives. This allowed for variations in composing styles. Each student wrote one story in a 45 minute time period and revised it two days later.

Students in the control group rewrote their stories without feedback. Students in the exchange group were randomly paired. One student from each pair was given their partner's story to read and discuss with the partner for 15 minutes. The partner whose story had just been critiqued then became the editor, reading the other student's paper and providing feedback for 15 minutes. Both students then revised their stories. Students in the receiving group were paired with students from the giving group. One student assigned to the giving group was given their partner's story to read. The story was read and the reader provided feedback for 15 minutes. The students receiving feedback then left for another class. The students giving feedback then edited their own stories without further discussion.

Scoring

The stories and their revisions were compared for the number and type of improvements made. The groups were then compared for differences in improvements between conditions. Scoring the stories included five points each for character-clarity, plot development, setting development, continuity and conclusion. These points were then combined to create a content score. Spelling, grammar, and punctuation errors were counted and divided from the total word count giving a "words per error" score. The content score was then added to the words per error score to create an overall performance score. To determine improvement from first write to rewrite, each student's revised story was scored similarly. Five additional points were given for each piece of information added during the revision process which provided further development or clarification. A words per error score was also calculated for the revised version. These scores were combined, as in the first write, for an overall performance score. Scores in content, words per error and overall performance from the first write were subtracted from the content, words per error, and overall performance scores of the edited story to create word error improvement, content improvement and overall improvement scores. Scores were compared within subjects from first write to rewrite and between subjects by condition.

RESULTS

Analysis included a 2 x 2 ANOVA to determine if there were significant differences in the means on the measure of writing improvement between giving feedback and getting feedback in three areas: words per error, content and overall improvement. Results showed there was no significant difference between the students who gave feedback and those who received feedback

714

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for the conditions of words per error improvement, F (2, 76) = .212, p = .810, content improvement, F (2, 76) = .780, p = .462, or overall improvement, F (2, 76) = .098, p = .907. Paired-samples t-tests determined there was significant improvement in words per error for two groups, give only and give and get. Paired t-tests also indicated significant content improvement for all groups (see Tables 1, 2).

Independent-samples t-tests indicated a significant difference in homogeneity between the give only and give and get conditions. The Levene's Test for Equality of Variances suggest significant levels of unequality for words per error and overall performance (p = .04). This may be due to a difference in sample size compounded by overall small sample sizes.

Table 1: Mean Scores of Words-per-Error for All Students

Group	n	First Write	Rewrite
Control	20	15.71	19.10
Give/Get	18	22.28	26.93*
Give only	18	17.19	27.63**
Get only	21	15.08	22.31

* significant improvement from first write to rewrite p < .05.
** significant improvement from first write to rewrite p < .01.

Table 2: Mean Scores for Content for All Students

Group	n	First Write	Rewrite
Control	20	16.50	20.25**
Give/Get	18	13.61	15.56*
Give only	18	5.46	6.03*
Get only	21	14.05	17.86**

* significant improvement from first write to rewrite p < .05
** significant improvement from first write to rewrite p < .01

DISCUSSION

The results of this study indicate that the type of feedback condition did not significantly influence the student's editing ability. In most instances, however, there was significant improvement within each group. Significance was not reached in only two cases, words per error of the control group and of the get feedback group. The fact that significant improvement was not reached in all groups for words per error is interesting. It appeared that students easily recognized the spelling and grammar errors in both their own writings and the writings of other students. In observing students during the feedback stage, it was noted that students tended to focus on spelling errors. This was also evidenced in their editing notations. This could be explained because this area of writing is concrete (words are either spelled correctly or incorrectly). However, the results suggest that this type of correction benefited from the act of giving feedback.

It was hypothesized that the process of editing another's work educated the student in the questioning skills necessary to edit his or her own work in a similar manner. Past researchers suggested that detecting areas of ambiguity required an objectivity or knowledge that only an outsider possessed. All groups demonstrated significant improvement in content from first write to revision. This may be due to the instruction students received in an effort to equalize their past educational experiences. In all classes, ambiguities and clarification in writing were discussed and modeled. Furthermore, students appeared genuinely interested in this questioning process.

It is interesting to note that although there was not a significant difference between groups for content improvement, results showed a tendency for students in the getting and not giving group and the control group to do better than the giving only group or giving and getting group. This is hard to understand. If these results could be broken apart, it may be suggested that the success of students receiving feedback supports Olson's (1990) theory, that egocentrism limits the student's ability to detect ambiguities. However to suggest this, students in the giving and getting group should have also done better than students in the giving only group. This was not the case, the students who gave and received feedback showed the least improvement.

To explain the success of the control group, it is necessary to consider the unique situation that arose. It was later discovered that the control group was a class in which two-thirds of the students worked at below grade level. This may have effected their level of performance. In a sense, they may have benefited more from instruction that the other classes due to their limited knowledge going into the project. They may have had a greater learning window. The constant modeling and use of visuals may have optimized their ability to understand the writing and the editing process. Their success may also be attributed to Hull's (1987) findings that poor writers, who are often poor readers, concentrate on comprehension as they try to understand text.

The results from the words per error scores suggest that it is more beneficial to give feedback than to get feedback. However, as with the content improvement scores, students who gave and got feedback did poorly. These students seemed as engaged as the others during instruction. Perhaps in the process of two-way editing the students lost their focus, however, this did not seem to be the case in observing their editing discussions.

Further research will need to include long-term instruction to override students' past education in editing practices. Allowing long-term instruction will control for students overly focusing on the areas to be measured, different learning styles and previous learning experiences.

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REFERENCES

Barrs, M. (1983). The new orthodoxy about writing: Confusing process and pedagogy. Language Arts, 60, 829-840.

Bereiter, C. & Scardamalia, M. (1987). The psychology of written composition. Hillsdale, NJ: Erlbaum.

Berninger, V., Yates, C., Cartwright, A., Rutberg, J., Remy, E., & Abbott, R. (1992). Lower-level developmental skills in beginning writing. Reading and Writing: An Interdisciplinary Journal, 4, 257-280.

Freedman, S. W. (1987). Response to student writing. Urbana: National Council of Teachers of English.

Liva, A., Fijalkow, E. & Fijalkow, J. (1994). Learning to use inner speech for improving reading and writing of poor readers. European Journal of Psychology of Education, 9, (4), 321-330.

Olson, V. L. Brakel (1990). The revising processes of sixth-grade writers with and without peer feedback. The Journal of Educational Research, 84, 22-29.

Piaget, J. (1955). The Language and Thought of the Child. (M. Gabain, Trans.). New York: Meridian.

Vygotsky, L. (1986). Thought and Language. (A. Kozulin, Trans.). Cambridge: The MIT Press. (Original work published 1934)

The Impact of Acculturation Type, Stress, and Social Support Among Mexican-American Adolescents

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Research has shown that the acculturation process is a source of stress for minority students leading to interpersonal stress and adjustment problems. For the Mexican-American population it is important to further investigate what impacts these experiences. The purpose of this study was to examine (a) the impact of acculturation type and gender on social support and (b) the impact of acculturation type, gender, and social support on stress among Mexican-American adolescents ($N=113$). Data analysis consisted of two ANCOVAs, one for each research question, which yielded significant results for gender on social support and social support on stress. The results have implications for intervention related to acculturation and social support skills. In addition, preventive measures can be used to decrease stress for students at risk.

BACKGROUND

U. S. Hispanics are quickly becoming the largest minority, and much research on acculturation and the effects of acculturation with this group has been done. Acculturation has been defined in many ways but all suggest that it is a process of change experienced by members of a minority group toward the adoption of the majority group's culture (Negy & Woods, 1992).

Most studies on acculturation have focused on adults, but in recent years a shift to examining culture change among younger populations has occurred. Primarily studies on youth investigate the impact of acculturation on health issues like drug use and pregnancy (Barrett, Joe, & Simpson, 1991; Reynoso, Felice & Shragg, 1993).

Other topics investigated have been the relation of acculturation and values in first generation Mexican-Americans (Domino and Acosta, 1987). The authors found that those showing a higher degree of acculturation ranked values similarly to rankings of those by Anglo subjects. Szapocznik, Scopetta, and Tillman (1977) found that factors that affected acculturation in a sample of Cuban immigrant families included variables such as length of exposure to the host culture, age, and gender. The authors reported that rates of acculturation differ among females and males with males acculturating faster. In addition, the process of acculturation affects family members differently. The process becomes accelerated in the children and "retarded" in the parents (Szapocznik et al., 1977).

Padilla (1980) described the process of acculturation as consisting of three stages. The first stage is contact. Contact occurs when someone from one culture enters another. Typically for children and adolescents contact occurs in the schools. The second stage is conflict. It is in this stage that and individual's response to the contact is examined. Conflict may occur if differences in world views, culture, and traditions between the individual and the new culture exist. The final stage is adjustment in the form of acceptance, reaction, or withdrawal. Students resolve conflict by either withdrawing from, reacting to, or accepting the new culture however for children and adolescents how they respond to conflict is not made independent of others. Their choices can be restricted by adults at home, school, or in the community.

The measurement of acculturation in children, adolescents, and adults has been the focus of many studies as well (Franco, 1983; Collier, 1985; Szapocznik, 1978; Mendoza, 1989; Olmedo, Martinez, & Martinez, 1978). Less research has been done on the impact of stressful changes on the development of adolescents. Factors that are associated with stress or stressful events in children and adolescents include the child's own characteristics (i.e. Type A behavior), factors inside/outside the home, parental fights/separation, academic retainment, the child's biopsychosocial competencies (including social support), and the pleasantness of events (Hawkins, 1981).

Research has also shown that the experiences at school are a source of stress for young people, impacting their homework, family, friends, as well as their physical or emotional well-being. Minority children may experience higher levels of school stress because of the differences in family ecology and school environment, leading to problems developing a sense of belonging and social support (Munsch & Wampler, 1993).

The process of acculturation itself has been found to be a potential source of stress called acculturative stress (Padilla, 1980), possibly impacting ethnic adolescents. Seeking and attaining acculturation instigates interpersonal stress in ethnic minorities and is accompanied by more adjustment problems (deDomanico, Crawford, & De Wolfe, 1994). A Mexican-American adolescent's adjustment can either be enhanced or inhibited by the acculturating process (deAnda & Becerra, 1984). Further, Williams and Berry (1991) emphasize the effect of acculturative stress:

> The concept of acculturative stress refers to one kind of stress, that in which the stressors are identified as having their source in the process of acculturation, often resulting in a particular set of stress behaviors that include anxiety, depression, feelings of marginality and alienation, heightened psychosomatic symptoms, and identity confusion. (p. 634)

These authors found that the degree of acculturative stress experienced depends on many factors: mode of acculturation, phase of acculturation, way in which majority culture exerts its acculturative influences, socioeconomic status, social support, acceptance/prestige of ones group in acculturation settings, and psychological variables (i.e. social support). Ramirez and Hosch (1991) also showed evidence that acculturative stress affected family functioning.

It has been suggested that bicultural (acculturating to the majority culture while keeping values from your own culture as well) students are better able to mediate acculturative stress in culturally uncertain situations (DeDomanico et al., 1994). DeDomanico et al (1994) also found that bicultural identity is related to better adjustment. As a result for minority children, being bicultural is more beneficial as far as social support and adapting are concerned. Another study by Montgomery (1992) with a sample of students from South Texas found "that as one moves through the generations, one becomes more bicultural/blended and comfortable and less bicultural/blended and alienated...over generations, subjects lose their enthusiasm for their Anglo preference, and indicated a more Mexican preference" (p. 217). As can be seen in these studies being bicultural was related to better coping in adolescents. However, a study on acculturation and adjustment by Moyerman and Forman (1992) failed to find a consistent unidirectional effect of acculturation on adjustment.

Support networks traditionally in the form of family ("familismo"), are important in the Mexican-American culture. Acculturation has an effect on this support system for adolescents in families and evidence has been contradictory. In a study by Ramirez and Hosch (1991) with families from a bicultural community it was found that encouraging biculturalism is important in minimizing detrimental effects of acculturation among these families with adolescents. Another study with a sample consisting of African-Americans, White, and Mexican-American adolescents making the transition to 7th grade showed that minority students involved relatives (parents and siblings) more often in their support networks than Whites in regard to social support. The extended family may be an important resource for minority youth as they explore their cultural heritage (Phinney & Chavira, 1992).

Researchers have failed to research fully the impact of acculturation type (from very Mexican-oriented to very Anglo-oriented) on stress and social support. Exploring these factors is important because they have been found to be interrelated, in particular social support on stress. It is believed that acculturation type and gender impact social support, and that all three of these variables influence stress. Thus this study attempts to find (a) the impact of acculturation type and gender on social support and (b) the impact of acculturation type, gender, and social support have on stress among Mexican-American adolescents.

METHOD

Participants

Hispanic students in grades 9 through 12 from schools in the Midwest and Southwest were asked to participate. Schools selected for this study were those with a high percentage of minority students. All Mexican-American students in the various schools were sent permission letters and those who returned them were selected for the project.

The identification of the students and their parents were compared. The majority of students (77%) identified as either Mexican-American (46%) or Mexican (31%). The majority of parent's (81%) identified as Mexican-American or Mexican of which 55% identified as Mexican.

Instruments

Acculturation Rating Scale for Mexican-Americans (ARSMA). The ARSMA (Cuéllar, Harris, & Jasso, 1980) consists of twenty items which measures acculturation at five different levels: Type 1, very Mexicano; Type 2, more Mexican oriented; Type 3, bicultural; Type 4, more Anglo oriented; and Type 5, Anglo oriented. The ARSMA is based on four factors: language familiarity, usage, and language; individual ethnic identity and generation; reading, writing, general cultural heritage and exposure; and ethnic interaction. The instrument possesses adequate reliability and validity.

Social, Attitudinal, Familial, Environmental (SAFE) Acculturative Stress Scale. The SAFE Acculturative Stress Scale (Padilla, 1986) consists 60 items rating from 1 (Not Stressful) to 5 (Extremely Stressful). Stressors among immigrant and later generation multi-cultural populations such as Mexican-Americans are assessed by the SAFE. Internal reliability for the SAFE revealed a coefficient of .89.

718

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The Interpersonal Support Evaluation List (ISEL) The ISEL (Cohen & Hoberman, 1983) consists of 5 types of social support based on the support-buffering model: total support, belonging support, self-esteem support, appraisal support, and tangible support. Currently, the ISEL has been changed to a questionnaire containing 40 items with four response choices ranging from Definitely True to Probably False. There is no reliability and validity available for this format.

Procedure

Once students returned their permission letters they were given a consent form. The instruments were administered as a group or individually. The questionnaires were administered by a designee at the sites.

Analysis

ANCOVAs were conducted to assess the influence of acculturation type and gender on social support and to estimate the effect of acculturation type, gender, and social support on stress.

RESULTS

Data Analysis

The first ANCOVA addressed the impact of acculturation type and gender on social support. The results of the ANCOVA revealed significant findings for gender. This suggests that differences in social support are accounted for by differences in gender.

Table 1: ANCOVA Results for Acculturation Type and Gender on Social Support*

Source	Df	SS	MS	Fvalue	Pr > F
Gender	1	1.20	1.20	6.50	0.01***
Error	110	20.28	0.18		
Corrected Total	112	21.69			

ISEL measures social support* ***significant

Results of the second ANCOVA measuring the influence of acculturation type, gender, and social support on stress revealed significance for social support. This suggests that social support influences the amount of stress.

Table 2: ANCOVA Results for Acculturation Type, Gender, and Social Support* on Stress

Source	Df	SS	MS	Fvalue	Pr > F
ISEL*	1	3.88	3.88	7.30	0.008***
Error	108	57.41	0.53		
Corrected Total	112	63.81			

* ISEL measures social support *** significant

Descriptive analysis indicated that a greater proportion of adolescents described themselves as Type 2 - Bicultural, more Mexican-oriented (55%). Within this group, a greater percentage rated their stress level as low. However, in comparison with different acculturation type adolescents those defined as Type 2 exhibited the greatest stress. Further, of 65 students ranked in the low stress level, 57% were students in Type 2. Mean analysis of gender and stress showed slightly higher stress among males than females (mean =2.6, S.D.=.79 vs. mean=2.53, S.D.=.79). On the other hand the women's mean on social support was higher than the men's (mean=3.17, S.D.=.43 vs mean=2.95, S.D.=.42).

DISCUSSION

In recent years an impetus to investigate academic success among Mexican-Americans has emerged. However, few studies have examined acculturation and psychological factors such as stress and social support among Mexican-American adolescents. In this study the purpose was to examine the impact of acculturation type and gender on social support and the effects of acculturation type, gender, and social support on stress. ANCOVAs were used to determine significance between the variables of interest. Descriptive analysis provided further examination of results.

The first ANCOVA revealed significant results for gender and social support. This suggests that significant gender differences exist, with women rating their support as higher. Results of the second ANCOVA on stress indicated significance for social support, suggesting that support makes a difference on how stress is mediated. Although not significant, descriptive analysis revealed that adolescents in Type 2 (Bicultural, Mexican-Oriented) showed the greatest and the least stress compared to others in differing acculturation types.

The results of this study support previous findings in relation to gender differences. Males showed slightly greater stress than women. However social support appeared to moderate these results. Women showed more social support than men. Given that men showed greater stress while women showed more social support, the data do not clarify whether women were still highly stressed. It could be that because of strong social support, women's stress was not perceived as high. Women have been shown to adapt easier, subsequently reducing stress levels (Garcia-Vázquez, Vázquez, & Huang, In Press). At the same time the females in the present study were at Type 2 suggesting a dynamic process of acculturation.

Although these results support previous findings, it was interesting to find that Type 2 adolescents were found to have the lowest and highest stress levels. Perhaps adolescents were at differing levels of acculturating, leading some to perceive more stress while others less. Further research could examine what contributes to stress when adolescents are at Type 2.

Implications

The information gained from this study can help in implementing academic and psychological interventions. For adolescents in the process of acculturation, it will be important to provide social support to ease the stress associated with the process. This will be especially important since stress affects social, emotional, and academic endeavors. Of particular importance would be to provide support for males, who may be experiencing greater sources of stress. As a result, preventive measures could be implemented to reduce stress for adolescents at risk. Counseling programs, peer support, and academic strategies are examples of preventive measures. At the same time, it will be critical to provide assistance for adolescents experiencing high stress. Since the females in this study seemed to have greater social support, examining the types of coping strategies they utilized could assist other adolescents.

Limitations

Limitations to this study may have influenced the findings. The sample size (N=113) and restriction of range on acculturation may have limited the significance of the study. In addition, the scope of the study did not address the relation between stress and social support. Teasing out their interaction could clarify their impact on other factors. Another limitation is the instruments employed. While these questionnaires are reliable and often used on children and adolescents they are not normed on adolescents. Because of these limitations further research with these variables is necessary, especially among Mexican-American adolescents. Limitations aside, the strength of the study lies in helping the professional understand the lives of Mexican-American adolescents.

REFERENCES

Barrett, M. E., Joe, G. W., & Simpson, D. D. (1991). Acculturation influences on inhalant use. *Hispanic Journal of Behavioral Sciences, 13*(3), 276-296.

Cohen, S. & Hoberman, H. M. (1983). Positive events and social supports as buffers of life change stress. *Journal of Applied Social Psychology, 13(2)*, 99-125.

Collier, C. (1985). Acculturation and education: Characteristics of referred and non-referred culturally and linguistically different children. *Dissertation Abstracts International, 46*, 2993A.

Cuéllar, I., Harris, L. C., & Jasso, R. (1980). An acculturation scale for Mexican-American normal and clinical populations. *Hispanic Journal of Behavioral Sciences*, 2, 199-217.

de Domanico, Y. B., Crawford, I., & De Wolfe, A. S. (1994). Ethnic identity and self-concept in Mexican-American adolescents: Is bicultural identity related to stress or better adjustment? *Child & Youth Forum, 23*(3), 197-206.

Der-Karabetian, A. & Ruiz, Y. (1993). Affective bicultural and global-human identity scales for Mexican-American adolescents.

Domino, G. & Acosta, A. (1987). The relation of acculturation and values in Mexican-Americans. *Hispanic Journal of Behavioral Sciences, 9*(2), 131-150.

Franco, J. (1993). An acculturation scale for Mexican-American children. *The Journal of General Psychology, 108*, 175-181.

Garcia-Vázquez, E., Vázquez, L., & Huang, C. (In Press). *College Student Journal.*

Hawkins, R. C. (1981, November). *Childhood stress and coping: A review and cognitive-developmental theory.* Paper presented at the meeting of the Texas Psychological Association, Houston, Texas.

Mendoza, R. H. (1989). An empirical scale to measure type and degree of acculturation in Mexican-American adolescents and adults. *Journal of Cross-Cultural Psychology, 20*(4), 372-385.

Montgomery, G. T. (1992). Comfort with acculturation status among students from South Texas. *Hispanic Journal of Behavioral Sciences, 14*(2), 201-223.

Moyerman, D. R. & Forman, B. D. (1992). Acculturation and adjustment: A meta-analytic study. *Hispanic Journal of Behavioral Sciences, 14*(2), 163-200.

Munsch, J. & Wampler, R. S. (1993). Ethnic differences in early adolescents' coping with school stress. *American Journal of Orthopsychiatry, 63*(4), 633-646.

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Negy, C. & Woods, D. J. (1992). The importance of acculturation in understanding research with Hispanic-Americans. *Hispanic Journal of Behavioral Sciences, 14*(2), 224-247.

Olmedo, E. L., Martinez, J. L., & Martinez, S. R. (1978). Measure of acculturation for Chicano adolescents. *Psychological Reports, 42*, 159-170.

Padilla, A. M. (1980). The role of cultural awareness and ethnic loyalty. In A. M. Padilla, (ed.) *Acculturation: Theory, models and some new findings* (p. 47-84). Boulder, Colorado: Westview Press.

Padilla, A. M. (1986). Acculturation and stress among immigrants and later generation individuals. In D. Frick, H. Hoefort, H. Lequire, R. Mackensen, & R. K. Silbereisen (Eds.), The quality of urban life: Social, psychological, and physical conditions. (Pp. 100-120). Berlin: de Gruyter.

Phinney, J. S. & Chavira, V. (1992). Ethnic identity and self-esteem: An exploratory longitudinal study. *Journal of Adolescence, 15*, 271-281.

Ramirez, J. I. & Hosch, H. M. (1991). The influence of acculturation of family functioning among Hispanic Americans in a bicultural community. *Biennial Conference on Community Research and Action, June 6-8.*

Reynoso, T. C., Felice, M. E., & Shragg, G. P. (1993). Does American acculturation affect outcome of Mexican-American teenage pregnancy? *Journal of Adolescent Health, 14*(4), 257-261.

Szapocznik, J., Scopetta, M. A., & Tillman, M. S. (1977, January). What changes, what remains the same, and what affects acculturative change in Cuban immigrant families. Paper presented at the meeting of the Conferencia: Los Cubanos en los Estados Unidos, Miami, Florida.

Szapocznik, J., Scopetta, M. A., Kurtines, W., & de los Angeles, M. A. (1978). Theory and measurement of acculturation. *Interamerican Journal of Psychology, 12*, 113-130.

Williams, C. L. & Berry, J. W. (1991). Primary prevention of acculturative stress among refugees. *American Psychologist, 46*(6), 632-641.

Physiological Responses to Racist Stressors Among African-American College Students

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The of the study was to investigate differences in cardiovascular responses to black on black racism and white on black racism. Thirty black male and female college students participated. The participants watched two scenes on videotape: a black person being harassed by another black person, and a black person being harassed by a white person. It was hypothesized that cardiovascular responses would be greater during the scenes depicting white on black racism. A t-test was used to detect differences in cardiovascular reactivity between African-American males and females. Significant gender differences were found in heart rate responses to both the white on black racism scene, t (40)= 5.54, p=.000, and the black on black racism scene, t (40)= 4.92, p=.000. A second significant finding was the diastolic blood pressure measurement to the white on black racism scene, t (37)= 2.00, p=.053. This study will help identify which type of racial stressors produce the greatest physiological responses to stress.

INTRODUCTION

Racism is the experience of ethnic prejudice or discrimination (Clark, Anderson & Clark, unpublished manuscript). Two main types of racism are attitudinal and behavioral (Yetman, 1985). Both forms of racism are debilitating stressors for many African-Americans (Lawrence, 1983). Attitudinal racism refer to attitudes or ways of thinking that discriminate against individuals or groups because of their phenotypic characteristics. Behavioral racism is referred to as any act of discrimination that denies an individual or group equitable treatment (Yetman, 1985).

Because of the difficulty of measuring physiological changes to racism in a natural environment, researchers have utilized the laboratory to obtain results (Clark, Anderson & Clark, unpublished manuscript). For example, Sutherland and Harrell (1986-1987) found that imagining racially noxious and fearful scenes produced an increase in facial muscle activity in women. When compared to resting measures, imagining these scenes also resulted in increases in heart rate (Sutherland & Harrell, 1986-1987). In examining the interaction of racism and gender, it was found that males showed higher cardiovascular reactivity to racist stressors than females (Stone, Dembroski, Costa & MacDougall, 1989).

The present study investigated gender differences in cardiovascular reactivity to black on black racism and white on black racism. It was hypothesized that males would have greater cardiovascular reactivity to both racist scenes than females.

METHOD

Participants

Twenty-five females from Spelman College in Atlanta, Georgia and twenty-five males from Morehouse College in Atlanta, Georgia volunteered to participate in the study. The students were between the ages of 18-26 and were screened for cardiovascular disorders.

Apparatuses

The Medex NCCOM3 impedance cardiograph and microcomputer system were used to assess heart rate. To obtain these measures, eight electrodes were placed on the neck and both sides of the body near the area of the xiphisternum. Blood pressure was taken by the Ohmeda Fina Pres Model 2300 blood pressure monitor. The psychological stressors used in the experiment were two racist scenes and one neutral scene on videotape. One of the racist scenes depicted African-American students being harassed by white students (white on black scene). The other racist scene depicted an African-American soldier of higher rank harassing another African-American soldier of lesser rank because of his race (black on black scene). The neutral scene, which served as a control, showed a rabbit running through a field at sunset. Prior to the experiment, each individual was given a screening form and an informed consent form. The screening form identified medical conditions that excluded the individual from participating in the study. The informed consent form was administered after an explanation of the nature of the study was given.

Procedure

Upon entrance into the participant room, each participant was given a screening form and a consent form. After the presentation of each scene, the participants were asked to reflect on what they saw. They were asked to put themselves in the position of the victim and speak to the authority figure. Heart rate and blood pressure were measured as the participants viewed the three scenes. Heart rate and blood pressure measurements were taken prior to the stimulus, during the stimulus, while the participant reflected on the stimulus, and while the participant recovered from the stimulus. Each period lasted eighty seconds and measurements were taken every twenty seconds. The mean averages of measurements were used in the analyses of the results.

RESULTS

A t-test was used to detect differences in cardiovascular reactivity between African- American males and females. Significant gender differences were found in heart rate responses to both the white on black racism scene, t (40)= 5.54, p=.000, and the black on black racism scene, t (40)= 4.92, p=.000, with females having higher cardiovascular responses than males. Females also had higher diastolic blood pressure measurements than males in response to the white on black racism scene, t (37)= 2.00, p=.053. In addition, a t-test was used to detect heart rate and blood pressure differences between the baseline and stimulus periods between males and females. These findings were not significant.

Figure 1

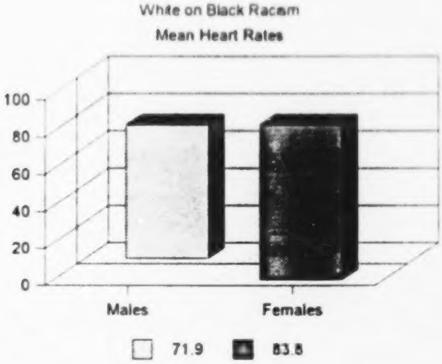


Figure 2

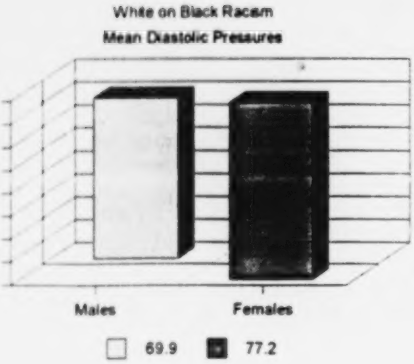
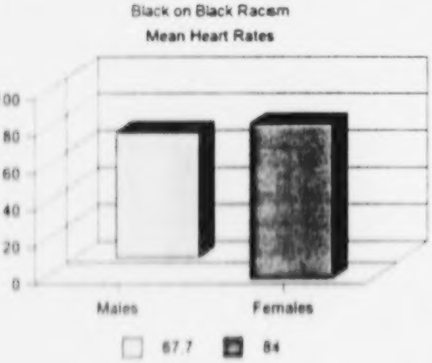


Figure 3



DISCUSSION

The hypothesis that males would have greater cardiovascular responses to the scenes than females was not supported. Females had higher blood pressure and heart rate activity than males. These findings contradicted research results found by Stone et al., (1989) who found that males had greater cardiovascular reactivity than females. One possible difference in the two studies is the nature of the stressor used. The present study used racist scenes as a stressor. Females were more responsive to such overt acts of racism than their male counterparts, possibly because women are socialized to express their feelings where as males are socialized to suppress their feelings.

It is believed that the present study will be helpful in identifying stressors that produce the greatest physiological responses. Once they are identified, researchers may be able to predict what stressors are most detrimental to a person's overall health and well being.

ACKNOWLEDGMENTS

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REFERENCES

Clark, R., Anderson, N. B., & Clark, V.R. (1997). Racism as a chronic stressor for African Americans: A Biobehavioral Model. Manuscript submitted for publication.

Lawrence, L.E. (1983). Stress and the black medical family. Journal of the National Medical Association, 75, 749-753.

Stone, S., Dembroski, T., Costa, P., & MacDougall, J. (1989). Gender differences in cardiovascular reactivity. Journal of Behavioral Medicine, 13, 137-141.

Sutherland, M. E., & Harrell, J.P. (1986-1987). Individual differences in physiological responses to fearful, racially noxious, and neutral imagery. Imagination, Cognition and Personality, 6, 133-150.

Yetman, N. (1985). Introduction: Definitions and perspectives. In N. Yetman (Ed.), Majority and minority: The dynamics of race and ethnicity in American life (4th ed., pp. 1-20). Boston: Allyn and Bacon.

Gender Differences in Perceptions of Marital Infidelity: Sexual Versus Emotional Cheating

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A study of martial infidelity was conducted in which undergraduate students at a small liberal arts college read passages containing sexual and emotional cheating behavior. Participants rated the degree of fault attributed to each party: the cheater, noncheater, and third-party. Differences in degree of fault for each party and between passages, the gender of the party found at fault compared to the gender of the participants (p<.003), and past infidelity of participants were explored. Evolutionary psychology was utilized to explain the differences found. Uxoricide, wife killing, is linked to this study as a consequence of martial infidelity.

BACKGROUND

Cheating, infidelity, and unfaithfulness are three synonymous terms for one behavior. But is it one behavior? A student can cheat on a test (Enker, 1987), a friend can be disloyal, and a spouse can be unfaithful (Peck, 1975). Studying infidelity can cover such a wide range of behaviors and conditions that it is necessary to limit the categorical terms (Thompson, 1984). This study encompasses extramarital infidelity.

Green, Lee and Lustig (1974) examine "five common motives that patients give when asked why they were unfaithful": sexual frustration, curiosity, feelings of revenge or boredom, and a need for acceptance and recognition from another person. Without the freedom within a relationship to have contact with the outside world and other persons (Rhyner, 1984) these five motives can cause excessive jealousy (Peck, 1975). "Jealousy is defined as an emotional state that is aroused by a perceived threat to a valued relationship or position and motivates behavior aimed at countering the threat. Jealousy is 'sexual' if the valued relationship is sexual" (Buss, Larsen, Westen, and Semmelroth, 1992; Daly, Wilson, and Weghorst, 1982, p. 11; Salovey, 1991; White and Mullen, 1989). It includes emotions such as fear and anger. The threat of a loss of love and all that the love encompasses feeds the fear to the point of jealousy (Izard, 1991). These motivations along with jealousy can lead to infidelity (Green, Lee, and Lustig, 1974).

Just as love is not limited to sexual attraction (Izard, 1991), infidelity is not limited to sexual encounters. It has only been in the last twenty years that the nonsexual components have received attention (Roscoe, Cavanaugh, and Kennedy, 1988; Weis and Slosmeric, 1981). The nonsexual component being "deep emotional attachment" (Buss, Larsen, Westen, and Semmelroth), commonly known as love. Thompson (1984) examined three types of marital infidelity: "(1) emotional (love), not sexual; (2) sexual (intercourse), not emotional; and (3) both emotional(love) and sexual (intercourse) in married subjects. Roscoe et al (1988) expanded the study of infidelity to include dating behavior.

Buss et al (1992) studied male and female adaptive problems faced over evolutionary history in mating contexts. The two evolutionary psychological issues discussed at great lengths are male sexual infidelity and female commitment infidelity in cultures where males invest heavily in children. "[Sixty percent] of the males sampled reported greater distress [than females] over potential sexual infidelity; in contrast, only 17% of females sampled chose that option, with 83% reporting that they would experience greater distress over a partner's emotional attachment to a rival". The evolutionary argument contends that males are more inclined to commit sexual acts of infidelity for population reasons, where as females are less likely to engage in sexual acts of infidelity for fear of "losing a man's investment" (Buss et al, 1992). In light of the Buss conclusion that females are more likely to be distressed with emotional infidelity and males with sexual infidelity because of the investment factors involved, one question remains unanswered.

Who is to blame? Mathes and Verstraete (1993) list two possibilities: the beloved and the third party, reasoning that the beloved has betrayed the individual with the third party. But is the individual completely free of responsibility? Does the relationship have any of the five motive qualities already discussed? The need for acceptance and recognition is great. If the individual is not receiving that attention from the beloved is he or she wrong for seeking it elsewhere?

It is the first hypothesis that males will find sexual extramarital infidelity by both sexes more upsetting than emotional extramarital infidelity, whereas females will find emotional extramarital infidelity more upsetting. A second hypothesis is that all subjects will view the female's role in the passage, be it the individual, the beloved, or the third party, as more at fault. The independent variables are the gender of the subjects, and the passages read. The dependent variables are which form of infidelity, sexual versus emotional, subjects find more upsetting; which party is found more at fault-individual (cheater), beloved (non-cheater), or third party; and the sex of the person found more at fault.

METHOD

Forty-eight participants, 23 males and 25 females were recruited from Hendrix College social psychology and anthropology classes to participate in this study. The first group consisted of 22 participants, while the second group contained 26. Two passages approximately one page each were used in each group. The first passage described a man who cheated on a woman with another woman for strictly sexual reasons. Cheating for strictly sexual reasons implies that the partner is only sexually attracted and feels no emotional bond with the third party. The second passage described a woman who cheated emotionally on a man with another man. Emotional cheating indicates that there is some type of emotional attachment felt between the third party and the cheating partner, although nothing sexual (kissing, intercourse, etc.) occurs between them. These two passages were used in the second condition also, although the genders in each passage were reversed. In all four passages, the couples are married to indicate a strong commitment between the two people.

A questionnaire consisting of ten questions was used to measure which type of cheating was considered more upsetting by the participants. It also assessed the degree of fault attributed to each party (cheater, non-cheater, or third party). An item read, "How much at fault do you perceive Jody (a character in the sexual cheating story) to be?" A 5-point Likert scale was used to measure the dependent variables (1=less at fault, 5=more at fault).

PROCEDURE

Testing occurred in two sessions. In the first session, participants met in a classroom and were instructed to read two passages, one sexual cheating passage and one emotional cheating passage. The genders of the cheater, noncheater, and third party varied among the passages read so the participants did not read about a male or female cheating in both passages. Each pair of passages were stapled alternately, to control for any ordering effect that may occur. After the participants finished reading both passages, a 10-item questionnaire was distributed. After all participants completed and returned the questionnaire to the experimenter, debriefing occurred. The second session was identical to the first.

RESULTS

A 2 X 2 factorial ANOVA was utilized to compare the type of cheating to the gender of the participant.

Table 1: Participants Perception of Sexual and Emotional Cheating on a 5-point Likert Scale (1=less upsetting, 5=more upsetting)

	TYPE OF CHEATING	
GENDER OF PARTICIPANT	SEXUAL	EMOTIONAL
MALE	4.870	3.000
FEMALE	4.920	2.920

Sexual cheating was found to be more upsetting than emotional cheating by both male and female participants, $p < .001$. This result supported only the first part of the hypothesis stating that males will find sexual cheating to be more upsetting than emotional cheating.

The second hypothesis, that females would be blamed more than their male counterpart in each passage, was not significant. However, in the sexual cheating passage, the female cheater, noncheater, and third-party tended to be blamed more than the male counterpart by an average of 1.327 points. In regard to the emotional cheating passage, the attribution of fault varied among males and females.

Another ANOVA measuring the interaction between gender of the participant and gender of the third-party was found to be statistically significant, $p < .003$.

Table 2: Fault Attributed to the Third-Party on a 5-point Likert Scale (1=less at fault, 5=more at fault)

	GENDER OF CHEATER	
GENDER OF PARTICIPANT	MALE	FEMALE
MALE	3.917	2.455
FEMALE	2.538	3.250

The male participant blamed the male third-party more than the female third-party, whereas the female participant blamed the female third-party more than the male third-party.

The next factorial ANOVA analyzed the gender of the participant, the participant's past experience of whether he or she sexually and/or emotionally cheated, and his or her opinion on how upsetting sexual cheating is.

Table 3: Participants Perception of Sexual Cheating on a 5-point Likert Scale (1=less upsetting, 5=more upsetting)

	Emotionally Cheated?		Sexually Cheated?	
GENDER OF PARTICIPANT	YES	NO	YES	NO
MALE	4.800	5.000	4.333	4.950
FEMALE	4.900	5.000	5.000	4.905

Although significant results were not found, some general trends were shown. Females tend to view sexual cheating as more upsetting than males do. Participants who had emotionally cheated before, do not view sexual cheating as upsetting as participants who had not emotionally cheated previously. Males who had sexually cheated do not view sexual cheating as upsetting as males who had not previously sexually cheated. Females who had sexually cheated view sexual cheating as more upsetting than females who had not sexually cheated previously.

Also, the 7 participants that admit to sexual cheating, viewed sexual cheating as less upsetting ($X = 4.714$) than the 41 participants who had not cheated sexually in the past ($X = 4.927$). The 37 participants that had emotionally cheated in the past considered sexual cheating as less upsetting ($X = 4.87$) than the 41 participants who had not emotionally cheated previously ($X = 4.927$).

The next ANOVA was similar to the previous one, except the opinion of the participant was on how upsetting emotional cheating was. There was a significant main effect for participants who have cheated previously, $p < .01$.

Table 4: Participants Perception of Emotional Cheating on a 5-point Likert Scale (1=less upsetting, 5=more upsetting)

	Emotionally Cheated?		Sexually Cheated?	
GENDER OF PARTICIPANT	YES	NO	YES	NO
MALE	2.533	3.875	2.667	3.050
FEMALE	2.700	3.800	1.750	3.143

Participants who had cheated emotionally or sexually, viewed emotional cheating as less upsetting than participants who had not emotionally cheated in the past. In general, participants who have not cheated previously (sexually or emotionally), view emotional cheating as more upsetting than those who have cheated (sexually or emotionally), although these results are not significant.

DISCUSSION

Results support the hypothesis that males find sexual infidelity worse than emotional infidelity. However, results also reveal females find sexual worse than emotional infidelity, which is contrary to the hypothesis. The previous research on the topic of cheating behavior, including unfaithfulness and infidelity, gave no indication that females would find sexual worse than emotional infidelity. This result may have been due to the assumption that all participants have the same understanding of emotional infidelity. The passages were meant to exemplify what emotional and sexual infidelity actually means so that the participants would have a basis to provide ratings on the questionnaire.

The trend discovered in the sexual passage, showing that the female character in each role was blamed more than her male counterpart, can be explained through gender stereotypes. In regard to the cheating character, historically it is accepted that males will have more than one sexual partner. They are said to have to "sow their wild oats". If this sowing does not take place before the marriage, then it is likely to happen after the bond. The infidelity behavior is often excused because "a man can not control his desires". Females on the other hand are expected to be with one and only one male for an entire lifetime. According to the norm, women should be virgins when married and remain faithful to the husband. In this sense it is only natural to ask: Who can blame the male for cheating? Is it not in his nature?

In a study by Wiggins and Ledener (1984), the relationship between the third-party and the noncheater was explored. In evolutionary theory it is often found that the third-party is looked down upon by members of the same sex because he or she is seen as "hurting one's own kind" (Shackelford and Buss, 1996). When a man cheats on a woman the third-party female has betrayed her gender by "stealing" a taken man. Participants relating to and having the same gender as the noncheater, view the third party as betraying their gender. This research supports the present study's findings in that the male participants blamed the male third-party more, whereas female participants blamed the female third-party more.

Another article by Wilson and Daley (1996) provide explanations for uxoricide, wife killing, that directly relates to the result of males blaming the male third-party more than the female third-party. Wifely infidelity is viewed as an exceptional provocation, likely to elicit a violent rage. Battered women nominate jealousy as the most frequent motive for their husbands assaults. According to the evolutionary theory, adaptive problems men face include the risk of losing their wife, a valuable reproductive source, to a rival and the risk of directing paternal investments to another man's child (Wilson and Daley, 1996).

In light of the past and present research, infidelity is a very obscure concept. It is very difficult to test participants since there are so many different degrees and levels of cheating. One way to elicit an honest response from participants may be to ask them to imagine themselves in a cheating situation. Infidelity is a subject that should be investigated so that one can understand the reasoning behind the action.

REFERENCES

Bell, B. , Frazier, M. , Calhoun, J. F. (1984) . Mixed-sex versus single-sex groups in person perception change of a case of infidelity. Family Therapy, 11 (2), 139-153.

Buss, D. M. , Larsen, R. J. , Westen, D. , Semmelroth, J. (1992) . Sex differences in jealousy: Evolution, physiology, and psychology. Psychological Science, 3 (4), 251-255.

Daly, M. , Wilson, M. I. , Weghorst, S. J. (1982) . Male sexual jealousy. Ethology and Sociobiology 3 (1) 11-27.

Enker, M. S. (1987) . Attitudinal and normative variables as predictors of cheating behavior. Journal of Cross Cultural Psychology 18, (3) , 315-330.

Green, S., & Bobele, M. (1988) . An interactional approach to marital infidelity: Including the "other woman" in therapy. Journal of Strategic and Systematic Therapies, 7 (4) , 35-47.

Greene, B. L. , Lee, R. R., Lustig, N. (1974) . Conscious and unconscious factors in marital infidelity. Medical Aspects of Human Sexuality, 8 (9), 97-105.

Golden, C. , Frazier, M. , Calhoun, J. F. (1984) . The sequence of treatment and assitional information in person perception change of a case of infidelity. Family Therapy, 11 (3), 229-240.

Izard, C. E. (1991) . The Psychology of Emotions. New York, New York: Plenum Press.

Mathes, E. W. , & Verstraete, C. (1993) . Jealous aggression: Who is the target, the beloved or the rival? Psychological Reports, 7 (2), 1071-1074.

Peck, B. B. (1975) . Therapeutic handling of marital infidelity. Journal of Family Counseling, 3 (2), 52-58.

Rhyner, B. (1984) . Psychological aspects of the male-female relationship. Psychologia An International Journal of Psychology in the Orient 27 (2) 105-114.

Roscoe, B. , Cavanaugh, L. E. , Kennedy, D. R. (1988) . Dating infidelity: Behaviors, reasons, and consequences. Adolescence 23 (89) , 35-43.

Shackelford, T. K. , Buss, D. M. (1996) . Betrayal in mateships, friendships, and coalitions. Personality an Social Psychology bulletin 22 (11), 1151-1161.

Thompson, A. P. , (1984) . Emotional and Sexual Components of extramarital relations. Journal of Marriage and the Family 46 35-43.

Wiggins, J. D. , & Lederer D. A. (1984) . Differential antecedents of infidelity in marriage. American Mental Health Counselors Association Journal 6 (4) , 152-161.

Childhood and Adolescent Abuse, Fear of Negative Evaluation, and Social Interaction Self Statements: A Correlational Analysis

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The purpose of this study was to determine if a link may be found between abuse history, fear of negative evaluation, and negative self-statements concerning heterosocial interaction. Participants were 59 female and 39 male college students from a semi-rural midwestern college. Correlational analyses were done for both genders between measures of childhood and adolescent abuse history, fear of negative evaluation, and the use of positive vs. negative self-statements concerning social interaction. Positive correlations were obtained between the scale for sexual abuse and fear of negative evaluation, and between the scale for sexual abuse and the negative self-statement scale in the female group. T-tests revealed a significant difference between genders for total scores on the Child Abuse and Trauma Scale (CAT; Sanders & Becker-Lausen, 1995) and for the negative home environment/neglect subscale of the CAT. Implications suggest that a woman with a prior history of sexual abuse may be more vulnerable during social interaction with an abusive man and therefore may also be more vulnerable to involvement in an abusive relationship. Findings of a significant difference between genders on the CAT, specifically in the area of negative home environment/neglect imply that girls suffer a higher level of abuse in this area than do boys.

BACKGROUND

The three major areas of child and adolescent abuse; those of neglect and verbal abuse, physical abuse, and sexual abuse, are likely to occur in the same family and this general parental abusiveness is associated with somatization, anxiety, depression, interpersonal sensitivity, obsessive-compulsive behavior, dissociation and suicidal ideation (Briere & Runtz, 1988). Furthermore, establishing trust in others may be difficult for children who have not received psychological help after an abuse incident (Kinard, 1982). Other negative psychological consequences of abuse are feelings of vulnerability and loss of control, guilt, self blame, and a heightened sense of fear and anxiety which can become generalized (Goodman, Koss, & Russo, 1993). Female victims of sexual abuse have reported insecurities concerning sexual attractiveness, lowered sexual self esteem, and negative feelings about men (Koss &Harvey, 1991; McCahill, Meyer, & Fischman, 1979). A history of abuse in childhood can have a damaging and enduring effect on personality functioning (Van der Kolk, 1987; 1988). Distortions of cognition such as a belief in one's own badness, and affect responses such as a hypersensitivity to potential rejection and feelings of humiliation and shame often exist in women with abuse history (Brown, 1987).

The desire to be accepted and to avoid rejection has long been viewed as a central human motive (Horney, 1937; Maslow, 1987; Baumeister &Leary, 1995). Concern with the unfavorable evaluation of others has been illustrated in a number of social situations including those involving conformity, prosocial behavior, self-presentation, self-serving attributions, social anxiety, self-handicapping, attitude change, compliance, and social facilitation (Schlenker, 1980). People who are highly concerned with negative evaluation are more likely to behave in ways that avoid the possibility of unfavorable evaluations, and thus be more responsive to evaluative situations (Leary, 1983). The Fear of Negative Evaluation Scale (FNE; Watson & Friend, 1969), was developed to determine the degree to which people experience apprehension at the prospect of being evaluated negatively. Individuals with high levels of fear of negative evaluation attempt to avoid potentially threatening social comparison information to a greater degree than those with low levels of fear of negative evaluation (Friend & Gilbert, 1973), and indicate they feel worse about negative evaluations than do people with little fear of negative evaluation (Smith & Sarason, 1975). Individuals with high levels of fear of negative evaluation also prefer to be in a positive asymmetrical relationship - being liked by another more than one likes the other - rather than a reciprocal relationship (Smith & Campbell, 1973). These

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individuals are also more concerned with making a good impression on others and try harder to do so during face to face conversations (Leary, 1983). In addition, those who score high on fearof negative evaluation measures also score high on measures of social approval seeking (Watson & Friend, 1969).

A significant number of adolescents experience anxiety and dissatisfaction with their social interactions, most notably with the opposite sex, and seek counseling more often for difficulties in heterosexual relationships than for any other reason (Martinson &Zerface, 1970). There are three existing models used to explain the etiology and maintenance of these social difficulties (Curran, 1977). This study follows the third model for which there is strong evidence stating that heterosocial problems are due to cognitive distortions. These cognitive distortions include the presence of irrational beliefs (Goldfried & Sobocinski, 1975), overly negative self-evaluations of social performance (Clark & Arkowitz, 1975; Glasgow & Arkowitz, 1975), negative self-statements (Cacioppo, Glass, & Merluzzi, 1979), excessively high standards for performance (Bandura, 1969), selective attention and memory for positive versus negative information about oneself and social performance (O'Banion & Arkowitz, 1977), and pathological patterns of attribution for social success and failure (Miller & Arkowitz, 1977).

As previously stated, victims of abuse show interpersonal sensitivity (Briere & Runtz, 1988), difficulty establishing trust (Kinard, 1982), generalized fear and anxiety (Goodman et al., 1993), damage to personality function (Van der Kolk, 1987; 1988), distortion of cognitions and a hypersensitivity to rejection (Brown,1987), and female victims of sexual abuse report insecurities about their own sexual attractiveness and have negative feelings about men (Koss & Harvey, 1991; McCahill et al., 1979). It was expected that childhood and adolescent abuse history would be positively correlated with the dimensions of fear of negative evaluation and negative self-statements concerning heterosocial interaction.

Furthermore, it has been suggested that women may have more reason to fear negative evaluation from others to the extent that they hold lower social power than men, and thus may be more dependent on others for approval because disapproval and rejection often entails material as well as social losses (Miller, 1995). Therefore, it was also expected that women would report a greater level of fear of negative evaluation than men.

METHOD

Participants. Participants were 59 female and 39 male college students from a semi-rural midwestern college. Participants ranged in age from 18 to 24 years (97%), and were from freshman psychology classes. Racial/ethnic composition was primarily white (98%).

Materials and Apparatus. The Child Abuse and Trauma Scale (CAT, Sanders & Becker-Lausen, 1995). The CAT is 38 item, 5 point Likert type scale designed to give a quantitative index of the frequency and extent of various types of maltreatment in childhood and adolescence.

The Brief Negative Evaluation Scale (BFNE, Leary, 1983). The BFNE is a 12 item, 5 point Likert type scale. It is a brief version of the original 30 item true-false scale; the Fear of Negative Evaluation scale (FNE, Watson & Friend, 1969), that is designed to measure the degree to which people experience apprehension at the prospect of being evaluated negatively.

The Social Interaction Self-Statement Test (SISST, Merluzzi, Biever,& Larsen, 1982). The SISST is a 30 item, 5 point Likert type scale designed to assess self-statements concerning heterosocial interactions which contains 15 positive (facilitative) and 15 negative (inhibitory) self-statements yielding a separate score for positive self-statements and a separate score for negative self-statements.

Procedure. Participants completed the three scales in same gender groups of 5 to 20 individuals. The order of questionnaires was varied to reduce influence effects from one scale to another. All three scales contain written self-directed instructions.

RESULTS

Abuse History and Fear of Negative Evaluation. A significant positive correlation was found between the CAT-subscale for sexual abuse and the BFNE: $r=.30$, $p<.05$, but only in the female group. Contrary to what was expected, overall CAT scores indicating the frequency and extent of maltreatment in childhood and adolescence did not correlate positively with fear of negative evaluation for either gender.

Abuse History and Self-Statements Concerning Social Interaction. A significant positive correlation between the CAT-subscale for sexual abuse and the negative self-statement scale of the SISST was found again only in the female group: $r=.34$, $p<.01$

Fear of Negative Evaluation and Self Statements Concerning Social Interaction. In the female group a high positive correlation was found between the BFNE and negative self-statement scale of the SISST: r=.71, p<.01, and conversely a negative correlation between the BFNE and the positive self-statement scale of the SISST: r=.54, p<.01. In the male group, a significant correlation was also found between the BFNE and the negative self-statement scale of the SISST: r=.43, p<.01.

Gender Differences. It was expected that women would score higher in fear of negative evaluation than men, however t-tests were not significant: t(96)=1.80, p<.074. T-tests did reveal a significant difference between genders for total scores on the CAT: t(96)=2.41, p<.018, and a highly significant difference between genders for the negative home environment/neglect subscale of the CAT: t(96)=2.82, p<.006.

DISCUSSION

Abuse History and Fear of Negative Evaluation. Findings suggest a link between a history of sexual abuse in women, specifically childhood and/or adolescent history of sexual abuse and an adult apprehension for being evaluated negatively. Implications relating to attraction for a woman who has been sexually abused in childhood, may simply be manifested in a propensity for this woman to find it difficult to initiate a conversation with a prospective partner because she is overly concerned with negative evaluation. Leary (1983) has found that people who fear negative evaluation are more likely to behave in ways that avoid the possibility of unfavorable evaluations, and thus be more responsive to such situations. A woman who has been sexually abused in childhood, fearing negative evaluation, may not only avoid initiating a conversation with a prospective partner, but may avoid any interaction until her fears are diminished.

Establishing trust becomes difficult for those who have suffered abuse (Kinard, 1982). Female victims of abuse report insecurities concerning sexual attractiveness, lowered sexual self esteem, and negative feelings about men (Koss & Harvey, 1991; McCahill et al., 1979). These reported insecurities help to explain in part why findings show a connection between fear of negative evaluation and childhood and adolescent sexual abuse. Individuals with high levels of fear of negative evaluation prefer to be in a relationship in which one is liked by another more than one likes the other (Smith & Campbell, 1973). This may be due to a need for constant approval rising out of a lack of trust and lowered sexual self esteem.

Watson and Friend (1969) found that individuals who feared negative evaluation not only avoided disapproval but sought approval. A jealous, controlling behavior has been found to be characteristic of abusive men (Downey & Feldman, 1996; Walker, 1984). It is speculated that this controlling behavior may play a role early on at the attraction level of dating or mate selection, in that an abusive man could use flattery or repeated reassurance to gain the trust of a woman who has been a victim of sexual abuse in childhood. It has often been reported by battered women that their abusive partner approached like a whirlwind claiming love at first sight and using flattery like "you're the only person I could ever talk to" or "I've never felt loved like this by anyone before" (Walker, 1984).

Abuse History and Self-Statements Concerning Heterosocial Interaction. A significant positive correlation was found between the measure of sexual abuse history and negative self-statements concerning heterosocial interaction, also again only in the female group. This finding suggests a link between childhood and adolescent abuse in women and negative self-statements or negative thoughts and expectations about heterosocial interaction. Distortions of cognitions such as a belief in one's own badness, and feelings of humiliation and shame have been found in women with abuse history (Brown, 1987). There is sufficient evidence that heterosocial problems are due to cognitive distortions, including negative self-statements (Cacioppo, Glass, & Merluzzi, 1979). The presence of a positive correlation between childhood and adolescent sexual abuse and negative self-statements concerning heterosocial interaction further supports the proposed connection between prior abuse and worry about negative outcomes during interaction. The aspect of "expecting the worst" lends support to the model of a woman with sexual abuse history being avoidant of initiating a heterosocial interaction on the basis that she expects that she will be rejected. In this scenario she may wait to be approached, reasoning that this aproachment is a sign of approval by the prospective partner. It is possible that an abusive man recognizes this weakness as an opportunity to dominate in - or have control of - the relationship.

Fear of Negative Evaluation and Self Statements Concerning Social Interaction. Positive correlations were found between fear of negative evaluation and negative self-statements for both

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genders, implying that one dimension may accompany the other. There was a high positive correlation between these two dimensions for the female group as well as a negative correlation between fear of negative evaluation and positive self-statements concerning heterosocial interaction. The later was absent in the male group. These findings show a stronger correlation between fear of negative evaluation and negative self-statements concerning heterosocial interaction for women.

Gender Differences. Although analysis approached significance, it cannot be generally stated according to the results of this study that women do indeed have an overall greater fear of negative evaluation than do men. It is significant to note that although women and men showed a comparable level of sexual abuse history, there were only relationships found between sexual abuse history and fear of negative evaluation and between sexual abuse history and negative cognitions during heterosocial interaction for women, supporting previous research that childhood and adolescent abuse does not produce the same effects in girls that it does in boys (Hughes, H.M. & Barad, S.J., 1983).

Important results of this study are the highly significant differences between genders for total scores on the CAT, specifically demonstrated by the negative home environment/neglect subscale of the CAT. The mean CAT score for women was more than double that of the men and the negative home atmosphere/neglect subscale mean score for women was over 33% higher than for men. These findings imply that girls suffer a higher level of negative home atmosphere and neglect than do boys. Negative home atmosphere is generally defined as the general negativity of the home atmosphere including loneliness and neglect (Sanders & Becker-Lausen, 1995). Questions in this scale include areas such as caring for one's self prior to being old enough, childhood stress levels as reported by the participants, parental verbal abuse and parental drug and alcohol abuse, and time spent left alone as a child.

Results that show women reporting higher levels of negative home environment/neglect may be reflected in part by the model of Dr. Laura Brown (1992) who has proposed the construct of Abuse/Oppression Artifact Disorder in understanding the presence and threat of trauma in the lives of girls and women. This model suggests in part that all women living in a culture (such as North America) where there is a high rate of sexual abuse and assault, are at risk to the effects of trauma. In this study the men reported similar levels of sexual abuse in childhood and adolescence to the women. With little doubt, as young men mature their increase in body size and strength may serve to lessen the fear of sexual abuse and assault in adulthood, a fear that does not diminish for most women. One of the most crippling definitions of psychic pain or trauma in response to abuse and oppression is that these responses are pathological. Effects such as these should be seen as natural and understandable responses to the trauma produced by the abuse and oppression of women. Brown (1992) also suggests that the effects of abuse and oppression do not necessarily need to come from overtly violent acts, but can also result from what she terms "violence to the soul and spirit". This is a factor that would appear to exist as a threat to girls and women of our society, as demonstrated in this study by the reported higher levels of negative home atmosphere and neglect of girls and young women than of boys and young men.

Limitations and Directions for Future Research. Generalizability of this study is limited by its' racial and culturally homogeneous groups. However, this constraint may offer additional support of the horrific prevalence of abuse of girls and young women in our society, and serves to further debunk the myth that abuse occurs only in the lower classes. Also important is that this study was limited to heterosocial design largely due to the design of the measures used. Further research is needed to compare homosocial interactions in relation to abuse history.

REFERENCES

Bandura, A. (1969). Principles of behavior modification. New York: Holt, Rinehart & Winston.

Baumeister, R., & Leary, M. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. Psychological Bulletin, 117, 497-529.

Briere, J., & Runtz, M. (1988b). Multivariate correlates of childhood psychological and physical maltreatment among university women. Child Abuse & Neglect, 12, 331-341.

Brown, L. S. (1992). A feminist critique of the personality disorders. In L. S. Brown, M. Ballou (Eds.), Personality and psychopathology: Feminist reappraisals (pp. 206-228), New York: Guilford Press.

Brown, L. S. (1987). From alienation to connection: Feminist therapy with post-traumatic stress disorder. Women and Therapy, 5, 13-26.

Cacioppo, J. T., Glass, C. R., & Merluzzi, T. V. (1979).Self-statements and self-evaluations: A cognitive response analysis of heterosocial anxiety. Cognitive Therapy and Research, 3, 249-262.

Clark, J. V., & Arckowitz, H. (1975). Social anxiety and self-evaluation of interpersonal performance. Psychological Reports, 36, 211-221.

Curran, J. P. (1977). Skills training as an approach to the treatment of heterosexual-social anxiety: A review. Psychological Bulletin, 84,140-157.

Downey, G., & Feldman, S. I. (1996). Implications of rejection sensitivity for intimate relationships. Journal of Personality and Social Psychology, 70, 1327-1343.

Friend, R. M., & Gilbert, J. (1973). Threat and fear of negative evaluation as determinants of locus of social comparisons. Journal of Personality, 41, 328-340.

Glasgow, R. E., & Arkowitz, H. (1975). The behavioral assessment of male and female social competence in dyadic heterosexual interactions. Behavior Therapy, 6, 488-498.

Glass, C. R., Merluzzi, T. V., Biever, J. L., & Larsen, K. H. (1982).Cognitive assessment of social anxiety: Development and validation of a self-statement questionnaire. Cognitive Therapy and Research,6, (37-55).

Goldfried, M. R., & Sobocinski, D. (1975). Effects of irrational beliefs on emotional arousal. Journal of Consulting and Clinical Psychology, 43, 504-510.

Goodman, L. A., Koss, M. P., & Russo, N. F. (1993). Violence against women: Physical and mental health effects. Part I: Research findings. Applied and Preventative Psychology, 2, 79-89.

Horney, K. (1937). The neurotic personality of our time. New York: Norton.

Hughes, H. M., & Barad, S. J. (1983). Psychological functioning of children in a battered women's shelter: A preliminary investigation. American Journal Of Orthopsychiatry, 53, 525-531.

Kinard, E. M. (1983). Experiencing child abuse: Effects on emotional adjustment. American Orthopsychiatry, 52, 82-91.

Koss, M. P., & Harvey, M. (1991). The rape victim: Clinical and community approaches to treatment. Lexington, MA: Stephen Greene Press.

Leary, M. R. (1983). Social anxiousness: The construct and its measurement. Journal of Personality Assessment, 47, 66-75.

Martinson, W. D., & Zerface, J.P. (1970). Comparison of individual counseling and a social program with nondaters. Journal of Counseling Psychology, 17, 36-40.

Maslow, A. (1987). Motivation and personality, (3rd ed.). New York: Harper & Row.

Mc Cahill, T. W., Meyer, L. C., & Fischman, A. M. (1979). The aftermath of rape. Lexington, MA: D.C. Heath & Co.

Miller, R. S. (1995). On the nature of embarrassability: Shyness, social evaluation, and social skill. Journal of Personality, 63, 315-335.

Miller, W. R., & Arkowitz, H. (1977). Anxiety and perceived causation in the social success and failure experiences: Disconfirmation of an attributional hypothesis in two experiments. Journal of Abnormal Psychology, 86, 665-668.

O'Banion, K., & Arkowitz, H. (1977). Social anxiety and selective memory for affective information about the self. Social Behavior and Personality, 5, 321-328.

Sanders, B. & Becker-Lausen, E. (1995). The measurement of psychological maltreatment: Early data on the child abuse and trauma scale. Child Abuse & Neglect, 19, 315-323.

Schlenker, B. R. (1980). Impression management: The self-concept, social identity, and interpersonal relations. Monterey, CA: Brooks/Cole.

Smith, R. E., & Campbell, A. L. (1973). Social anxiety and strain toward symmetry in dyadic attraction. Journal of Personality and Social Psychology, 28, 101-107.

Smith, R. E., & Saranson, I. G. (1975). Social anxiety and the evaluation of negative interpersonal feedback. Journal of Consulting and Clinical Psychology, 43, 429.

Van der Kolk, B. A. (1988). The trauma spectrum: The interactions of biological and social events in the genesis of the trauma response. Journal of Traumatic Stress, 1, 273-290.

Van der Kolk, B. A. (Ed.) (1987). Psychological Trauma. Washington, DC: American Psychiatric Press.

Walker, L. E., (1984). The battered woman syndrome. New York: Springer.

Watson, D., & Friend, R. (1969). Measurement of social-evaluative anxiety. Journal of Consulting and Clinical Psychology, 33, 448-457.

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Coping Strategies Among African-American and Caucasian Female College Students

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The current study examined differences in anger expression, hostility, and John Henryism among African-American and Caucasian female college students. It was hypothesized that African-American women would score high on the anger-out subscale of the Spielberger Anger Expression Scale and Caucasian women would score high on the anger-in subscale. In addition, it was also hypothesized that there would be no difference in hostility and John Henryism between the African-American and Caucasian participants. Also, a positive correlation between John Henryism, hostility, and baseline cardiovascular responses was predicted. Nine African-American females from Spelman College and eight Caucasian females from Smith College participated in the present study. Each participant was given the Spielberger Anger Expression Scale, the Cook and Medley Hostility Scale, and the John Henryism Scale for Active Coping. Baseline measures of heart rate and blood pressure were taken prior to the administration of the scales. A t-test was used to examine ethnic group differences in scores on all coping scales. There were no significant differences between African-American and Caucasian on any of the coping questionnaires. In addition, a Pearson correlation test was used to examine the relationship between baseline cardiovascular responses and the coping questionnaires. None of the correlations was significant.

INTRODUCTION

The importance of coping in determining the impact of psychological stress has been recognized in past research. The current study examined the relationship between three coping strategies (anger expression, hostility, and John Henryism) and baseline cardiovascular reactivity in African-American and Caucasian female college students. A brief review of the literature that examines the three coping styles is presented below.

Anger Expression

Anger expression is defined as an indicator of one's behavior toward others. This construct determines whether individuals suppress their anger (anger-in), outwardly express their anger (anger-out), or control both the experience and expression of anger (anger-control) (Spielberger, Johnson, Russell, Crane, Jacobs & Worden, 1985). Research has shown that individuals exhibiting the anger-in style tend to have higher blood pressure when placed in anger provoking situations (Armstead, Lawler, Gorden, Cross & Gibbons, 1989). Gentry, Chesney, Gary, Hall, and Harburg (1982) found that females with high levels of anger in, had higher systolic blood pressures than females with anger-out expression.

Hostility

Hostility is a personality construct seen in people who are easily angered, have high levels of resentment and irritability, and are cynical and mistrusting of others (Smith & Frohm, 1990). Suarez & Williams (1990) reported that individuals with high hostility scores responded to an anger-arousing laboratory challenge with greater cardiovascular responses than individuals with low hostility scores. Scherwitz, Perkins, Chesney, and Hughes (1991) found that young Black males with limited education had the highest scores on the Cook and Medley Hostility Scale, whereas older educated white females had the lowest scores. Similar findings were reported by Barefoot, Peterson, Dahlstrom, and Seigler (1991), who found higher hostility scores in non-White men and subjects of low socioeconomic status.

John Henryism

John Henryism is a behavior pattern used to describe individuals with a predisposition to actively cope with psychological stressors of everyday life (James, Keenen, Strogartz, Browning & Garrett, 1992). Found most often in Black men, high levels of John Henryism have been correlated with high blood pressure (James, Strogatz, Wing & Ramsey, 1987). Black men who obtained high scores on John Henryism, yet had limited education, had higher diastolic blood pressures than men who had median scores on both the scale and blood pressure. Many studies have shown that there were no significant differences in John Henryism between black men and women (eg. James, Hartnett & Kalsbeek, 1983). Yet a recent study conducted by Jackson (1994) showed that women scored higher on the John Henryism scale than men.

The purpose of this study was to investigate the relationship of coping strategies, blood pressure and heart rate in African-American and Caucasian female college students. It was hypothesized that African-American women would score higher on the anger-out subscale of the Spielberger Anger Expression Scale than Caucasian women. It was also hypothesized that Caucasian participants would score higher on the anger-in subscale of the Spielberger Anger Expression Scale than African-American women. It was also hypothesized that there would be no difference in hostility and John Henryism between the African-American and Caucasian participants. Also, there would be a positive correlation between John Henryism, hostility and baseline cardiovascular responses in both ethnic groups.

METHOD

Participants

Twenty females from Spelman College in Atlanta, Georgia and twenty females from Smith College in Northampton, Massachusetts volunteered to participate in the study. The students were between the ages of 18-26 and were screened for cardiovascular disorders.

Questionnaires and Forms

Prior to the experiment, each individual was given a screening form and an informed consent form. The screening form identified medical conditions that excluded the individual from participating in the study. The informed consent form was administered after an explanation of the nature of the study was given. The Cook and Medley Hostility Scale (Cook & Medley, 1954) - a measure of hostility, the Spielberger Anger Expression Scale (Spielberger, Johnson, Russell, Crane, Jacobs & Worden, 1985) - a measure of expressed anger vs suppressed anger coping strategies, and the John Henryism Scale for Active Coping (James, Keenen, Strogartz, Browning & Garrett, 1992)- a measure of motivation toward success in the face of adverse circumstances, were used.

Apparatuses

The Medex NCCOM3 cardiac impedance cardiograph and microcomputer system were used to assess heart rate. To obtain these measures, eight electrodes were placed on the neck and both sides of the body near the area of the xiphisternum. All signals were read into the cardiovascular monitor and interfaced to a Radio Shack TSR 80 portable computer. Digital printouts of the cardiac measures were obtained through a Hewlett Packard printer. Blood pressure was taken by the Ohmeda Fina Pres Model 2300 blood pressure monitor.

Procedure

Upon entrance of the laboratory, each participant was given a screening form and an informed consent form. After all questions were answered, the recording equipment was attached. Baseline measures were taken for three minutes as the participants sat in a comfortable recliner. After this rest period, the participants were given the coping questionnaires.

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RESULTS

A t-test was used to examine ethnic group differences in scores on the Cook and Medley Hostility Scale, the John Henryism Scale for Active Coping and the anger-out and anger-in sub-scales of the Spielberger Anger Expression Scale. There were no significant differences between African-Americans and Caucasians on any of the coping questionnaires. The finding was expected for hostility and John Henryism but not for the anger-in or anger-out sub-scales of the Spielberger Anger Expression Scale.

A Pearson Correlation test was used to examine the relationship between hostility, John Henryism, anger-in, anger-out, anger control, overall anger expression and baseline cardiovascular responses. None of the correlations was significant. (See Table 1)

DISCUSSION

The present study did not support the hypothesis that African-Americans and Caucasians express their anger differently. The results of this study indicate that there are no ethnic group differences in anger expression when using college females. This finding is supported by Dimsdale, Pierce, Schoenfeld, Brown, Zusman, and Grahman (1986) who found significant differences between anger and systolic blood pressure among black and white men, but not for women.

The hypothesis stating that there would be no difference in hostility and John Henryism between African-American and Caucasian female college students was supported by our data as well as other studies (eg. Suarez & Williams, 1990). The results of this study did not support the hypothesis that there would be a positive correlation between John Henryism, hostility and baseline cardiovascular responses. There was no significant correlation between these factors possibly because of the limitations in data analysis. Seventeen subjects were analyzed in the correlation. A complete data analysis of all forty subjects needs to be completed before a definite conclusion can be made.

Table 1

Correlations Among Anger Expression John Henryism, Hostility and Baseline Cardiovascular Responses

	HR BASE	SYS BASE	DIA BASE
HOS	- .1256	.1194	.0691
JH	.1702	.0320	.1385
AIN	.0836	- .2385	- .2378
AOUT	.0510	- .0620	- .0828
ACON	- .1215	.2027	.0206
AEX	.1221	- .2299	- .1446

HR BASE - Baseline Heart Rate
SYS BASE - Baseline Systolic Pressure
DIA BASE - Baseline Diastolic Pressure
HOS - Hostility
AOUT - Anger out
AIN - Anger In
ACON - Anger Control
AEX - Anger Expression
JH - John Henryism

Note: None of the correlations was significant at the $p < .05$ level.

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REFERENCES

Armstead, C.A., Lawler, K.A., Gorden, G., Cross, J., & Gibbons, J. (1989). Relationship of racial stressors on blood pressure responses and anger expression in black college students. Health Psychology, 8, 541-556.

Barefoot, J.C., Peterson, B.L. Dahlstrom, G.W. & Seigler, I.C. (1991). Health Psychology, 10, 18-24.

Dimsdale, J.E., Pierce, C., Schoenfeld, D., Brown, A., Zusman, R., & Graham, R. (1986). Suppressed anger and blood pressure: The effects of race, sex, social class, obesity, and age. Psychosomatic Medicine, 48, 430-435.

Gentry, W.D., Chesney, A.P., Gary, H.E., Hall, P.P., & Harburg, E. (1982). Habitual anger-coping styles: Effects on mean blood pressure and risk for essential hypertension. Psychosomatic Medicine, 44, 195-202.

Jackson, L.A. (1994). John Henryism and blood pressure in Black college students. Journal of Behavioral Medicine, 17, 69-79.

James, S.A., Keenen, N.L., Strogartz, D.S., Browning, S.R. & Garrett, J.M. (1992). Socioeconomic status, John Henryism and blood pressure in Black adults. American Journal of Epidemiology, 135, 59-67.

James, S.A., Harnett, A.A. & Kalsbeek, W.D. (1983). John Henryism and blood pressure differences among Black men. Journal of Behavioral Medicine, 6, 259-277.

James, S.A., Strogartz, D.S., W3ing, S.B., & Ramsey, D.L. (1987). Socioeconomic status, John Henryism and hypertension in Blacks and Whites. American Journal of Epidemiology, 126, 664-673.

Scherwitz, L., Perkins, L., Chesney, M. & Hughes, G. (1991). Cook-Medley hostility scale and subsets: Relationship to demographic and psychosocial characteristics in young adults in the CARDIA study. Psychosomatic Medicine, 53, 36-49.

Smith, T.W. & Frohm, K.D. (1985). What's so unhealthy about hostility? Construct validity and psychosocial correlates of the Cook and Medley Ho Scale. Journal of Health Psychology, 39, 503-520.

Spielberger, C.D., Johnson, E.H., Russell, S.F., Crane, R.J., Jacobs, G.A. & Worden, T.J. (1985). Experience and expression of anger: Construction and Validation of an anger expression scale. In Chesney, M.A. & Rosenman, R.H. (Eds.)

The Effects of the Administration of Methysergide and Ritanserin, Two Serotonin Antagonists, on the Behavioral Repertoire of Zebra Finches *(Taeniopygia guttata)*

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ABSTRACT

The effects of methysergide and ritanserin, two similar 5-HT2 antagonists, on the behaviors of adult, male zebra finches were investigated after acute intraperitoneal injection (0.5, 1.0, 2.0 mg/kg and 0.3, 1.0 mg/kg respectively). Behaviors of each bird (n=9) were examined for the hour post-injection in an aviary using ethological procedures. Surprisingly, the particpants' aggressive displays did not vary among the conditions for either antagonist. The percentage of time spent inactive, however, was significantly greater following methysergide administrations, and a similar pattern was seen for ritanserin injections. These findings of decreased aggression and increased inactivity contrast with some findings from other mammals.

BACKGROUND

Much of the research that has manipulated serotonin levels in animal species thus far has led to notable changes in aggressive behavior. However, this research has studied a single behavior in isolation rather than exploring how the entire behavioral profile of an animal might have been affected. Wingfield (1978) has introduced a field perspective to study the role of physiological processes on behavior, which results in greater ecological validity. Not only do the results determine whether or not the manipulation caused a particular behavior, the general effects on the animal's behavioral repertoire can be explored. Therefore, it is relevant to take the behavioral repertoire of an animal and categorize behaviors to develop a conceptional understanding of aggression.

Studies by Moyer (1968, as cited in Feldman & Quenzer, 1984) have shown that aggression has a specific neurochemical basis. Reduced levels of serotonin (also known as 5-HT) lead to an increase in aggressive behavior, while increases in 5-HT lead to a decrease (Eichelman, 1987). Most of this work has been conducted on mammals (although see Buchanan, Shrier, & Hill, 1994). Few studies have examined the effects of serotonin antagonists, agents that block the effects of 5-HT, on the complete behavioral profile of passerines, more specifically, zebra finches (*Taeniopygia guttata*). The following two experiments explored the effects of two serotonin antagonists, methysergide and ritanserin, on the wide variety of behaviors unique to zebra finches. It was expected that these 5-HT antagonists would increase their aggressive behaviors.

EXPERIMENT 1: METHYSERGIDE ADMINISTRATION

Methysergide is a serotonin antagonist that specifically blocks the subtype-2 receptors of 5-HT. The effects of four different doses on the behavioral repertoire of male zebra finches were examined.

METHOD

Zebra finches are sexually dimorphic, Australian grassfinches of the family Estrildidae. Like other estrildids, they form life-long pair bonds, with both sexes participating in nest construction, incubation, brooding, and feeding of the altricial young (Burley, Krantzberg, & Radman, 1982). In nature, zebra finches breed in loose colonies typically in low shrubs.

Nine, adult male zebra finches were used as participants for this study. Each participant was banded with a numbered aluminum leg band and a unique combination of three color bands. All bands were of colors previously demonstrated to be neutral in attractiveness by Burley *et al.* (1982). Prior to experimentation, they were housed in unisexual groups. Each male was then introduced into an aviary (2.7m x 2.7m) with their respective female partner, creating a total of nine pairs. An additional three pairs were also released into the aviary, but did not receive treatment. All birds were kept on a regime of ad libitum food, water, and nesting materials. A 14L:10D photoperiod was maintained throughout the study, with light onset at 0800h. Nests were checked daily between 0900 and 1200 hours. At this time, the number of eggs, hatchlings, and fledglings were recorded at each active nest. Daily maintenance of the aviary was also performed during this time.

The aviary contained three solid walls and a galvanized metal screen, with a standard-size door for entry. Inside the aviary, three PVC pipes, 7.5 cm in diameter, were situated 1.5 m apart and ran the height of the room. Five dowels were placed through each pipe, creating ten perches per pipe. Thirty wicker baskets were positioned and numbered at the ends of perches as sites for nests. Perches were 45 cm long and spaced at heights from 0.9 to 2.1 meters off the floor. A food station was located on the wall across from each pipe which included water troughs, a hanging feeder with perches, a metal food trough, a cuttlebone, and a bin filled with cotton for nest building.

Methysergide was purchased from the Sigma Chemical Company and was combined with 0.9% saline vehicle. The vehicle alone was administered when the birds received the control condition. Disposable tuberculin syringes (1 cc) and needles (26 3/8) were used for the i.p. injections. Timex stopwatches were used to time the recovery and observation periods. A Radio Shack tape recorder was used to record all observations. Wire mesh cages (3.7 m x 3.7 m x 4.9 m) individually housed participants following injection.

The participants were given a three day habituation period following their release into the aviary. The study consisted of a random presentation of four drug conditions to all nine birds: three distinct dosages of methysergide (0.5 mg/kg, 1.0 mg/kg, 2.0 mg/kg) and a saline (control) condition (0.0 mg/kg). Conditions were randomly labeled A, B, C, or D, and the experimenter was blind to the dosage being delivered. Two to three recuperation days following drug administration were allotted to all participants. Therefore, the complete injection phase consisted of four days of afternoon observation, spread over an eleven-day time period. Most of the treatment conditions were administered during the pre-laying phase of the birds' reproductive cycle (61%) and no participants had advanced past the incubation phase during testing.

At the start of each test period, three birds were selected at random and tested sequentially. The first bird to be observed on an injection day was removed from the aviary at its designated time and given an i.p. injection of the drug condition specified. The birds was then placed in the wire mesh cage for a period of 15 minutes, prior to returning to the aviary. Following re-release into the aviary, a five minute habituation period elapsed before observations were recorded for an hour. The date, time, coding of condition injected, participant's number and color code, and all behavioral observations were recorded into the recorder. After the observations were completed, this procedure was then repeated for the remaining two finches selected.

Audio tapes were transcribed upon completion of observations. Using the continuous sampling method, all behaviors were recorded to determine their rate of occurrence. In addition, the instantaneous sampling method was also employed in order to record the specific behavior at the end of one-minute intervals; these data enabled the calculation of the proportion of time spent in 12 behavioral categories: aggression, courtship, communication, inactivity, ingestion, locomotion, nesting, maintenance, incubation, social preening, defense, and miscellaneous behaviors. The data were then collated to examine the behavioral changes across the four treatment phases. A Friedman's two-way analysis of variance by ranks was used to examine possible differences among the treatment conditions for the categories of behaviors. Each category was analyzed separately using the rates of behaviors, derived from continuous sampling, and using the percentage of time spent in the behavior, assessed by instantaneous sampling. If a Friedman's ANOVA was significant, follow-up tests were conducted using the Wilcoxin's nonparametric test ($p<0.05$).

RESULTS

Courtship and communication behaviors were so infrequent that they were not subject to statistical analysis. Initially, the participants displayed a wide variety of behaviors. However, as the dosage of methysergide increased, this variation diminished, and the time spent inactive significantly increased ($X^2r = 14.20$, $df=3$, $p<0.05$), so that there was significantly more inactivity under the two highest doses.

Correspondingly, the rate of locomotor activity varied significantly among the treatment conditions ($X^2r = 9.83$, $df=3$, $p<0.05$). The average number of bouts per hour of

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locomotor behavior during the saline condition was significantly greater than the number of bouts during either the 0.5 mg/kg or 1.0 mg/kg dosage condition. The mean rates of behaviors for each of the 12 behavioral categories as a function of two methysergide doses (0.0 mg/kg (control) and 2.0 mg/kg (highest dose)) are presented below in Figure 1.

The percentage of time spent in maintenance behaviors as well as the rate of maintenance activity also varied significantly among the treatment conditions ($X^2r = 12.63$, df=3, $p<0.05$, $X^2r = 13.53$, df=3, $p<0.05$ respectively). An average of 11.30% of the participants' time was spent on maintenance behaviors when injected with the control, however, this value decreased significantly to 1.48% in the highest dose of methysergide (2.0 mg/kg) and to 0.37% in the 1.0 mg/kg dose. Similarly, the average rate of maintenance behavior was 63.33 bouts per hour during the saline condition, but following the highest dose of methysergide the behavior decreased significantly to an average of 24.78 bouts per hour (Figure 1).

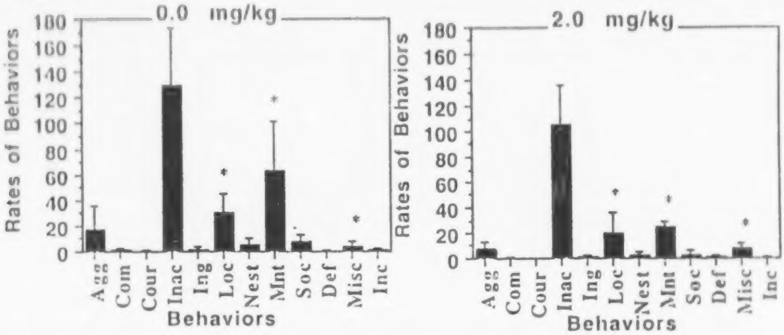

Figure 1. Mean rates of behaviors for each of the 12 behavioral categories (aggression, communication, courtship, inactivity, ingestion, locomotion, nesting, maintenance, social preening, defense, miscellaneous behaviors, and incubation) as a function of methysergide dose (0.0 mg/kg (control) and 2.0 mg/kg (highest dose)).

A similar pattern among the treatment conditions was seen in the rates of nesting behaviors ($X^2r = 6.70$, df=3, $p=0.08$). The average number of bouts of nesting during the saline condition was twice the number of bouts during both the 0.5 mg/kg and 2.0 mg/kg conditions, and four times the number of bouts during the 1.0 mg/kg condition (Figure 1). The percentage of time spent nesting, however, did not vary significantly among the conditions ($X^2r = 2.30$, df=3, $p>0.05$).

The rate of miscellaneous behaviors varied significantly among the conditions ($X^2r = 10.03$, df=3, $p<0.05$). These behaviors consisted of twitching and a response that resembled coughing and were often associated with the methysergide injections.

DISCUSSION

The results of this first experiment suggest that methysergide is an activity depressant in zebra finches. The treatment conditions yielded no significant differences for aggressive behaviors and therefore the initial hypothesis is not supported.

Previous experiments have demonstrated that serotonin antagonists like methysergide usually decrease the frequency of sleep (inactivity) (Feldman & Quenzer, 1984). In this experiment, the percentage of time spent inactive varied significantly among the treatment conditions, showing an increase rather than a decrease in inactive behavior following methysergide exposure. Furthermore, the range of doses of methysergide employed here all showed similar behavioral effects, in that they decreased activity and social interaction among the birds. Thus, no linear effect was obtained for a dose-response curve.

EXPERIMENT 2: RITANSERIN ADMINISTRATION

In order to be confident that the results of Experiment 1 are due to the specific neurological effects of methysergide and the physiological makeup of finches, a similar but more potent serotonin antagonist was utilized. Ritanserin slowly dissociates from the same 5-HT_2 receptor sites as methysergide (Leysen, Van Gompel, Gommeren, Woestenborghs, &

Janssen, 1986)

Previous research on mammals using ethological procedures has demonstrated that ritanserin increases aggression. Gao & Cutler (1993) found that the aggressive behaviors of mice increased after administration of ritanserin, as did digging and investigative behaviors. In addition, Sommerfelt & Ursin (1993) determined that administration of ritanserin increased waking and decreased slow wave sleep in cats.

If the same patterns of behaviors occur in the finches from ritanserin administration as they did from methysergide, it is more likely that serotonin is, in fact, the neurotransmitter responsible.

METHOD

Eight of the nine male participants from Experiment 1 were used for the second experiment. Although this species is known to form life-long pair bonds (Burley *et al.*, 1982), one male participant had lost his mate to a non-participating male. Therefore, this male was used for Experiment 2. All other procedures were the same as discussed in Experiment 1, except three drug conditions were randomly presented: two distinct dosages of ritanserin (0.3 mg/kg and 1.0 mg/kg) and a saline condition (0.0 mg/kg).

RESULTS

More than half of the trials occurred during the pre-laying period of the reproductive cycle, with the others happening during either egg-laying or incubation. Behaviors such as communication, courtship, social preening, and defense were infrequent, and thus, were not subject to statistical analysis. Aggression, incubation, and miscellaneous behaviors were somewhat infrequent, but analyses indicated no significant differences between the three drug conditions for any of these behavioral categories.

Figure 2 (below) illustrates the mean percentage of time spent in each of the 12 behavioral categories as a function of two ritanserin doses, 0.0 mg/kg (control) and 1.0 mg/kg (highest dose). The percentage of time spent in locomotion varied significantly among the treatment conditions ($X^2r = 7.15$, df=2, $p<0.05$). Participants given the control spent, on average, five times more time in locomotor activities than they did following ritanserin administration. The finches also spent significantly more time performing ingestion behaviors when in the control condition than in either drug condition ($X^2r = 7.55$, df=2, $p<0.05$). A pattern was seen among the treatment conditions in the percentage of time spent inactive ($X^2r = 4.94$, df=2, $p=0.09$). A similar trend was observed in the time spent in nesting behaviors ($X^2r = 5.33$, df=2, $p=0.07$). Nearly twice the amount of time was spent nesting when participants were given the control.

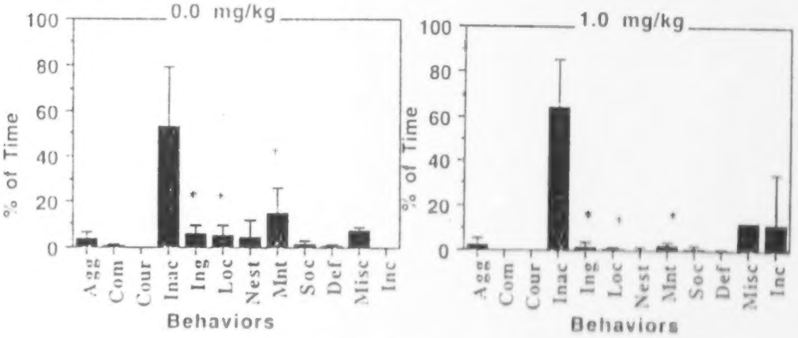

Figure 2. Mean percentage of time spent in each of the 12 behavioral categories (aggression, communication, courtship, inactivity, ingestion, locomotion, nesting, maintenance, social preening, defense, miscellaneous behaviors, and incubation) as a function of ritanserin dose (0.0 mg/kg (control) and 1.0 mg/kg (highest dose)).

The average rate of maintenance behaviors varied significantly among the conditions ($X^2r = 9.56$, df=2, $p<0.05$) with significantly fewer bouts of maintenance occurring following ritanserin administration. In addition, the percentage of time finches spent in maintenance decreased significantly with increasing exposure to ritanserin (Figure 2: $X^2r = 12.48$, df=2,

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$p<0.05$). A trend among the conditions also existed in the rates of ingestion ($X^2r = 5.27$, df=2, $p=0.07$), in that during the saline condition there were twice as many bouts of ingestion than during either ritanserin condition.

DISCUSSION

The finches engaged in more ingestion and maintenance behaviors following ritanserin administration than after methysergide injections. In addition, the participants did not display as many "miscellaneous" behaviors, such as "coughing," twitching, and crouching when injected with ritanserin. Although inactivity was significantly greater after methysergide treatment, only a slight trend in greater inactivity was seen following ritanserin administration. Correspondingly, there was no significant difference among the treatment conditions for aggressive behaviors following either antagonist. Similar to methysergide, for the majority of the behaviors observed, the effects of the two ritanserin conditions did not significantly differ from one another but were significantly different from the control condition.

Because observed behaviors after ritanserin administration resembled those behaviors after methysergide administration, the hypothesis that serotonin may be the neurotransmitter responsible for the behavioral effects in the finches is supported. There are only a few findings of decreased aggression and increased inactivity due to ritanserin administration in the existing published literature on animals. Elliott, Walsh, Close, Higgins, & Hayes (1990) found that ritanserin increased cataleptic behavior (similar to inactivity) in both rats and marmosets. Sommerfelt & Ursin (1993) note that slow wave sleep was increased following ritanserin administration in humans and rats. And a study on mice (1991) demonstrated that ritanserin inhibited isolation-induced aggressive behavior at a high but not debilitating dose (10 mg/kg, i.p.), (White, Kucharik, & Moyer).

Future studies must now determine the role of these antagonists in blocking serotonin receptors in bird species such as zebra finches. It is important to determine how the finches' neurochemical systems relate to other animal species studied in order to resolve whether these differences are due to different physiological mechanisms.

REFERENCES

Buchanan, C.P., Shrier, E.M., & Hill, W.L. (1994). Time-dependent effects of PCPA on social aggression in chicks. Pharmacology, Biochemistry, and Behavior, 49, 483-488.

Burley, N., Krantzberg, G., & Radman, P. (1982). Influence of colour-banding on the conspecific preferences of zebra finches. Animal Behavior, 30, 444-455.

Eichelman, B. (1987). Neurochemical bases of aggressive behavior. Psychiatric Annals, 17, 371-374.

Elliott, P.J., Walsh, D.M., Close, S.P., Higgins, G.A., & Hayes, A.G. (1990). Behavioral effects of serotonin agonists and antagonists in the rat and marmoset. Neuropharmacology, 29, 949-956.

Feldman, R.S. & Quenzer, L.F. (1984). Fundamentals of Neuropsychopharmacology. Sunderland: Sinauer Associates.

Gao, B. & Cutler, M.G. (1993). Effects of acute and subchronic administration of ritanserin on the social behavior of mice. Neuropharmacology, 32, 256-272.

Leysen, J.E., Van Gompel, P., Gommeren, W., Woestenborghs, R., & Janssen, P.A.J. (1986). Down regulation of serotonin-S_2 antagonists: ritanserin and setoperone. Psychopharmacology, 88, 434-444.

White, S.M., Kucharik, R.F., &Moyer, J.A. (1991). Effects of serotonergic agents on isolation-induced aggression. Pharmacology, Biochemistry, and Behavior, 39, 729-736.

Wingfield, J.C. (1978). The endocrinology of a natural breeding population of the White-crowned Sparrow. Physiological Zoology, 51, 188-205.

Context and Quality of Social Interaction of Children with Severe Language Delays in a Full Inclusion Preschool Program

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On the assumption that young children learn through interaction with others, this study focuses on the social interactions of children with mild or severe oral language delays and their peers (those who are developing normally and those with other special needs) in a full inclusion preschool. Videotapes of 16 children (4 with no more than modest language delays; 4 with severe language delays; and 8 normally developing peers matched for age and gender) were coded for this study. Subjects were previously videotaped for approximately 20 minutes each during free play for a larger ongoing study. Four tapes per child were scored episodically whenever a subject engaged in interaction with peers or with both peers and adults together. Each episode was coded for context of activity (gross motor, sedentary, themed activity, or transition), quality of interaction (positive/neutral or negative; equal or unequal in status), occurrence of adult facilitation, and the make-up of the peer group. Analyses revealed that children with severe language delays spent less time in social interactions than did their normally developing peers and their peers with lesser language delays. However, within their limited interactions, it was found that children with severe language delays spent more time in interactions involving gross motor play, and spent more time in interactions that were facilitated by adults than did their normally developing peers.

BACKGROUND

In the past decade there has been an increase in preschools mainstreaming children with disabilities, due, in part, to the Education of the Handicapped Act Amendments of 1986 (PL 99-457). This Act mandates that states provide early intervention services in the least restrictive environment to all eligible children from birth to 5 years of age (Rice, 1993; Thiele & Hamilton, 1991). Now that there is legal support for all children to participate in the same educational programs, questions have risen with respect to how the interactions among this diverse population influence individual development. Lev Vygotsky suggests that, "Education generates and leads development, which is the result of social learning through the internalization of culture and social relationships" (Gindis, 1995; Vygotsky, 1978).

Social interactions are important because they are thought to promote cognitive, social, and emotional development (Siegel, et al., 1985; Piaget, 1932; Hartup, 1976). Rice (1991) states that a child's development may be influenced by language ability, while social interactions may play a specific role in the enhancement of language development. By enhancing developmentally important social interactions, with opportunities to interact with peers who are developing normally, children with language delays may benefit from attending a full inclusion program. While some findings have shown the benefits of social interactions, other research has shown that children with language delays may be "at risk" for social isolation (Harper & McCluskey, 1996). Therefore, recent studies have focused on children with special needs, their participation in social interactions, and the resulting influence that it has on their development. Guralnick (1990) reported that

> "handicapped children form a socially separate subgroup in preschool settings. In general nonhandicapped children tend to interact far less frequently with handicapped children than they did with other nonhandicapped children ... Moreover, greater degrees of social separation are found for children with more severe disabilities" (287). "Handicapped children are perceived as being of lower social status and are treated accordingly as reflected in speech style analyses ... this latter pattern is also found when delayed children interact with other delayed children' (294)".

Further research by Guralnick has supported the notion that children with special needs may have more frequent interactions with children developing normally depending upon the relative success of their interactions. He found that children with communication disorders were more successful when interacting with their normally developing peer groups than with their peers with special needs (Guralnick et al., 1996).

Several studies suggest that children with communication disorders in a mainstreamed setting are less socially integrated because of the tendency for children with language delays to be involved in groups with both adults and peers and not in groups with their peers alone. Children with delays interacted less with their peers and more with adults than did children developing normally (Daily, 1996; Hadley & Rice, 1991, Guralnick et al. 1996). While research has shown

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that adults are a part of such interactions, little is known of the effect of the adult's participation in the interaction or of the context of activities in which these interactions typically take place. The present study focused in more detail on the peer social interactions of children with language delays, both with and without adult involvement to examine what role adults play in the facilitation of such involvement. Additionally, this study focused on the context of the children's interactions, including their activity (gross motor, sedentary, and themed activities, or transition) and who they are interacting with (children developing normally, children with special needs, or both).While some research has examined what kind of play (i.e., solitary, parallel, and group play) children with language delays are involved in during interaction, few have examined the context of the child's play activities (Guralnick & Groom, 1987; Hadley & Rice, 1991).

This study is focused on the types of activities in which these children were engaged during interaction, who was involved in the interaction, and the quality of the interaction. This research was conducted to answer the following questions: What are the effects of speech and/or language impairment on the social interactions among preschool children? Compared to their peers, do children with severe language delays: spend more or less total time in interaction? spend more or less time in interaction while involved in an activity? spend more or less time in interaction involving adult facilitation? engage in more positive or negative interaction? engage in more interaction that is equal or unequal in status? How do these interactions affect the child's development and social relationships? Hypotheses for this study were that children with language delays would spend less time in overall interaction; less time in specific activities such as gross motor play, sedentary activities, and themed activities, and more time in transition; have more interactions involving adult facilitation; and have more interactions that are negative and unequal in nature.

METHOD

Subjects

A total of 16 preschool children attending either a morning or an afternoon preschool at the Center for Child and Family Studies (CCFS) at the University of California at Davis were selected for this study. All were a part of a longer, ongoing study being conducted at the CCFS. Subjects ranged in age from 38 months to 58 months (M = 49). Eight children with a variety of special needs including Cerebral Palsy, Autism, and Down Syndrome, were matched by sex and approximate age to 8 children who were developing normally.

For the purpose of this study, subjects were grouped based on language ability. Eight of the subjects were developing normally with no language delays. Four of the subjects with special needs had no more than modest oral language delays; while four had very severe oral language delays. The children in this last group were virtually without expressive oral language abilities. Children who were incapable of independent locomotion, regardless of their language abilities, were not included in the study as subjects.

Setting

The CCFS is a full inclusion preschool which can be described as a least restrictive environment. The preschool philosophy emphasizes and promotes cognitive, social and emotional development through exploration and autonomy. The adults in the classroom included a program director, the classroom head teacher(s), a special education teacher, and 6 to 8 advanced student teachers. With a caregiver-child ratio of 1:4, the classroom consisted of approximately 30 children developing normally and 5 children with special needs. Student teachers often worked in conjunction with the special education teachers, assisting with children with special needs. The preschool has both a morning and an afternoon program where free play is scheduled into the children's daily activity. During this time the children have access to both indoor and outdoor activities including themed areas, such as a doll house or tractor; arts and crafts areas; climbing structures for gross motor play; and quiet areas for individual reading, puzzles, and blocks.

Procedure

Four videotapes each of selected subjects were drawn from those collected as part of a larger study at the CCFS. In that study, children were filmed in 20 minute blocks of time during their free play periods using a Panasonic VHS video camera and a Realistic FM wireless microphone transmitter and receiver. Each child wore a "belt" with a pouch containing the microphone transmitter. This allowed researchers to film children from quite a distances while maintaining good quality sound on the recording. For this study, the total videotaped observation time per subject for the four observations selected ranged from 71.83 to 91.42 minutes (mean = 81.4).

Data was coded in real time and entered into a spread sheet on Excel. Episodes were scored according to time on the VCR clock counter and time was reset at the beginning of each observation. Each time there was a change in a codeable variable a new interaction was scored. Total length of each video taped observation was also recorded. Interactions were coded episodically for the following variables: context of activity, quality of interaction, adult facilitation, type of interaction, and peer(s) involved. Context of activity included Gross Motor (large body movements such as running, climbing, bicycle riding), Sedentary (reading, arts and crafts, puzzles), Themed Activity (make-believe play, with or with out objects) and Transition (movement between activity; not engaged in any activity). Quality of Interaction was coded as either Negative (interactions involving conflict and/or unpleasant, hostile or rejecting behavior) or Positive/Neutral (all instances where the interaction was not negative; includes smiling, laughing, and pleasant or helpful behaviors) and Unequal (interactions where the subject or peer treats another in a condescending or developmentally unequal manner, perhaps with the use of "motherese" type language) or Equal (respectfully speaking to others as though they are at the same developmental level). Adult Facilitation defines whether an interaction was Facilitated (when a caregiver is present and is involved in the subject's interaction, acting as a communication center or mediator) or Non facilitated (an interaction that is not dependent on the absence or presence of the caregiver). Type of Interaction was coded to examine who was involved in the interaction. This could be either Interaction Peer (peer to peer) or Interaction Both (both children and adults). The variable of Peer(s) Involved codes for who the subject is interacting with: Developing Normally (all children who are developing normally), Special Needs (all subjects with developmental disabilities, including other children at the center who are motorically impaired but who are not subjects for our study) or Mixed Group (both children developing normally and those with special needs).

Two observers evaluated 12% (N=8) of the videotapes for final training and refinement of coding before assessing interobserver agreement. Confusion matrices were made for each of the following groups of variables: context of activity, quality of interaction and adult facilitation, and type of interaction and peer(s) involved. Interobserver agreement was then assessed on 6% (N=4) of the videotapes and Cohen's Kappa was calculated to measure the agreement between observers, correcting for chance. Kappa was .74 for context of activity, .80 for quality of interaction/adult facilitation, and .86 for type of interaction/peer(s) involved.

The data were aggregated across observations for each subject. Percent of total observation time in interaction, as well as percent of interaction time for each of the variables was computed. The three groups were then compared for significant results using a Mann-Whitney U sum of ranks test. We compared the three groups for percent of total observation time spent in interaction and percent of actual interaction time spent in each variable.

RESULTS

The interactions of children developing normally were compared to those of their peers who had moderate and severe language delays, likewise, all other crosswise comparisons between groups were made. As shown in figure 1, normal children and those with modest language delays spent significantly more time in interaction than did children with severe language delays (p = .0243) and (p = .0285) respectively. There were no differences in overall interaction time between normal children and those with moderate delays.

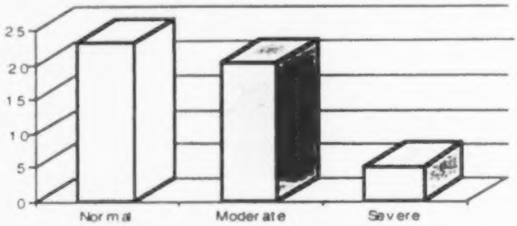

Figure 1. Percent of Total Observation Time Spent In Interaction

Two statistically significant differences were found between groups in the context of interactions. Of their actual time spent in interaction, children with severe language delays engaged in proportionally more gross motor play compared to their normally developing peers (p = .0081). Additionally, children with moderate language delays spent less time in transition, not involved in any specific or organized activity (p = .0035) compared to their normally developing peers. There were no significant differences found between groups in sedentary or themed activity (see Figure 2).

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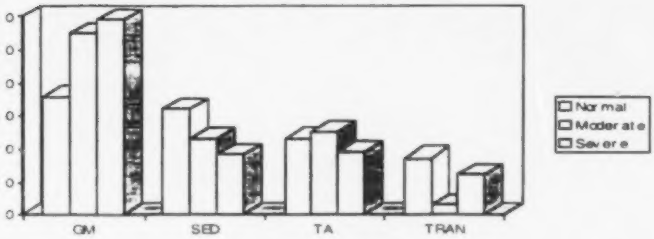

Figure 2. Percent of Interaction Time for Context of Activity

Although there were no group differences in the quality of interactions or the make-up of the peer group, there was an influence of adult facilitation on the relative interaction times of the normal children and those with severe language delays. Significant differences revealed that children with severe language delays had relatively more interactions when an adult facilitated the interaction (p = .0243) and relatively fewer interactions when there was no adult facilitation (p = .0243) when compared to their normal peers.

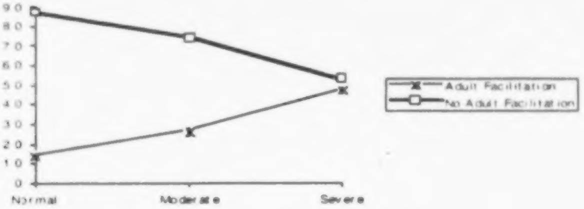

Figure 3. Percent of Interaction Time Involving Adult Facilitation

DISCUSSION

The results of this study indicate that children with severe language delays spent less time in peer interaction than their peers with moderate language delays and those developing normally. This finding supports the results of Hadley & Rice (1991), who found that children with limited communication skills were involved in proportionately fewer peer interactions than their peers developing normally. It is important to note that Hadley & Rice (1991) were looking at the number of interactions while the present study examined the percent of time in interaction for children with severe language delays. Harper & McCluskey (1996) found that, while the number of episodes involving interaction did not differ between groups, there was a significant difference in the percent of time that children with language delays engaged in social interaction when compared to children developing normally. Both studies support the idea that differences in language ability contribute to a child's overall participation in social interaction.

Of their actual time spent in interaction, children with severe language delays spent more time in gross motor activity than did their peers developing normally. More of the interactions of children with severe language delays were during gross motor play (59%) compared to their time spent interacting in other activities: sedentary (18%), themed activity (19%) and transition (12%). This difference may be because gross motor activities generally include more body language and physical contact than verbal communication, while activities such as sedentary play and themed activities involve greater use of verbal communication. Rice & Hadley (1991) suggest that children with severe language delays had a lower proportion of episodes interacting during activities such as dramatic play because they involve greater conversational demands and more advanced communication skills. Therefore children with severe language delays may benefit if more activities were less dependent on oral language and more supportive of other modes of communication. The results of this study may suggest that children with language delays spend less time in interaction because they do not have the means to sustain exchanges in verbal communication.

Compared to their peers developing normally, children with severe language delays had a greater percent of interaction time involving adult facilitation. This overall pattern of increasing involvement of adult facilitation with an increase in language severity could imply that these children with increasing language delays are increasingly dependent upon the support of caregivers as moderators and facilitators of their social interactions. There were no differences in the quality of the interactions between the three groups, thus there must be something else that is contributing to the minimal interactions of children with severe language delays. The findings show that the interactions of children in a full inclusion setting may be a function of their environment. Children with special needs, specifically those with language delays, are in need of activities that promote interaction through nonverbal means, allowing these children to have more interaction with their peers. Children with language delays may be in need of adults who will facilitate their involvement in social interactions with their peers.

This study is limited due to a small sample size of 16 children. The subjects were nonrepresentative of the general population being students at a University preschool where the abundance of caregivers and ethnic diversity of the preschool class may have had a substantial influence on their interactions. Although none of the subjects had major motoric impairments, they may have had other disability factors (Downs Syndrome, Cerebral Palsy, Autism) that contributed to their limited time in interaction. In addition, due to constraints in time, a sequential analysis of the data was not made, nor was there an examination of the data across variables. The data shows how much time each child spent interacting in gross motor activity, but does not show how much of that time involved adult facilitation.

Future research is needed to examine the effect of adult intervention and influence on positive interactions among children with and without language delays, and to examine how the environmental features of a full inclusion preschool might be modified to promote success in social interaction. Also, more information is needed about the mode of communication used in interactions, with implications for how it affects a child's overall time in interaction.

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REFERENCES

Buysse, V., & Baily, D. B., Jr. (1993). Behavioral and developmental outcomes in young children with disabilities in integrated and segregated settings: A review of comparative studies. *Journal of Special Education*, 26, 434-461.

Daily, W. (1996). Peer interaction: Differences in initiation among developmentally-delayed and normally-developing children. Unpublished M.S. thesis, University of California at Davis.

Gindis, B. (1995). The social/cultural implication of disability: Vygotsky's paradigm for special education. *Educational Psychologist*, 30, 77-81.

Guralnick, M. J. (1991). The next decade of research in the effectiveness of early intervention. *Exceptional Children*, 58, 174-183.

Guralnick, M. J., Connor, R. T., Hammond, M. A., Gottman, J. M., & Kinnish, K. (1996). The peer relations of preschool children with communication disorders. *Child Development*, 67, 471-489.

Guralnick, M. J., & Groom, J.M. (1987). The peer relations of mildly delayed and non handicapped preschool children in mainstreamed play groups. *Child Development*, 58, 1556-1572.

Hadley, P. A., Rice, M. L. (1991). Conversational responsiveness of speech- and language-impaired preschoolers. *Journal of Speech and Hearing Research*, 34, 1308-1317.

Harper, L.V. & McCluskey, K. (1996). Social involvement with peers and teacher behavior as a function of type and severity of mainstreamed preschoolers' disabilities. Unpublished summary of preliminary findings, Department of Human & Community Development, University of California at Davis.

Hartup, W.W. (1976). Peer interaction and the behavioral development of the individual child. In: Psychopathology and Child Development, Schopler, E. & Reichler, R.J., Eds. Plenum, New York.

Lieber, J. & Beckman, P. J. (1991). The role of toys in individual and dyadic play among young children with handicaps. *Journal of Applied Developmental Psychology*, 12, 189-203.

Piaget, J. (1932) The Moral Judgement of the Child. Kegan Paul, London.

Rice, M. (1993). Book Chapter, "Don't talk to him; he's weird": A social consequences account of language and social interactions. In: Enhancing children's communication: Research foundations for intervention. Communication and language intervention series, 2, 139-158. Kaiser, A. P. & Gray, D. B., Eds. Paul H. Brookes Publishing, Baltimore, MD.

Rice, M. L., Sell, M. A., & Hadley, P. A. (1991). Social interactions of speech- and language-impaired children. *Journal of Speech and Hearing Research*, 34, 1299-1307.

Siegel, L. S., Cunningham, C. E., & van der Spuy, H. I. J. (1985). Interactions of language-delayed and normal preschool boys with their peers. *Journal of Child Psychology and Psychiatry*, 26, 77-83.

Thiele, J.E., & Hamilton, J.L. (1991). Implementing the early childhood formula: Programs under PL 99-457. *Journal of Early Intervention*, 15, 5-12.

Vygotsky, L. S. (1978)Mind in Society. Cambridge, MA: Harvard University Press.

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Characteristics Associated with Premature Drop Out in Client-Centered Play Therapy

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According to previous research, Client-Centered Play Therapy (CCPT) is effective with a variety of childhood problems. CCPT allows children to work with their problems at their own pace. Although CCPT has popular support, it has also been shown that a large portion of children in CCPT do not complete their treatment. In an effort to examine these issues in greater detail, this study examines and compares the characteristics of clients who do and do not complete CCPT. Subjects of this study consisted of 48 girls and boys ages 4-14 who received CCPT at a university-based child and family outpatient counseling clinic. Factors important in differentiating successful from non-successful completers included: mother's age, education, child gender, and living arrangements.

BACKGROUND

Few databased research studies have been conducted on the characteristics of the effectiveness of Client-Centered Play Therapy (CCPT), in comparison to other child psychotherapies. CCPT assumes children can solve their own problems and are capable of re-creating their world and their relationship to it in play (Landreth, 1991). Ginsberg (1993) defines the objective of CCPT as:

> Essentially, the objective in Client-Centered Play Therapy is to provide a context in which a child's own resources are utilized to foster change and growth. Under these conditions, attention needs to be directed toward the context of play sessions, materials used, limits including time, therapist's behavior, and the interaction of these components to provide opportunity for the child to be free to express those feelings and to take more responsibility for them (p. 124).

Studies have shown CCPT to be effective in the following areas: (a) decrease and alleviation of aggressive acting-out (Barlow, Strother, & Landreth, 1985; Willock, 1983), (b) improved emotional adjustment of children of divorced parents and of abused and neglected children (Mendell, Mann & McDermott, 1983), (c) reduction of stress and anxiety in hospitalized children (Golden, 1983), (d) increased and corrected academic and speech performance (Axline, 1947, 1949; Guerney, 1983, Pumfrey & Elliot, 1970), (e) decreased emotional and intellectual problems of the mentally retarded (Leland, 1983; Leland & Smith, 1962; Pothier, 1967), (f) better social and emotional adjustment and improved self-esteem (Axline, 1948, 1964; Bleck & Bleck, 1982; Crow, 1989; King & Ekstein, 1967; Pothier, 1967; Ude-Pestel, 1977), (g) amelioration of elective mutism and stuttering (Barlow, Strother & Landreth, 1986; Wakaba, 1983), and (h) relieving psychosomatic difficulties such as asthma, ulcerative colitus and allergies (Dudek, 1967).

Given that CCPT, along with other child psychotherapies have proven their effectiveness, it is surprising so many leave treatment prematurely. It is not uncommon in a variety of mental health settings for 50% of clients to leave treatment without prior knowledge and agreement of their therapists (Pekarik, 1983; Phillips, 1985). Since it is desirable to have clients stay for the full duration of treatment, it is important to investigate the characteristics of those who terminate prematurely.

Kazdin and Mazurick (1994) examined early and late terminaters in child psychotherapies in general. The results of the study indicated no significant differences when examining therapists, treatment conditions, and age and sex of the child as variables. Discriminant function analyses combining early and late terminaters and comparing them to the completers indicated that mother's age, single-parent family, child history of anti-social behavior, child contact with anti-social peers, receipt of public assistance, number of conduct disorder symptoms, and child IQ were all strong contributing factors of premature termination. The terminators tended to be younger mothers, single parents, nonbiological parents, more likely to be from a minority group, and those who had more severe child impairment in relation to conduct, academic disjunction, and social behavior.

Kazdin, Mazurick, & Siegal (1994) conducted a study of various child psychotherapies to see whether individuals who drop out of therapy are more severely impaired to begin with (pretreatment) or whether they differ on subject and demographic characteristics that contribute to dropout. Results revealed terminators had greater socioeconomic disadvantage, more stressful living conditions (e.g., single parents, more perceived stress, more life events), and more severe and chronic child dysfunction. The study also found that those who completed treatment made larger gains than their matched counterparts who dropped out (when comparing progress in pretreatment problem areas). While these studies provide insights into general issues of termination in child psychotherapy there are no studies that examine the issue in children receiving CCPT. The focus of this study is to examine specific variables of those clients who do not complete therapy and to compare them to those who do complete.

METHOD

Participants

Forty-five families served as participants in this study. The sample was drawn from closed treatment files covering seven consecutive years at a university-based child and family outpatient-counseling clinic. Description of subject selection and characteristics are included in the procedure section.

Instruments

All clients in the study completed the following measures as part of the initial procedure. The Parenting Stress Index scores (PSI; Abidin, 1986), Child Behavior Checklist, (CBCL; Achenbach, 1991) and demographic information.

Procedure

To be included in the study, parents must have completed an intake interview, completed the measures describe above and brought their child to at least two sessions of client-centered play therapy. Graduate students conducted therapy with training in CCPT at a university-based child and family-counseling clinic.

The demographic questionnaire assessed the age, gender, ethnicity, and living arrangements of the child as well as parental age and education, and reason for referral.

In addition to the information gathered as part of the intake information, therapist's experience and gender were coded along with termination status. Completion and non-completion was determined by a review of the client's files. The non-completion group included those who: (a) never returned, (b) had a schedule conflict and never returned, (c) insisted on termination, or (d) were assigned a new therapist and never returned. The completer group included those were judged to have successfully completed treatment. This decision was based on a mutual agreement between the therapist and client that treatment was successfully completed.

The final sample included 45 children and their parents. While both parents were encouraged to attend the intake interview and complete the measures, mothers were the primary respondents and the subsequent data analysis using the CBCL and PSI were based on maternal reports. Of the 45 children who received CCPT, 28 were non-completers(NC)and 17 were completers(C). Of the non-completers, 61% (n=17) were male and 39% (n=11) were female. In the C group, 88% (n=15) were male with 12% (n=2)being female. In the NC group 21% (n=6) lived with both biological parents, 14% (n=4) lived in two parent households with remarried parents, adoptive parents, or relatives, and 65% (n=18) lived in single parent families. Of the C group 47 % (n=8) lived with both biological parents, 24% (n=4) lived with stepparents, and 29% (n=5) lived in single parent families. The majority of children in both the NC and C groups were Caucasian (94% and 100% respectively). Reasons for referral were categorized into three broad groups, Internalizing Problems (including emotional and self-esteem problems) , Externalizing Problems (including behavior problems, ADHD) and Social problems (including social and family problems. Percentages for these categories for the C group was 47 % (n=8) Internalizing problems, 47% (n=8) Externalizing problems, and 6% (n=1) Social problems. For the NC group 36% (n=10) presented with Internalizing . 53% (n=15) with Externalizing , and 11% (n=3) with

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Social problems. Additional characteristics of the sample are presented in Table 1.

RESULTS

The categorical variables, child gender and living arrangements were examined using Chi-Square tests. A 2 x 2 chi-square analysis indicated a significant relationship between group status and gender ($x2 = 3.90$, $p < .05$). There were significantly more boys in the completer group than in the non-completer group. To analyze living arrangements, categories were collapsed to increase cell sizes resulting in two categories, living in a two-parent household or living in a single parent household. A 2 X 2 Chi-Square analysis was significant ($X2 = 5.148$, $p < .03$) indicating that children in the NC group were more likely to live in a single parent family. Next, a series of univariate analyses of variance (ANOVA's) were performed on the demographic variables of child age, maternal age and education, and number of sessions attended. Results are presented in Table 1. There were significant differences between the groups for mother's age ($F = 4.38$, $p<.05$) and mother's education ($F = 4.66$, $P < .05$). Mother's age and mother's education (in years) were both lower in the non-completer groups. A second series of ANOVA's examining parental stress and child behavior failed to reveal significant differences between groups. Results are presented in Table 2. Finally, the therapist variables of level of experience and gender were examined. Therapist experience was rated as either beginning (had taken a course in CCPT and completed a supervised practicum) or advanced (had completed advanced CCPT coursework and practicum). Using these criteria 82% (n=14) of the therapists in the completers group were beginning and 18% (n=3) were advanced. For the noncompleter group 64% (n=18) were beginning therapists with 36% (n=10) being advanced. Results of a 2 X 2 Chi-Square analysis were not significant. A final Chi-Square analysis showed a significant relationship between therapist gender and completion status ($X2 = 4.71$, $p < .03$). There were significantly more male therapists in the Completion group. Eighty two percent (n=14) of the therapists in the C group were male and 18% (n=3) female compared to 50% male (n=14) and 50 % female (n=14) in the NC group.

Table 1: Sample Characteristics and ANOVA's

Variable	Completion Group (N = 17) M	SD	Non-Completion Group (N = 28) M	SD	F
Child Age	8.53	2.70	7.30	2.60	2.80
Maternal Age	38.40	5.02	33.00	9.40	4.38*
Maternal Education (in years)	15.00	2.60	12.90	2.90	4.66*
Number of Sessions Attended	13.53	6.80	11.03	8.25	0.42

*$p < .05$

Table 2: Parenting Stress and Child Behavior ANOVA's

Variable	Completion Group (N = 17) M	SD	Non-Completion Group (N = 28) M	SD	F
Parenting Stress Index					
Child Domain	125.25	22.30	125.20	22.30	0.00
Parent Domain	127.10	26.10	135.20	27.00	0.94
Child Behavior Checklist					
Internalizing	58.00	10.15	62.30	14.40	1.12
Externalizing	58.50	12.51	63.03	16.10	0.90

DISCUSSION

The findings of this study were consistent with the findings of Kazdin and Mazurick (1994) in regards to the non-completer group consisting children with younger mothers living in single parent households. In addition, the current study found that the level of maternal education was lower for mothers whose children did not complete CCPT. These results were independent of number of sessions attended or age of the child. Although analyses did not reveal significant results there tended to be certain trends in the data that support previous studies. There was a tendency for the non-completers to be referred more often than the completers for externalizing behavior problems and social problems. Similarly, parent reports of child behavioral problems tended to be higher in the non-completer group. There was some indication that parenting stress due to parental characteristics was higher in parents in the non-completion group. Compared to the sample in the Kazdin and Mazurick study (1994) the sample in this study may be less impaired in terms of environmental stressors and child behavior problems. However, taken together the data would suggest that the stress and hardship presented by being a young single parent with less educational experience and a child with externalizing behavior problems makes compliance with child psychotherapy more difficult.

Unlike Kazdin and Mazurick (1994) there were significant effects related to gender. In the current study, the completion group was composed primarily of boys. Similarly, the therapists of children in this group were also predominantly male. This suggests that matching of child and therapist gender in CCPT may enhance completion of treatment.

There are several limitations that restrict generalizations that can be made about child psychotherapy in general; and CCPT in particular. The sample in the study was homogeneous in terms of ethnicity being exclusively Caucasian. In addition services were provided in the context of a university based clinic and as such may have attracted families who were familiar and comfortable with the university environment. The small sample size also warrants caution as in the case of the interesting findings in regard to therapist and child gender. Replications using a larger sample size with more diverse demographic characteristics would increase external validity and generalizability.

Overall, the findings would suggest that there are more similarities than differences between those who fail to complete CCPT and terminators from child psychotherapy in general. The results of this study as well as those of others would strongly suggest that factors related to completion or termination of child psychotherapy are more related to demographic and life situation factors than to the type of treatment approach utilized. It seems rather evident that those most at risk for premature termination are young single mothers who may have less educational opportunity and training and who have children with externalizing behavior problems. Attempts to address the issues of stress in the lives of these mothers and ways to combat it may help facilitate successful participation in child psychotherapy.

REFERENCES

Abidin, R. R. (1986). Parenting Stress Index. Charlottesville, VA: Pediatric Press.

Achenbach, T. (1991). Manual for the Child Behavior Checklist and Revised Child Behavior Profile. Burlington, VT: Achenbach.

American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.). Washington, DC: Author.

Axline, V. (1947). Nondirective play therapy for poor readers. Journal of Consulting Psychology, 11, 61-69.

Axline, V. (1948). Play therapy: Race and conflict in young children. Journal of Abnormal andSocial Psychology, 43, 300-310.

Axline, V. (1964). Dibs: In Search of Self. Boston: Houghton Mifflin.

Barlow, K., Strother, J., & Landreth, G. (1985). Client-centered play therapy: Nancy from baldness to curls. The School Counselor, 32, 347-356.

Bleck, R. & Bleck, B. (1982). The disruptive child's play group. Elementary School Guidance and Counseling, 17, 137-141.

Crow, J. (1989). Play therapy with low achievers in reading. Unpublished doctoral dissertation, University of North Texas.

Dudek, S. (1967). Suggestion and play therapy in the cure of wants in children: A pilot study. Journal of Nervous and Mental Disease, 145, 37-42.

Ginsberg, B. (1993). Catharsis. In C. H. Schaefer (Ed.), The Therapeutic Powers of Play (pp.124). Northvale, New Jersey: Jason Aronson, Inc.

Golden, D. B. (1983). Play therapy for hospitalized children. In C. E. Schaefer & K. L. O'Conner (Eds.), Handbook of Play Therapy (pp. 213-233). New York: John Wiley & Sons.

Guerney, L. (1983). Play therapy with learning disabled children. In C. E. Schaefer & K. L. O'Conner (Eds.), Handbook of Play Therapy (pp. 419-435). New York: John Wiley & Sons.

Kazdin, A., & Mazurick, J. (1994). Dropping out of child psychotherapy: Distinguishing

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early and late dropouts over the course of treatment. Journal of Consulting and Clinical Psychology, 62 (5), 1069-1074.

Kazdin, A., Mazurick, J., & Siegal, T. (1994). Treatment outcome among children with externalizing disorder who terminate prematurely versus those who complete psychotherapy. American Academy of Child Adolescent Psychiatry, 33, (4).

King, P., & Ekstein, R. (1967). The search for ego controls: Progression of play activity in psychotherapy with a schizophrenic child. Psychoanalytic Review, 54, 25-37.

Landreth, G. L. (1991). Play Therapy: The Art of the Relationship Muncie, Indiana: Accelerated Development.

Leland, H. (1983). Play therapy for mentally retarded and developmentally disabled children. In C. E. Schaefer & K. L. O'Conner (Eds.). Handbook of Play Therapy (pp. 436-454). New York: John Wiley & Sons.

Leland, H., & Smith, D. (1962). Unstructured material in play therapy for emotionally disturbed, brain damaged, mentally retarded children. American Journal of Mental Deficiency, 66, 621-628.

Mann, E., & McDermott, J. (1983). Play therapy for victims of child abuse and neglect. In C. E. Schaefer & K. L. O'Conner (Eds.), Handbook of Play Therapy (pp. 283-307). New York: John Wiley & Sons.

Mendell, A. E. (1983). Play therapy with children of divorced parents. In C. E. Schaefer & K. L. O'Conner (Eds.), Handbook of Play Therapy, (pp. 320-354). New York: John Wiley & Sons.

Pekarik, G. (1983). Follow-up adjustment of outpatient dropouts. American Journal of Orthopsychiatry, 53, 501-511.

Phillips, E. L. (1985). Psychotherapy revised: New frontiers in research and practice. Hillsdale, New Jersey: Erlbaum.

Pothier, P. C. (1967). Resolving conflict through play fantasy. Journal of Psychiatric Nursing and Mental Health Services, 5, 141-147.

Pumfrey, P., & Elliot, C. (1970). Play therapy, social adjustment, and reading attainment. Educational Research, 12, 183-193.

Wakaba, Y. (1983). Group play therapy for Japanese children who stutter. Journal of Fluency Disorders 8, 93-118.

Willock, B. (1983). Play therapy with the aggressive, acting-out child. In C. E. Schaefer & K. L. O'Conner (Eds.). Handbook of Play Therapy (pp. 386- 411). New York: John Wiley & Sons.

Helping Behavior Rates and Demographics: A Comparative Analysis

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Steblay's 1987 meta-analysis examined the relationship between population size and bystander helping behavior, finding only a small negative correlation ($r = -.10$). In this study I hypothesized that two demographic variables, population density and racial heterogeneity, would have a stronger link to helping rates. The U.S. Department of Commerce and Bureau of the Census provided demographic information for the 24 cities included in Steblay's analysis. Steblay's review provided the bystander helping behavior data. In support of the hypothesis, a negative correlation was found between population density and helping behavior, $r = -.48$, $p = .009$, and between helping behavior and racial heterogeneity $r = -.68$, $p = .000$. Discussion will examine theoretical reasons for these relationships.

INTRODUCTION

The rural-urban hypothesis suggests that rural people are more helpful to strangers in need of help than are urban people. Many studies have tested this phenomenon, with mixed results. Steblay (1987) went one step closer to understanding the rural-urban phenomenon by synthesizing data that tested this hypothesis. In a meta-analysis which included 35 studies, the relationship between helping rates and population size was not as strong as anticipated, $r = -.10$. This small relationship suggests that other variables, besides population size, account for differential helping behavior rates in rural versus urban areas.

The logical next step is to explore other variables that could assist in the explanation of helping behavior rates in rural settings versus urban settings. The two demographic variables that will be considered in this study are population density and the racial diversity of a population.

Population Density

A study done by Levine, Martinez, Brase, and Sorenson (1994) examined helping rates in 36 cities. They found that the correlation coefficient reflecting the relationship between helping rates and population density was higher ($r = -.44$, $p < .001$) than the coefficient which resulted from correlating helping behavior and population size ($r = .04$). This supports Milgram's overload theory of urban living (1970). He suggests that in highly populated areas, the responsibility to help may be transferred to other onlookers, thus the low bystander helping behavior in densely populated areas.

Racial Diversity

This variable has not been considered as a specific means to explain helping behavior in urban versus non-urban areas. However, theorists have suggested that heterogeneity is an important issue when understanding human interaction and population (Wirth, 1938; Fischer, 1975). Studies have compared helping behavior across cultures (Yousif & Korea 1995; Hedge & Yousif, 1992), but for the purpose of this study, the diversity within a city is important.

Fischer (1975) theorized that a large population supports subcultures. He suggested that the more populated a geographical area is, the greater the potential cohesion of constituent subgroups. Applying this rationale, it is reasonable to predict that, while bystander helping behavior may be greater within subcultures, it will be less across subcultures.

Because cities contain many subcultures, racial heterogeneity could create fear or apprehension toward helping. This notion is supported by a study done by Heald-Moore (1995), in which she found that "whites are more fearful of encountering black than white strangers and blacks appear to be slightly more fearful of encountering white than black strangers" (271). According to Milgram's (1975) overload theory, "the city dweller can reduce excessive demands and screen out urban heterogeneity by responding along ethnic lines"

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(1426). There are many elements that contribute to the urban overload theory; among them are the two variables considered in this study, population density and racial diversity. Therefore, the more racially heterogeneous a population, the less likely a stranger, of any race or ethnicity, will receive help.

The intention of this study is to add to the understanding of Steblay's (1987) hypothesis which suggested that people of a rural area were more helpful to strangers than those of the city. Where the meta-analysis used population size as a variable gaining insignificant results, bystander helping behavior is correlated with population density and racial diversity. The more densely populated an area is, and the higher the heterogeneity of the population, the less likely a stranger will receive help.

METHOD

Participants

Demographics were sought for 19 United States cities and five United States towns out of the 35 studies which were included in the meta-analysis (Steblay, 1987). This study did not include all of the cities considered in Steblay's analysis because towns with populations less than 1,000, cities vaguely labeled, and populations located outside of the United States, were not represented in the census data.

The different kinds of helping behavior "categories rang[e] from simple requests (e.g., give time of day) to quite demanding pleas (e.g., help an injured pedestrian)" (348). All the studies included in the meta-analysis tested helping behavior as a contextual variable. This means "that the helping test took place either in a rural area or in the city" (349).

Procedure

The information used to statistically refute or accept the null hypotheses came from several sources. The studies included in Steblay's (1987) meta-analysis supplied the bystander helping behavior rates. Because most of these studies were done in the late 70's and early 80's, the population size and racial demographics were extracted from the United States Department of Commerce & Bureau's *1980 Census of the Population*. Finally, land area, which is necessary to compute population density, was found in the *1990 Census of Population and Housing Unit Counts*.

Racial heterogeneity was defined by counting the number of ethnic groups of 20 persons or more within a city or small town. The Bureau of the Census created 16 categories, all of them included in the count. Between three to 16 categories were found in each city.

RESULTS

A one-tailed bivariate correlation coefficient was calculated to test each of the two hypotheses. The first hypothesis stated that helping rates would drop as a population increased in density. Twenty-eight bystander helping behavior rates gathered from different parts of the U.S., including 19 cities and five small towns, were correlated with population density, yielding a negative relationship of $r = -.48$, $p = .009$, (CI 95%: -.71 to -.21).

The second hypothesis suggested that the more racially heterogeneous a population was, the less likely bystander helping behavior would occur. Correlating helping behavior rates with the number of ethnic groups within a population resulted in $r = -.68$, $p = .000$, (CI 95%: -.82 to -.46).

If bystander helping behavior is low in a racially heterogeneous society, it should be high within a homogeneous population. Because the small town populations considered in this study are predominately white, the Caucasian demographic represented homogeneity. The correlation between bystander helping behavior and the percentage of Caucasian race resulted in $r = .41$, ($p = .02$).

DISCUSSION

The results of this study show that the variables population density and racial heterogeneity have significant relationships to bystander helping behavior. The higher the population density and racial heterogeneity, which are characteristics of city life, the lower the bystander helping behavior. This helps to explain Steblay's (1987) rural-urban hypothesis in a way that is correlational not causal.

Population density

Not only do findings support the study done by Levine et al. (1994), they also relate well with Milgram's (1970) overload theory. The overload theory suggests that people in urbanized areas are likely to keep high level societal stimuli under control by creating tighter boundaries. Milgram maintains that a person has "filtering devices" which help to minimize social interactions. The desire for low social interaction may be one reason for decreased bystander helping behavior in densely populated areas.

Racial diversity

A significant negative correlation was found between racial diversity and bystander helping behavior. When considering the theoretical implications of the findings, two shortcoming must be evaluated. First, the studies included in Steblay's meta-analysis did not point out the race, ethnicity, or whatever could suggest that the helper was from a subculture which differed from the person receiving the help. Second, the studies did not indicate which part of the city or small town the bystander helping behavior was tested. Demographics of a city can change within blocks. Therefore, racial diversity is one element of the heterogeneous makeup of city life.

Fischer's (1975) theory of subcultures and Milgram's (1970) overload theory help to theoretically explain the findings, however, building a sense of community may provide better insight. That is, even if a neighborhood were racially heterogeneous, residents' knowledge of one another may create a sense of security, hence an increase of bystander helping behavior. The support for this is found in the correlation between homogeneity and bystander helping behavior.

The conceptualization of racial homogeneity comes from the fact that the small towns included in this study were dominated by a Caucasian population. The percentage of Caucasians in an area, such as city or town, were positively correlated with the bystander helping behavior. The more homogeneous a population, the more likely bystander helping behavior will occur.

Reiss (1974) may explain high bystander helping behavior in rural areas by comparing the different ways in which humans interact in the rural community and the urban populated area. He suggests that people of the small towns have higher face-to-face contact and have longer lasting, strong relationships with each other then the people who live in the city. This creates a sense of stability and security. Consequently, if an event occurs out of the norm in the subculture - a stranger in need of help - the rural citizen feels safe to extend a hand.

The strong correlations investigated in this study help to explain the rural-urban hypothesis Steblay (1987) predicted in her meta-analysis. That is, "Country people are more helpful than city people" (346). It is wondered if the urbanites can learn from the citizens of rural USA. Because a rural area has a small population size, it allows residents to become familiar with one another. By having block parties or by having a community center, neighborhoods within an urban area could gain the same sense of community as a small town. Knowledge about the general routine of the people who live within a close proximity may help a resident gain the feeling of stability, thus increasing bystander helping behavior. To strengthen the validity and the reliability of this study, bystander helping behavior should be tested within areas of a city that have made the conscious effort to create the sense of community, whether they are predominately white, black, Asian, or racially diverse.

REFERENCES

Fischer, C. S. (1975). Toward a subcultural theory of urbanism. *American Journal of Sociology, 80*, 1319-1341.

Heald-Moore, T. (1995). Fear of black strangers. *Social Science Research, 24* 262-280.

Hedge, A., & Yousif, Y. (1992). Effects of urban size, urgency, and cost on helpfulness: a cross-cultural comparison between the United Kingdom and Sudan. *Journal of Cross- Cultural Psychology, 23*, 107-115.

Levine, R. V., Martinez, T. S., Brase, G., & Sorenson K. (1994). Helping in 36 U.S. Cities. *Journal of Personality and Social Psychology, 67*, 69-82.

Milgram, S. (1970). The experience of living in cities. *Science, 167*, 1461-1467.

Reiss, Albert J. Jr. (1959). Rural-urban and status differences in interpersonal contacts. In Charles Tilly (Ed., 1974), An urban world (pp.331-348). Canada: Little, Brown and Company.

Steblay, N. M.(1987). Helping behavior in rural and urban environments: a meta-analysis. *Psychology Bulletin, 102*, 346-356.

U.S. Department of Commerce & Bureau of the Census. (1983). *County and City Data Book.* Washington D.C.

U.S. Department of Commerce & Bureau of the Census. (1980). *Census of the Population.* Washington D.C.

U.S. Department of Commerce & Bureau of the Census. (1980). *Census of the Population and Housing Units.* Washington D.C.

Wirth, L. (1938). Urbanism as a way of life. *The American Journal of Sociology, 44*, 1-24.

BEST COPY AVAILABLE

Yousif, Y. & Korte C. (1995). Urbanization, culture, and helpfulness: Cross-cultural studies in England and the Sudan. *Journal of Cross-Cultural Psychology*, *26 (5)*, 474-489.

Parents' Marital Status, Father-Daughter Intimacy and Young Adult Females' Dating Relationships

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The affective relationships of young adult females and their fathers were investigated for effects on dating relationships, dating anxiety, and interpersonal trust. Ninety-six college females completed questionnaires about father-daughter intimacy, dating satisfaction, dating anxiety, and trust. It was hypothesized that females with divorced vs. married parents, and females scoring lower on the intimacy scale, regardless of family structure, would experience less father-daughter intimacy, lower dating satisfaction and trust, and higher dating anxiety. Multivariate analysis of variance showed that females with divorced vs. married parents experienced significantly less intimacy with their fathers but similar levels of trust, anxiety, and satisfaction. Comparisons of females high and low in father-daughter intimacy showed no differences in trust, anxiety, or dating satisfaction. The relative importance of parents' marital status versus other factors relevant to divorce (e.g., intimacy, presence of a stepfather) will be discussed.

INTRODUCTION

Divorce has become a common occurrence in the lives of children today. At least two out of five children will see their parents separate while growing up (Ahrons & Rodgers, 1987). Research on the consequences of parental divorce on children has focused mainly on the adjustment of children under age 18. Less attention has been given to the long-term effects of childhood family structure on parent-child relations and interpersonal relationships in young adulthood (Cooney & Uhlenberg, 1990).

Following divorce, many children experience a decrease in the quantity and quality of contact with the noncustodial parent, usually the father (Amato & Rezac, 1994). Data from the National Survey of Children show that five years after divorce, nearly half of all children have not seen their fathers in the past year (Furstenberg, Nord, Peterson, & Zill, 1983). Children's separation from fathers continues into adulthood. Cooney and Uhlenberg (1990), with National Survey of Families and Households (NSFH) data on fathers aged 50 to 79, found that divorce reduced men's contact with adult children.

Teresa Cooney (1994) addressed the influence of recent parental divorce on contact and affective relations between 485 white young adults, ages 18-23, and their parents. Young adults from divorced families had less contact with their fathers, and daughters of divorce reported less intimacy in relation to their fathers than did their intact-family peers. Wallerstein & Kelly (1980) reported that 5 years after divorce, only 30% of children were able to build a mutually satisfying relationship with their nonresidential father.

Not only does divorce influence the parent-child relationship, but it also affects the child's interpersonal relations. A meta-analysis of 33 studies found that adults who experienced parental divorce as children, compared with those from married families, have poorer psychological adjustment and greater marital instability (Amato & Keith, 1991a). Research on adults and college students suggests that the experience of parental divorce in childhood is associated with reductions in the ability to develop and maintain supportive friendships and dating relationships (Slater & Calhoun, 1988 as cited in Black & Pedro Carroll, 1993). In a long-term follow up study in the United Kingdom, Wadsworth, Maclean, Kuh, and Rodgers (1990) found that both male and female college students of divorced families had less trust in a future spouse and greater dissatisfaction with the frequency of their dating relationships compared with children of nondivorced families. Those whose parents had divorced were less optimistic about the success of their own future marriages.

This finding supports research by Wallerstein (1987) who found that 16-18-year-old children of divorce, particularly young women, mentioned a sense of vulnerability and a fear of being hurt in romantic relationships. Although the participants intended to marry and believed in romantic love, two-thirds of Wallerstein's respondents were apprehensive about the possible

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breakup of their own future marriages. Wallerstein and Blakeslee (1989) described a related phenomenon known as the "sleeper effect," where divorce has long-term negative effects on children not expected on the basis of their earlier adjustment. They wrote, "We saw many young women with acute delayed depression that is certainly a sleeper effect of divorce...A significant number of young women are living-with an intolerable level of anxiety about betrayal" (p.62).

Black & Pedro-Carroll (1993) studied the long-term effects of parental divorce, interparental conflict, and parent-child relationships on interpersonal and generalized trust. The results showed that the effects of family disruption on psychological well-being were indirect, that is, mediated by the quality of parent-child relationships. For women, parental divorce was also associated with less emotional security with their fathers. In addition, Booth, Brinkerhoff, & White (1984) found that while there were no significant differences between children of divorced and intact families, those suffering a decline in parent-child relationships as a result of divorce reported lower satisfaction with heterosexual relationships. Another possible indirect effect involves the quality of the relationship with a stepfather. Wallerstein & Kelly (1980) found that after divorce many children turned to their stepfathers and away from their biological fathers. If the children found a warm response, they came to love and admire their stepfathers and consciously choose them as role models over their biological fathers.

The present study further explored the effects divorce has on heterosexual dating relationships of young adult females. Possible differences between young adult women of divorced versus intact families were studied, as well as differences between groups higher in father-daughter intimacy and lower in father-daughter intimacy. Females with divorced versus married parents were expected to experience less father-daughter intimacy, lower dating satisfaction and trust, and higher dating anxiety. Based on the previous literature's findings that intimacy is a possible mediating factor, females scoring lower on the intimacy scale, regardless of family structure, were also hypothesized to experience less dating satisfaction, less trust and more anxiety. Due to the potential mediating effects of a step-father, an additional question was explored to determine whether differences exist between young adult women with married parents versus divorced with a stepfather in father-daughter intimacy, satisfaction, trust, or anxiety.

METHOD

Participants

The sample included 96 female college students from two small, private, women's colleges in the southeast: 66 with married parents, 25 with divorced parents, 4 with widowed parents, and 1 with parents who had never married. Scores from five participants who had never engaged in a serious dating relationship were excluded from the analysis, resulting in a sample size of 91. The participants were 95% white, middle class individuals between the ages of 18-22. Sixteen of the 25 participants with divorced parents had a stepfather. The average age at which children's parents divorced was 6.04.

Materials

The participants completed the following instruments: the Dyadic Trust Scale (Larzelere & Huston, 1980), the Heterosocial Assessment Inventory for Women (Kolko, 1985), the Adult Child-Parent Intimacy Scale (Walker & Thompson, 1983), and a questionnaire adapted from Booth et al., (1984) to assess the quality of dating relationships.

The Dyadic Trust Scale (Larzelere & Huston, 1980) contains eight items that measure the extent to which one trusts a partner. The authors report that the item-total correlations are high, ranging from .72 to .89.

The Heterosocial Assessment Inventory for Women (Kolko, 1985) consists of brief descriptions of 12 situations representing three areas of heterosocial behavior: "finding dates, making conversation, and initiating physical or sexual activity" (Kolko, 1985, p.52). The situations all focus on men. For this study, only an anxiety subscale score was examined. The split-half correlation for anxiety was .77 while test-retest reliability was .81.

Parent-child intimacy was assessed with a 17-item scale of adult child-parent intimacy adapted from Walker and Thompson (1983). The items assessed feelings that exist between the respondents and each of their parents. For this study, participants were asked to think about their feelings toward their fathers only. High scores would indicate greater father-daughter intimacy. A questionnaire was adapted from Booth et al. (1984), to assess the quality of relations for those in a serious dating relationship. Participants also answered questions that determined their serious dating relationship status. Scores from the five participants who were not currently involved in a serious dating relationship or had never seriously dated another person were not included in the analyses. If the participant was not currently in a serious dating relationship, she was asked to think about her most recent serious relationship when completing the surveys.

The author devised eight demographic items which included age, year in school, number of siblings, parental education, and parental marital status. The participants with divorced parents also answered three additional questions that included which biological parent they had lived with the most, what age they were when their parents had divorced, and the average number of weeks per year they visited with the noncustodial parent.

Procedure

At the beginning of the session, the experimenter distributed packets of surveys to the participants with the instructions to complete the surveys in the order in which they appeared. Each packet included the four surveys along with a demographic questionnaire. The adult child-parent intimacy scale was at the bottom of each packet to insure that it did not sensitize those whose parents had been divorced and cause them to respond in a socially desirable way. Survey completion occurred in one session and lasted approximately thirty minutes. The participants in both the intact and the divorced groups completed the same surveys. However, those with divorced parents were also asked to complete the parent-intimacy scale thinking about their stepfathers, if applicable. The participants' scores on the parent-intimacy scale categorized them in either the lower-intimacy or higher-intimacy groups.

RESULTS

Multivariate analysis of variance (MANOVA) showed that females with divorced versus married parents experienced less intimacy with their fathers, $F(1,83) = 20.89$, $p < .01$. Scores from the 5 participants with widowed or never married parents were not included in this analysis. No significant differences in interpersonal trust, dating anxiety, and dating satisfaction, based on marital status of the parents, were found.

A second MANOVA was conducted to compare levels of father-daughter intimacy in young women from divorced families with stepfathers and females from married families. Females from divorced families with stepfathers versus those from married families experienced less intimacy with their stepfathers, $F(1,74) = 5.77$, $p < .01$. Those with married parents scored highest on father-daughter intimacy, dating satisfaction, and trust, compared with those from divorced and divorced with a stepfather. However, young women with stepfathers had lower mean scores for dating anxiety than those with married parents. Mean scores by marital status (married, divorced, and divorced with a stepfather) are shown for father-daughter intimacy, dating satisfaction, interpersonal trust, and dating anxiety (see Table 1). As is often the case with divorce, the amount of time participants spent with their fathers declined with age. Between the ages of 0-4, participants visited their noncustodial father for an average of 18.00 weeks a year, while this figure dropped to 8.05 weeks a year between the ages of 15-18.

A third MANOVA was run for intimacy using a median split procedure to categorize participants into lower and higher intimacy groups, regardless of family structure. On a parent-child intimacy scale from 17-119, those with scores 89 and below comprised the lower intimacy group while those with scores from 90-119 were in the higher intimacy group. Comparisons of females higher and lower in father-daughter intimacy showed no differences in trust, anxiety, or dating satisfaction.

Table 1: Means and Standard Deviations by Marital Status for Father-Daughter Intimacy, Dating Satisfaction, Interpersonal Trust, and Dating Anxiety

	Married			Divorced			Divorced with Stepfather		
	M	SD	n	M	SD	n	M	SD	n
Father-daughter intimacy	104.39	21.31	66	76.88	35.93	25	86.63	31.57	16
Dating Satisfaction	16.80	3.05	66	17.50	2.95	25	16.93	2.89	16
Interpersonal trust	41.94	10.10	66	44.38	8.00	25	43.00	8.68	16
Dating anxiety	68.44	14.35	66	65.28	13.21	25	60.50	10.62	16

DISCUSSION

The current study examined the effects of parental divorce on father-daughter intimacy, dating satisfaction, interpersonal trust, and dating anxiety as reported by young adult offspring, ages 18-22. Although differences were not found between females with divorced versus married parents in satisfaction, trust, or anxiety, there were differences in father-daughter intimacy. There were also differences in father-daughter intimacy and dating anxiety between participants with stepfathers and those with married parents.

The differences in father-daughter intimacy support findings in similar studies. Cooney's (1994) study of adult children of recent parental divorce found that the young adults with recently divorced parents reported less intimate and more distant relations with their fathers than did their peers from married families. The former also noted significantly less contact with their fathers over the years. The current study also found a decline in contact with the father over time since divorce, which has obvious implications for father-daughter intimacy as well as other key variables.

The current study did not find differences in the dating relationships of females with divorced versus married parents despite the prevalence of previous research which shows that females of divorced families experience increased conflict in intimate relationships (Aro & Palosaari, 1992). One reason significant differences were not found in this study could be that young women may have recovered from the divorce sufficiently to show few negative effects other than in their intimate relationship with their noncustodial father.

A recent 10-year study (Dunlop & Burns, 1995) examined 80 young men and women who were adolescents when their parents divorced for a "sleeper effect." The "sleeper effect," first reported by Wallerstein and Blakeslee (1989) refers to the phenomenon whereby young people, especially young women, found to be coping well initially experience a significant reversal in adjustment in early adulthood. In their study, Dunlop and Burns found that, after 10 years, the adjustment of young women from divorced families had not declined in comparison to women from intact families. Specifically, no significant differences by family group were found for intimacy, relationship wariness, or relationship satisfaction 10 years after the divorce. Wallerstein & Kelly (1980) found that as children of divorce matured emotionally and intellectually, their understanding of the divorce was likely to change. In this way, their intellectual and emotional efforts to cope with the divorce were reorganized at each developmental stage and extended throughout the growing-up years. This explanation might be relevant to the current study as the average age at which participants experienced the divorce of their parents was 6. Since the divorce occurred relatively early in the lives of the young women, they might have already recovered from any effects the divorce might have had.

Even when long-term effects are found, they tend to be weak. After conducting a meta-analysis on studies dealing with the long-term consequences of parental divorce on adult well-being, Amato and Keith (1991) reported that while parental divorce has broad negative consequences for quality of life in adulthood, the effect sizes in this literature are generally weak. In addition to the weak long-term effects in the divorce literature, a second explanation for the similarities between young women with divorced and married parents may be the mediating effects of the quality of family relationships. Dunlop (1991) suggested that the degree of family conflict and the presence of a highly caring but nonoverprotective relationship - rather than the divorced or married family structure - were the most important predictors of adolescent adjustment. In the present study, 64% of the participants with divorced parents had a step-father and most reported a fairly high level of intimacy with him. Those with a stepfather scored similarly to those with married parents on interpersonal trust and dating satisfaction and also reported lower amounts of dating anxiety. Wallerstein & Kelly (1980) found that children of divorce turned to their stepfathers as models instead of their biological fathers. These children moved ahead in their development and in school, and were benefited by the divorce, which not only separated them from a psychologically destructive relationship, but also brought them an opportunity for an experience within a happy family. Also, it's possible that after seeing their mothers resolve an unsatisfactory marriage and move on to form a new relationship, the young women with stepfathers felt less anxious about their own dating relationships.

One of Wallerstein & Kelly's (1980) most important findings is the significance of the relationship at the present in determining outcome at that time. The parent-child relationships of previous years appeared not to be sufficient to maintain good functioning at the present. Because of the discontinuity in many parent-child relationships following divorce, the importance of the present relationship is especially great. Given that the overall mean score for

763

intimacy among participants with divorced and married parents in the current study was above average, this might explain the lack of significant differences in interpersonal trust and dating satisfaction between participants with divorced and married parents. If most of the participants in this study have fairly high levels of intimacy with their fathers at the present time, they might not be affected negatively in these areas.

Future research should be conducted using methodologies that rely less on self-report data which is always subject to social desirability. In addition, future research might focus on whether the effects of divorce in the life of the individual diminish over time as well. Children of divorce might be better adjusted as young adults if the divorce occurred when they were younger. As Wallerstein & Kelly (1980) discovered in their longitudinal study, it might also be that all of these different components are intricately connected. Although the various factors might seem to be functioning independently, they might be intertwined in ways that are yet to be seen. In their study, some of the components affecting the outcome of children's response to divorce included: the extent to which the child did not feel rejected in relationship with the noncustodial parent, the extent to which this relationship has continued on a regular basis, the availability to the child of a supportive human network, the extent to which the parents had been able to resolve and put aside their conflicts, and the sex and age of the child. Combining factors such as current age, recency of the divorce, mediating effects of important family relationships, and experience with their own dating relationships may reveal more about the intricate process of adjustment to parental divorce for young adult women.

REFERENCES

Ahrons, C.R., & Rodgers, R.H. (1987). Divorced families. New York: Norton.

Amato, P.R. & Keith, B. (1991). Parental divorce and adult well-being: A meta-analysis. Journal of Marriage and the Family, 53, 43-58.

Amato, P.R., & Rezac, S.J. (1994). Contact with nonresident parents, interparental conflict, and children's behavior. Journal of Family Issues, 15, 191-205.

Aquilino, W.S. (1994). Impact of childhood family disruption on young adult's relationships with parents. Journal of Marriage and the Family, 56, 295-310.

Aro, H.M., & Palosaari, U.K. (1992). Parental divorce, adolescence, and transition to young adulthood: A follow-up study. American Journal of Orthopsychiatry, 62, 421-428.

Black, A.E., & Pedro-Carroll, J. (1993). Role of parent-child relationships in mediating the effects of marital disruption. Journal of the American Academy of Child Adolescent Psychiatry, 32"5, 1019-1026.

Booth, A., Brinkerhoff, D.B., & White, L.K. (1984). The impact of parental divorce on courtship. Journal of Marriage and the Family, 46, 85-94.

Cooney, T.M. (1994). Young adults' relations with parents: The influence of recent parental divorce. Journal of Marriage and the Family, 56, 45-54.

Cooney, T.M., Hutchinson, M.K., & Leather, D.M. (1995). Surviving the breakup: Predictors of parent-adult child relations after parental divorce. Family Relations, 44, 153-161.

Cooney, T., & Uhlenberg, P. (1990). The role of divorce in men's relations with the adult child after mid-life. Journal of Marriage and the Family, 52, 677-688.

Dunlop, R. & Burns, A. (1995). The sleeper effect -myth or reality? Journal of Marriage and the Family, 5, 375-385.

Franklin, K.M., Janoff-Bulman, R., & Roberts, J.E. (1990). Long-term impact of parental divorce on optimism and trust: Changes in general assumptions or narrow beliefs? Journal of Personality and Social Psychology, 59, 743-755.

Furstenberg, F.F., & Teitler, J.O. (1994). Reconsidering the effects of marital disruption: What happens to children of divorce in early adulthood? Journal of Family Issues, 15, 179-183.

Larzelere, R.E. & Huston, T.L. (1980). The dyadic trust scale: Toward understanding interpersonal trust in close relationships. Journal of Marriage and the Family, 42, 595-603.

Wallerstein, J.S., & Kelly, J. (1980). Surviving the breakup. New York: Basic Books.

Wallerstein, J.S., & Corbin, S.B. (1989). Daughters of divorce: Report from a 10-year follow up. American Journal of Orthopsychiatry, 59, 593-604.

Wallerstein, J.S., & Blakeslee, S. (1989). Second chances: Men, women and children a decade after divorce. New York: Ticknor & Fields.

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Investigating Physiological Responses to Sexual Harassment

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The purpose of the present study was to examine the effects of ethnic group affiliation and race of victim on physiological responses to sexual harassment in female college students. It was hypothesized that there would be no differences in the physiological responses to sexual harassment between African-American and Caucasian females. It was also hypothesized that there would be greater cardiovascular reactivity when the participants and the victim of the harassment are of the same race. Twenty students from a predominantly African-American female college and twenty students from a predominantly white female college participated in this study. The participants watched a videotape of two scenes showing females being sexually harassed by male co-workers. Measurements of heart rate and blood pressure were taken as the participants watched the videotape. T-test analyses revealed that African-American females had higher systolic blood pressure during both scenes. No significant differences were found for heart rate or diastolic blood pressure.

INTRODUCTION

Sexual harassment is known to induce stress. It is prominent in both the workplace and academia; however people have different ideas about its definition (Jaschik & Fretz, 1991). For example, Dziech and Weiner (1984) stated that sexual harassment is a broad range of behaviors that may occur singly or repeatedly. Sandler (1990) stated that the definition of sexual harassment must include a wide range of behaviors that occur at inappropriate times. Walker, Erickson and Woolsey (1985) stated that the definition must include an interaction between the person with unequal power and the person with lesser power whereas the person with lesser power is the victim.

The research on the physiological effects of sexual harassment is virtually non-existent, however, there is a small database of studies investigating the relationship between race and sexual harassment. On one hand there is much research to suggest differences in the incidence of sexual harassment based on race. For example, Gruber and Bjorn (1982) found that African-American female auto workers were more likely to be harassed on the job than their white counterparts. However, Mansfield, Loch, Henderson, Vicary, Cohn, and Young (1991) found that women who work in traditionally male professions experience sexual harassment more often than women who work in more traditionally female professions. In a study of sexual harassment among restaurant workers, Giuffre and Williams (1994) found that behaviors were more likely to be regarded as sexual harassment if the race of the perpetrator was different from that of the victim.

In contrast to the studies cited above, there have been several studies published which state that there is no significant difference between women of color and Caucasian women's experiences with sexual harassment. In a study conducted to examine the prevalence of sexual harassment in the Navy, Rosenfeld (1994) found that race and ethnicity played no role sexual harassment. Niebuhur and Boyles (1991) also investigated sexual harassment of military personnel and did not find any effects of ethnicity, gender, and previous experience on juror's judgements in sexual harassment cases. Ethnicity did not have a significant effect on the decisions made. So, it appears that there is conflicting evidence concerning the effect race may have on the incidence and reporting of and responses to sexual harassment. It is evident that more work needs to be done in this area before any conclusions can be drawn.

METHOD

Participants

Twenty students from an all female predominantly African-American college and twenty students from an all female predominantly white college between the ages of 18-24 participated in this study. Participants were paid for their participation and were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 1992).

Apparatuses

Prior to the experiment, each individual was given a screening form and an informed consent form. The screening form identified medical conditions that would prevent individuals from participating in the study. The informed consent form was administered after an explanation of the nature of the study. The Medex NCCOM3 cardiac impedance system was used to assess heart rate. To obtain this measure, eight electrodes were placed on the neck and both sides of the body near the area of the xiphisternum. All signals were fed into the cardiovascular monitor and interfaced to a Radio Shack TSR 80 portable computer. Digital printouts of the cardiac measures were obtained through a Hewlett Packard printer. Blood pressure was assessed by the Ohmeda Fina Pres blood pressure monitor. The emotionally arousing stimuli used in the experiment were two scenes portraying sexual harassment and one neutral scene on videotape. One of the sexist scenes depicted an African-American woman being sexually harassed by her African-American male co-worker. Another scene depicted a Caucasian woman being sexually harassed by her Caucasian male co-worker. The neutral scene, which served as a control, depicted a rabbit running in a field at sunset.

Procedure

Upon entrance into the subject room, each participant was given a screening form and a consent form. After all of the participants questions were answered, the recording equipment was attached. After the presentation of each scene, the participants were asked to reflect on what they saw. They were asked to put themselves in the position of the victim and speak to the authority figure. Heart rate and blood pressure were measured as the participants viewed and reflected on two scenes depicting sexual harassment and a neutral scene. The measurements of heart rate and blood pressure were taken prior to the stimulus (pre-stimulus period), during the stimulus (stimulus period), while the subject was reflecting on the stimulus (reflection period), and while the subject was resting from the stimulus (post-stimulus). Each period, with the exception of the stimulus, lasted eighty seconds. The stimulus period lasted three minutes. Measurements were taken every twenty seconds throughout all periods. The averages of the measurements were used in the analyses.

RESULTS

T-test analyses were used to analyze ethnic group differences in heart rate and systolic and diastolic blood pressure reactivity to sexual harassment scenes. Hypothesis #1 (that there would be no differences in physiological responses to sexual harassment between African-American and Caucasian females) was not supported. African-American females had higher systolic blood pressure during the stimulus period of the white on white scene $t(15)=2.41$, $p=.029$. These individuals also had higher systolic blood pressure during the pre-stimulus period $t(15)=2.45$, $p=.027$, the stimulus period $t(15)=2.66$, $p=.018$ and post-stimulus period $t(15)=2.38$, $p=.032$ of the black on black scene. In addition, African-American females had a higher systolic blood pressures in response to both the white on white scene (collapsed across periods) $t=(15)=2.25$, $p=.040$ and the black on black scene (collapsed across periods) $t=(15)=2.37$ $p=.032$.

Hypothesis #2 (that there would be greater cardiovascular reactivity when the participants and the victim of the harassment are of the same race) was also not supported in that African-American females had higher systolic blood pressures to the white on white scene than their Caucasian counterparts (see the t value above). No significant differences were reported for heart rate or diastolic blood pressure.

DISCUSSION

The results of the study did not support the hypotheses presented. There were no significant differences reported for heart rate or diastolic blood pressure. Although there were no baseline differences for any of the physiological mesurements between the two groups, African-American females had higher systolic blood pressure during the stimulus period of the white on white scene and during the pre-stimulus, stimulus, and post-stimulus periods of the black on black scene. This finding shows that African-American women were more affected by the sexual harassment scenes. The heightened level of sensitivity by these individuals to this form of discrimination may be due to previous encounters with racial discrimination and harassment that African-American women experience. This finding is supported by Gruber and Bjorn (1982) who found that African-American female auto workers were more likely to be harassed on the job than their white female counterparts. In addition, the African-American women in their study reported experiencing racism more often than they experienced sexual harassment. The racial discrimination that these women encountered may have affected their responses to sexual harassment (Gruber & Bjorn, 1982). More research needs to be done in this area before any definite conclusions about ethnic differences in responses to sexual harassment can be made.

TABLE I

*Mean Systolic Blood Pressure Reactivity in African-American and Caucasian Female College Students

	African-Americans	Caucasians
Stimulus Period (white on white scene)	142 mm/Hg	109 mm/Hg
Pre-stimulus Period (black on black scene)	134 mm/Hg	105 mm/Hg
Stimulus Period (black on black scene)	141 mm/Hg	107 mm/Hg
Post-stimulus Period (black on black scene)	134 mm/Hg	106 mm/Hg
white on white scene (collapsed across periods)	139 mm/Hg	111 mm/Hg
black on black scene (collapsed across periods)	139 mm/Hg	110 mm/Hg

*Mean differences are significant at the $p < .05$ level

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767

REFERENCES

American Pyschological Association (1992) Ethical Principles of psychologists and code of conduct. American Psychologist, 47, 1597-1611

Dziech, B. W., & Wiener, L. (1984) The Lecherous Professor Sexual Harassment on Campus Boston: Beacon Press

Giuffre, P. & Williams, C. (1994). Boundary Lines: Labeling sexual harasment in restaurants. Gender and Society, 8, 378-401.

Gruber, J., & Bjorn, L. (1982). Blue collar blues; The sexual harassment of autoworkers. Work and Occupations, 9, 271-298

Jaschik, M. L., & Fretz, B. R.(1991). Women's perceptions and labeling of sexual harassment. Sex Roles, 25, (1/2), 19-23.

Mansfield, P., Koch, P., Henderson, J., Vicary, J., Cohn, M., & Young, E. (1991) The job climate for women in traditionally male blue collar occupations. Sex Roles, 25, 63-79.

Niebuhur, R., & Boyles, W. (1991). Sexual harassment of military personnel. An examination of power differentials. International Journal of Intercultural Relations, 15, 445-457.

Sandler, B. R. (1990). Sexual harassment; A new issue for institutions. Initiatives, 52(4), 5-10.

Walker, G., Erikson, L., & Woolsey, L. (1985). Sexual harassment: Ethical research and clinical implications in the academic setting. International Journal of Women's Studies, 8(4), 424- 433.

Peace Builders Case Study:
Combating Violence Through the Exercise of Positive Choices in an Elementary School in California

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fig. # 1

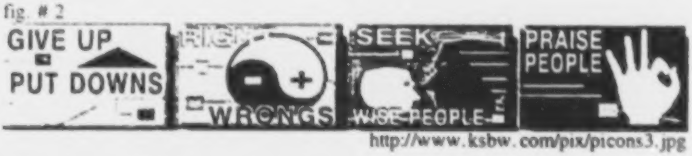
http://www.ksbw.com/pix/peace.jpg

Schools have been subject of social intervention programs for many years. Anti-violence programs have been playing an important role in deterring criminal activities in small communities and in society as a whole. Some intervention programs are created to teach a particular group of people positive and constructive life choices. They seek also to create productive members of the community.

INTRODUCTION

The study is based on a program referred to as Peace Builders. An intervention program combating violence while focusing on the practice of its four principles described below.

fig. # 2



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The Objectives of the Study were to:
Determine the origin of Peace Builders Program.
Describe the purpose of the program.
Examine the implementation of the program
Establish the possible effects of the program in the children.

LITERATURE REVIEW

The Peace Builders program was created in Tucson, Arizona by Dr. Dennis Embry. The purpose of the program is to develop children's sensitivity towards positive attitudes through the practice of the following four main principles which are: praise people, give up put downs, seek wise people, and right wrongs/notice hurts. The

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program is directed primarily at children from kindergarten through sixth grade. Peace Builders is an organized way to practice proven techniques (building blocks) in reducing violence. Although targeted at the children, the program requires the involvement of teachers, students, family, and the community as a whole. Everyone can contribute according to their capabilities as well as their individual positions in the community. The program teaches children, teachers, and other adults positive behavior skills which can be applied in many aspects of their daily life.

Peace Builders has been working in partnership with other programs with similar interests such as the VIPC (Violent Injury Prevention Coalition) which focuses on the prevention and decrease of violent acts and injuries in the City of Salinas California where this study took place. Peace Builders is a community implemented plan based on simple language "building peace" through the practice of the principles. Rather than "stopping violence" by enforcing unacceptable behaviors. It is a pro-active rather than a reactive language.

The effectiveness of the program in some part depends on the effort put into the implementation. When applied in schools, it is necessary to train all the personnel involved in the school in order to properly distribute the information and to practice its principles.

Dr. Dennis Embry mentioned in his review to this program, "that youth violence can be reduced dramatically over the next decade if communities apply the knowledge gained from this research to practices of parenting, day care, schooling, and adult role modeling." (The Community Awareness and Education Committee, Pg.7)

Because youth violence is such a problem in society, finding ways to reduce this social problem is necessary to ensure our schools' safety, as well as that of our communities. Dr. Embry's program allows everybody to contribute to the improvement and safety of society. The program is publicly recognized and available to everyone who wants to make a difference; all it takes is time and a little effort.

The study of intervention is based on the following: simply put children raised in violent surroundings, whether that violence is physical or emotional, suffer from and react to the disorder in ways that create more violence. This body of research shows that there are actual changes in the brain chemistry of children as a result of prolonged exposure to the stress of violence and abuse. These changes lead to depression, and anti-social behaviors. The surest way to reduce or stop this violence is to create family, school, and community environments which emphasize the following:

1) provide extensive positive models instead of negative models
2) reduce negative cues or threatening stimuli
3) show positive behaviors in many permutations to assure generalization of behavior
4) model coping actions (seeking help and problem-solving)
5) provide frequent opportunities to discuss and correct knowledge and actions
6) provide high rates of positive feedback for imitation
7) include many cues, prompts, or tools that facilitate generalization across time, people, behavior, and settings. (Embry, 1994)

METHODOLOGY

The research methodologies used in the research project was participant observation and ethnographic research. In face to face participation, the researcher visited an elementary school in Salinas, in which she interacted and participated with students at the 5th grade level within that school. The ethnographer incorporated the Peace builders program in the research project by actually delivering the program.

An example of field participation was to create case scenarios and to ask the children how they would use their Peace Building skills to solve a particular problem. The researcher would then engage along with the students in analyzing and discussing the responses in an interactive environment.

Every week the children were given a homework assignment in which they were to write down what they had experienced at home and on the streets. Explaining the situation(s), who they helped, how they solve the problem, how they felt about helping others, and how they found the situation to be related to what they have learn in the program. The purpose was to practice their peace building skills at home and at school to

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write down everything they found to be related to what they had learned in the program. The following week, the children were asked to share their experiences with the rest of the class which enabled them to compare problems and solutions. I found this activity to be useful in the practice of the four main principles. Occasionally, the researcher would lead a discussion of the student's papers to the class. After the papers were reviewed, more case scenarios were given to the children to resolve issues concerning how they could implement their Peace building skills.

In other method of collection of data, the children were divided into three groups and organized in the construction of a Peace Building mural. Everyone participated in the creation of the mural by contributing his/her artistic talents. The purpose of the mural was to send a message of peace throughout the school. The children expressed their own ideas about Peace Building concepts through art. Students exchanged thoughts to be expressed in the mural in which the researcher was actively involved. This activity gave the researcher a chance to get to know the children on a more personal level and to establish a stronger rapport. Paints, crayons, markers, and glitter were used in the creation of the mural. Participant observation and group engagement were important methods in the collection of this data.

Along with participation, the researcher used ethnographic research which is the core methodological approach for the study of this research. The researcher needed to get a picture of the people in their natural settings. In doing so the researcher used emic (to find out how the group itself sees and categorizes its world) and etic (involves imposing categories developed outside the group) (Kane, Pg. 65) approaches of ethnography. The purpose was to get the students point of view of the program, and to interpret their responses. To get the point of view of the children the researcher would ask them questions about the program and whether or not they wanted to be Peace Builders. No structure questionnaire was used.

The researchers observed the children in the classroom setting taking notes on the interactions taking place. Discussion groups were conducted after every meeting in order to analyze findings.

THEORETICAL FRAMEWORK

The research was based on multicasual theories, all of which emphasized intervention strategies that give importance to praise, and positive actions, as opposed to pointing out negative behaviors.

Dr. Dinkmeyer and Dr.Mckay Wrote the book, "Raising a Responsible Child". In the book, the authors emphasized the point that psychological equilibrium is a product of need satisfaction. According to the book each individual has the following psychological needs:

1. To be loved and accepted
2. To be secure and relatively free of threat
3. To belong and to identify with a part of a group
4. To be approved and recognized for the way in which he/she functions
5. To move toward independence, responsibility, and decision making

Dinkmeyer and Mckay both conclude that,"..failure to feel and perceive self as accepted, loved, secure, approved, and responsible are forces that stimulate misbehavior." (Dinkmeyer, McKay Pg. 29).

It is on this premise that Peace Builders thrives .

The program applies its four main principles which, in turn, enforce positive aspects of behavior at all levels. These principles promote positive behaviors in the classroom and in the daily lives of students. Instead of having a list of don'ts, the classroom is filled with plenty of creative and productive things to do. This type of environment is conducive for the child to engage in more behaviors that are socially acceptable. While involved with the Peace Builders Program, children get positive attention thus their self esteem rises. This positive reinforcement allows children to build positive self images. All the new tools of coping acquired from the program go beyond the classroom. The children take the tools that they have learned and bring them on to the playground, into their homes, and to the community.

Parents learn that children react well to positive incentives; thus, the Peace Builders' principles become part of their home life. One of the children in the study drew a picture illustrating how her mother was arguing with her aunt. This particular child told her mother that she should notice hurts and right wrongs. This is a common example of how Peace Builders involves all sectors of the community. Exemplary behavior is recognized by the school every month. A Peace Builder of the month is recognized with an award presented to him/her in front of the entire school. Parents of the children are invited to the assembly and applauded for their participation.

CONCLUSION

It is the promotion of socially acceptable behaviors that encourages students to do the best that they can. Children want to feel accepted, approved, responsible, loved, and secure. These feelings are developed and nurtured in the Peace Builders Program. The study showed that the program's implementation on children in the fifth grade has had a positive impact. The program gave students a better understanding of cooperativism, team interaction, and positive behaviors. It allowed them to interact in a positive environment helping each other and understanding the benefits of positive self, responsibility, and accomplishment in doing so. Reducing the opportunities for misbehavior, the program encourages self respect, mutual respect, and non-violence. The smiles on the faces of the students, reduced incidents of violence on campus, and 100 percent participation by students are strong indicators that the program is working. More data will be gathered over the next few years by those following the progress of the program. An award dinner was held to honor Peace Builders by the City.

REFERENCES

The Community Awareness and Education Committee, Salinas, CA. Peace Builders: The VIPC of Salinas, A community Implementation Plan. Published by: Salinas California: Heartsprings. Inc., 1992. 7

Dr. Don Dinkmeyer and Dr. Gary D. McKay. Raising a Responsible Child. New York: Simon and Schuster, 1973. 29

Kane, Eileen. Doing Your Own Research. New York: Marion Boyers, 1990. 65

Peace Builders Action Guide. Arizona : Heartsprings Inc., 1995.

The Psychobiological Effects of Narcolepsy: Its Causes and Treatments

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The function of sleep has been a mystery for thousands of years. Scientific breakthroughs in the 1950s lead to the discovery of the physical components of sleep and its abnormalities resulting in the discovery of sleep disorders.

Narcolepsy is a sleeping disorder characterized by short episodes of rapid eye movement (REM) sleep numerous times throughout the day. The abnormal REM sleep pattern of narcoleptics is physiologically and psychologically problematic which have been shown to cause psychosocial damages. Current treatments for narcolepsy include psychostimulants such as dextroamphetamine and methylphenidate, but research on the effectiveness of these drugs have shown that until the exact physiological causes of narcolepsy are known, developing truly effective drug treatments is nearly impossible. A theoretical model for the pathophysiology of narcolepsy has been developed for the animal model for narcolepsy, and will help create a human pathophysiological model. Recent technological developments with sleep study equipment have made the future for studying the causes of physiological sleep mechanisms and narcolepsy very promising.

DESCRIPTION

Narcolepsy is a sleeping disorder characterized by uncontrollable sleep episodes at various times throughout the day. This uncontrollable onset of sleep is not caused by a lack of sleep from the previous night. From the sleep attacks that narcoleptics experience, it is apparent that rapid eye movement (REM) sleep is functioning abnormally.

Narcolepsy is the second-leading cause of excessive daytime sleepiness (EDS) diagnosed by sleep centers, following obstructive sleep apnea. Studies on the epidemiology of narcolepsy show that 0.2 to 1.6 per thousand in European countries, Japan, and the United States are affected, a frequency at least as large as Multiple Sclerosis and Parkinson's disease (Aldrich et al., 1994; Goswami and Thorpy, 1990). In the United States, approximately 200,000 people have narcolepsy, but only 50,000 are diagnosed.

The other symptoms of narcolepsy are cataplexy, sleep paralysis, and hypnagogic hallucinations. Cataplexy is a rapid loss of voluntary muscle control that lasts from a few seconds to 20 minutes. Cataplexy can be mild, and thus experienced as a buckling of knees, sagging facial muscles, nodding head, and/or loss of arm strength. More severe cases may cause a full physical collapse or a fall. Sleep paralysis is a mechanism that causes brief loss of muscle control when one is falling asleep or waking up. Although partially aware of the surroundings, people are unable to move and speak. Unlike cataplexy, sleep paralysis usually disappears when the subject is touched by another person. Hypnagogic hallucinations are very much like dreams, and usually involve images or sounds of strange animals or prowlers. They are often frightening because they are uncontrollable and waking up is not possible or seems far away. The dream-like experiences are

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also disturbing because they can be mistaken for the hallucinations or delusions of mental illness.

Diagnosis of narcolepsy is confirmed at a sleep center through two tests: the Maintenance of Wakefulness Test (MWT) and the Multiple Sleep Latency Test (MSLT). Together these tests monitor how long it takes the subject to fall asleep at various times throughout the day and at night. The various stages of sleep are also recorded, and narcoleptics are identified by the short amount of time it takes for them to enter REM sleep. Normal sleepers usually enter REM sleep about ninety minutes after falling asleep, while narcoleptics usually enter REM sleep about five minutes after falling asleep.

Narcolepsy can be treated through behavioral modifications and drug therapy, although usually both are used for the best results. Behavioral therapy primarily consists of short naps taken thoughout the day. Drug therapy is based on stimulant medications sometimes combined with antidepressant medications; however, new and better types of drugs are being tested for improved efficacy in relieving narcoleptic symptoms.

Stimulant Therapy

Psychomotor stimulants produce behavioral activation usually accompanied by increases in arousal, motor activity and alertness. The three major classes of psychomotor stimulants include direct acting sympathomimetics, indirect acting sympathomimetics, and stimulants that have other mechanisms of action. Sympathomimetic compounds share similar molecular structures of a basic benzene ring with an ethylamine side chain attached, such as in betaphenethylamine from which amphetamine and methamphetamine are derived. Direct sympathomimetics include ephedrine which was the first drug used to help alleviate EDS. In 1935, Prinzmetal and Bloomberg tried using indirect sympathomimetics, and found that there were less peripheral side effects, lower cost and lower toxicity when compared to direct sympathomimetics.

Currently, indirect sympathomimetics are the best therapeutic stimulants that help alleviate EDS. Most of the indirect sympathomimetics that are available for clinical use focus on the dopaminergic system primarily, with a smaller effect on the adrenergic (norepinephrine) system. Indirect sympathomimetics act primarily by increasing the amount of monoamines available in the synaptic cleft by blocking the reuptake of, and enhancing the release of several neurotransmitters such as dopamine (DA), norepinephrine (NE), and serotonin (5-HT) (Aldrich et al., 1994).

There are two psychostimulants approved by the FDA to treat the excessive daytime sleepiness (EDS) of narcolepsy are indirect sympathomimetics--dextroamphetamine and methylphenidate. These drugs have an effect on the facilitory action of central catacholaminergic transmission and both dextroamphetamine and methylphenidate are the only two drugs that could bring MWT sleep latencies to approximately 70 percent of normal levels (see Figure 1) (Mitler et al., 1994). Although statistically and clinically significant therapeutic changes for dextroamphetamine, methylphenidate, pemoline, and modafinil were apparent (Mitler et al., 1994). In another study, methamphetamine had the greatest change on MWT sleep latencies when compared to dextroamphetamine and methylphenidate (see Figure 1) (Aldrich et al., 1994). Pemoline is another indirect sympathomimetic, but does not have as significant effect in treating EDS (Mitler, 1994). Modafinil is a stimulant that has a different mechanism than the indirect sympathomimetics, but seems to alleviate EDS as much as the other drugs, and with less sever side effects (Aldrich et al., 1994). Modafinil is the first drug in 20 years to reviewed by the FDA for treatment in narcolepsy.

The primary effects of indirect sympathomimetics appear to be on the dopamine systems in the CNS. The midbrain dopamine systems include two major pathways that project to different parts of the forebrain and appear to be responsible for the various aspects of psychomotor stimulant actions. The first mesocorticolimbic DA system projects to the ventral forebrain, including the nucleus accumbens, olfactory tubercle, septum and frontal cortex. The second nigrostriatal DA system arising from the substantia nigra, projects to the corpus striatum and the frontal cortex. These two DA systems are affected similarly by stimulants, suggesting that they could be working in the similar ways concerning neural cicuitry. Exactly which one of the two dopaminergic pathways is primarily involved in narcolepsy has not been determined.

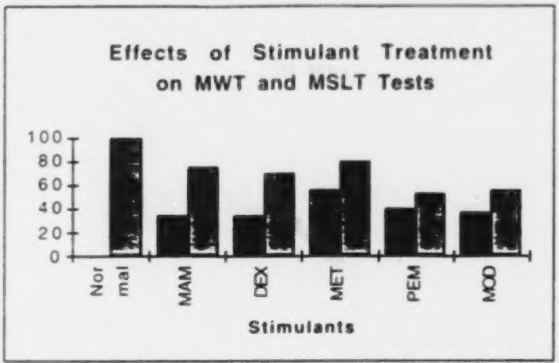

Figure 1: The darker gray corresponds to baseline percentage of sleep latency and the lighter gray corresponds to the stimulant treatment percentage of sleep latency compared to normal (for the MSLT normal is 13.4 minutes and for the MWT that is 18.9 minutes); MAM (Methamphetamine), DEX (Dextroamphetamine), MET (Methylphenidate), PEM (Pemoline), and MOD (Modafinil).

Antidepressant Therapy

Narcoleptics who suffer from cataplexy have been recommended to take tricyclic antidepressants which act primarily on norepinephrine (NE) and help prevent REM sleep onset. These drugs are usually taken in addition to the stimulants used to alleviate EDS. There are a number which have been tested for maximum efficacy, and there is little agreement among the experts for the best choices. Tricyclic antidepressants have been clinically effective in controlling hypnagogic hallucinations and sleep paralysis, the two less common symptoms in narcolepsy, but their mechanistic acton is still unknown (Aldrich et al., 1994). Most of the tricyclic antidepressants also have numerous side effects, such as dry mouth, anorexia, sweating, constipation, decreased blood pressure, and even drowsiness.

Imipramine seems to be one of the most documented anti-cataplectic agents. It acts as a potent inhibitor of NE uptake, with a minimal effect on DA uptake. Desimipramine and chlorimipramine have structures like imipramine and are used to treat cataplexy. All are prescribed for about 75-200 mg in daily divided doses (Goswami and Thorpy, 1990).

Protryptaline administered periodically at 15-60 mg/day is the United States' top anti-cataplectic agent (Goswami and Thorpy, 1990). Protryptaline is thought to help treat EDS, but is not effective in treating EDS when used alone. Protryptaline administered with indirect sympathomimetics such as methylphenidate or dextroamphetamine has proven to be clinically successful for those who experience EDS and cataplexy (Mitler and Hadjukovic, 1994).

REM SLEEP RESEARCH

Up to this point there has been little discussion of REM sleep, but it is the focal point when discussing the pathophysiological causes of narcolepsy. The unique feature of narcolepsy is that all the symptoms appear as a result of REM sleep intruding on waking function. Loss of muscle coordination also seems to play a role in narcolepsy since all of the symptoms are associated with it.

Narcolepsy is not the only abnormal REM sleeping disorder. Post Traumatic Stress Disorder (PTSD) and REM sleep behavior disorder (RBD) are two other abnormal REM disorders that would benefit greatly if the actual physiological components of REM sleep were known. Yet there has been little scientific study on the nature of REM sleep and dreaming. For abnormal REM sleep conditions, the best scientific pursuit of effective treatment is based solely on the physiological and anatomical knowledge of the function of REM sleep.

To determine the functional and neuroanatomical role of REM sleep is a difficult task to undertake with a lack of sufficient studies done on both roles. To accomplish these physiological and neuroanatomical goals, research must be conducted in two areas: through animal and human models.

Genetic Research

Doberman pinschers seem to have cataplectic episodes much like humans with narcolepsy that was first observed in the 1970s. A particular family of Dobermans was found with narcolepsy in 1977.

Over 84 litters of Doberman pinschers, Labrador retrievers, and mixed breeds have been bred at a Stanford dog colony through 1995. Dr. Mignot, the director of the Center for Narcolepsy at Stanford, has found that narcolepsy in Dobermans and Labrador retreivers is an autosomal recessive trait with full penetrance. Mignot's studies have shown that the canine narcolepsy gene is tightly linked with a gene that is highly homologous to the human immunoglobulin switch gene, strongly suggesting that the immune system plays a role in the development of narcolepsy. Since 1983 when researchers in Japan found that the human leukocyte antigen HLA-DR2 was common to those with narcolepsy, any attempt to identify another immune link to humans has failed. Specifically, the DQBI-0602 allele is found in 98 percent of narcoleptics, regardless of ethnic background, but 25 percent of the general population also has it (Mignot, 1996).

Another finding that only 17-25 percent of monozygotic twins are concordant with narcolepsy suggests that there are environmental factors neccessary to trigger the illness (Mignot, 1996). Additionally, about 1-2 percent of narcoleptics with cataplexy have a first degree relative that also suffers from the disorder. From these low statistics these data indicate that there are environmental and genetic components to developing narcolepsy.

Brain Research

Since recent technological advances have made noninvasive measurements of the anatomy of the brain possible, anatomical evidence can be combined with psychological examination of the human to understand symptoms and conditions of certain disorders.

Positron Emission Topography (PET) scan and Magnetic Resonance Imaging (MRI) are two developments that record the physiology of the brain in order to reveal how it is working. Similarly, the various stages of sleep are recorded by electroencephalograms (EEG) which are used at sleep

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centers to confirm narcolepsy by timing SOREMPS (Sleep Onset REM Periods) by gauging the time it takes for the theta rhythm of REM sleep to occur. The EEG records when REM sleep is happening, but is not able to determine which brain structures are active.

A study combining the PET scan and EEG at the Cyclotron Research Center at the University of Liege in Belgium was the first study measuring brain activity during REM sleep. EOG and EMG (electro-oculogram and electromyogram respectively) recordings of the subjects were also taken (Maquet, 1996).

This was the first comprehensive study assessing the structures active in REM sleep in humans (Maquet, 1996). The original thirty males involved in the study was diminshed to seven because the men had to show certain sleep behaviors that would allow the machines to accurately record the data. These sleep behaviors could have unintentionally selected a particular type of sleeper which would have an effect on the results. Better technology making subjects more comfortable and the tests easier to record will improve the validity of the results.

The PET-EEG results showed that the regional cerebral blood flow was positively correlated to REM sleep in the pontine tegmentum, left thalamus, both amygdaloid complexes, anterior cingulate cortex, and right parietal operculum. The study concluded that given the role of the amygdaloid complexes in the acquisition of emotionally influenced memories, the pattern of activation in the amygdala and the cortical areas provides a biological basis for the processing of some type of memory during REM sleep.

There were also negative correlations between regional cerebral blood flow and REM sleep in the dorsolateral prefrontal cortex, the parietal cortex, the posterior cingulate cortex and the precuneus. Less blood flow to the prefrontal cortex is logical since it is the area that is most active in conscious states, whereas during sleeping which is an unconscious act, it would make sense that the prefrontal cortex is inactive.

This is the first time the role of the amygdaloid complexes has been shown to be involved in REM sleep (Maquet, 1996). The abundant activity of the amygdaloid complexes suggests that the dreaming that occurs in REM sleep is emotionally based, and could be a release of stored emotion gathered during the day. It may be that given the role of the amygdaloid complexes in the acquisition of emotionally influenced memories, the pattern of activation in the amygdala and the cortical areas provides a biological basis for the processing of some type of memory during REM sleep. Much more research confirming the results from this study need to be done in order for the amygdala involvement in REM sleep to be validated.

The amygdala is also connected physiologically to the onset of canine narcolepsy. From Dr. Mignot's research there has been recorded neuronal degeneration localized in the lateral nucleus of the amygdala and in the medial septal nucleus of the narcoleptic canine. The onset of this degeneration begins about one month prior to the onset of symptoms and only lasts about two months (Mignot, 1996). The degree of degeneration is 100 percent more than the degeneration in normal dogs (Mignot, 1996). The onset of the degeration takes place at about two months of age. Coincidentally most human narcoleptics begin showing symptoms between the ages of 10 and 25, usually during adolescence.

While PET brain scans show active brain structures, MRI brain scans are much more detailed and accurate. Up until very recently it was impossible to combine the EEG and MRI in order to record the brain structures active during REM sleep. The EEG shows when REM sleep is occuring, and the MRI shows what brain structures are active, but both could not be combined.

Data on sleep fMRI was presented at the Harvard Institute of Medicine by Dr. Jeffrey Sutton on April 7, 1997. The audience was very receptive to the new technology allowing for the combination of the EEG and MRI in order to see which brain structures are active during sleep. The analysis of the first tests done with the fMRI are not yet complete, but frontal changes (mostly deactivation), cingulate, parietal, and temporal changes seem to occur as non-REM sleep progresses. Brain regions activated during REM sleep are the amygdala and V1, otherwise known as Area 17 of the primary visual cortex. This is a strong indication that the amygdala is definitely activated during REM sleep because both the PET scan and the fMRI have found it to be activated.

The PET study and the EEG-fMRI technological advancement are the types of human studies that are needed to determine the functional neuroanatomy of REM sleep. While these studies have only begun determining the neuroanatomical function of REM sleep, once that is known, then the cause of narcolepsy and its abnormal REM sleep mechanism is that much closer.

BIBLIOGRAPHY

Aldrich, Michael, et al. "ASDA Standards of Practice-- Narcolepsy and Its Treatment with Stimulants." Sleep. 1994; 17(4): 352-371.

Goswami, Meeta and Michael J. Thorpy. Narcolepsy Primer: A Guide for Physicians, Patients, and Their Families. Montefiore Medical Center. 1990.

Lewis, Ricki. "PET Casts Light on Dreaming." Biophotonics International. Nov/Dec. 1996; 36-37.

Maquet, Pierre, et al. "Functional Neuroanatomy of Human Rapid-Eye-Movement Sleep and Movement." Nature. 1996; 383: 163-6.

Mignot, E. "Perspectives in Narcolepsy Research and Therapy." Current Opinion in Pulmonary Medicine. 1996; 2: 482-487.

Mitler, Merrill. "Evaluation of Treatment With Stimulants in Narcolepsy." Sleep. 1994; 17: 103-106.

Mitler, Merrill, and Roza Hajdukovic. "Relative Efficacy of Drugs for the Treatment of Sleepiness in Narcolepsy." Sleep. 1994; 14(3): 218-220

Racial Similarity, Cost to Helper, and Sex as Determinants of Helping Behavior

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The purpose of this study was to examine how racial similarity, cost to helper, and sex would affect the likelihood of eliciting altruistic responses. Two hundred forty resumes were left at public telephones. Attached to the resumes was a picture of the applicant, which conveyed information as to the race (White vs. Black) and sex of the individual, a self-addressed envelope which either had a stamp affixed to it (no cost to the helper), or no stamp (cost to the helper), and a cover letter indicating that the resume must be mailed immediately. Racial similarity was manipulated by the location the letter was left in (predominantly White neighborhood vs. predominantly Black neighborhood). A loglinear analysis was performed on the frequency of resumes returned. As predicted, delivery of the resume was facilitated more when there was no cost to the helper. Females were assisted more than males when the altruistic response entailed cost to the helper. Individuals from the predominantly White neighborhood assisted the White applicant more than the Black applicant, and individuals from the predominantly Black neighborhood assisted the Black applicant more than the White applicant. This finding suggests that racial similarity is a factor affecting altruistic behavior. No other findings were significant.

INTRODUCTION

Altruism refers to acts that suggest an unselfish concern for the welfare of others. If it can be determined which factors influence an altruistic response in individuals, the probability of receiving help in the future can be increased.

Implications of altruistic behavior include motivations of "social responsibility, guilt reaction, dependency, obligation, reciprocity, modeling, and reinforcement" (Tipton & Jenkins, 1974, p. 209). The introduction of a cost to helper variable has been found to suppress the reinforcing value as motivation to help. Thibaut and Kelley's (1959) economic theory of social interaction states that the relative cost to and reward to the individual will determine how an individual will behave in interpersonal situations. An overwhelming decrease in altruism has resulted as cost variables are implemented. In a study done by Wagner and Wheeler (1969), altruism was examined in terms of generous versus selfish models and high versus low cost levels of helping. The low cost level facilitated both the generous and selfish models, while the high cost inhibited both. Similar results are found in a study done by Tipton and Jenkins (1974) in which response cost on the acquisition of instrumentally conditioned helping behavior was studied. In this study, slower responses, indicating less altruistic behavior, were found across trials involving a cost, as opposed to no cost, variable. These findings strongly suggest that cost to a potential helper is one of the strongest deterrents in altruistic behavior. Few studies, however, have examined the strength of the cost variable in relation to racial similarity.

Race and its effect on altruism has been studied and reported in several different ways. The most frequent analysis of the effect of race on altruism involves observing which race is helped most overall. A study done by Bryan and Test (1967) examined the influence of a solicitor's race on the donation behavior of shoppers. It was found that "the Negro solicitor elicited a statistically significant lower percentage of donors than did the Caucasian" (Bryan & Test, 1967, p. 405). The variables of interpersonal attraction and avoidance from contact with a minority group member were attributed to the basis of difference in donation behavior.

One of the more famous studies of the late sixties and early seventies was the dropped wallet experiment. The first study, done between 1966 and 1968, found that Whites tended to return the "lost" wallet more frequently to Whites. Blacks, however, did not show a preference for returning a found wallet to other Blacks (Hornstein, 1976). This study was replicated in the early seventies, yielding a slight shift in results. Whites continued to favor Whites, but this time more Blacks returned the wallet, and there was a tendency for them to return wallets to other Blacks more frequently than to Whites. It appears that a new black consciousness had emerged. The present study considers essentially the same phenomenon; with a prediction that this consciousness has continued, and has even grown.

The effect of sex on altruism has been focus of many previous studies. Most earlier studies found that females were helped more than males (Colaizzi, Williams, & Kayson, 1984; Feinman, 1978; Gentile, Naughton, & Kayson, 1986; Mallozzi, McDermott & Kayson, 1990; Sileo & Kayson, 1988; Simon, 1971). Colaizzi et al. (1984) reported that stranded female motorists when dialing a wrong number and had no money or change to make another phone call, upon asking the person to call another number for them, received assistance more rapidly than males. Gentile et al. (1986) performed a similar experiment using the stranded motorist with no means of making another call, and found similar results. Mallozzi et al. (1990), also experimenting with a similar situation, found that fewer cars passed a stranded female motorist than a male in the same predicament. Sileo and Kayson (1988), found that women making annoying phone calls were listened to longer than men.

The purpose of this study was to examine how racial similarity, cost to helper, and sex of the person in need of help would affect the likelihood of eliciting altruistic responses. It was predicted that more altruistic responses would occur when there was no cost to the helper, when the victim was of the same race, and when the victim was a female.

METHOD

This experiment involved the researchers "accidentally" losing 240 resumes. The resumes, depicting an applicant pursuing a career in marketing, were left at public telephones in lower Westchester County, New York. Attached to the resume was a picture of the applicant, which conveyed information as to the race (white or black) and the sex (male or female) of the applicant. The physical attractiveness of the applicants was relatively equal, determined by independent raters. There was also a cover letter attached to the front of the resume written by the applicant to his or her mother stressing that the resume must be mailed immediately. In addition, there was a self-addressed envelope that was either stamped or not stamped. If the envelope had a stamp affixed to it, there was no cost to the helper. If there was no stamp, there was the cost to the helper of having to supply the postage. Racial similarity was the fourth variable manipulated in this study. Racial similarity was manipulated by the location the letter was left in (predominantly white neighborhood or predominantly black neighborhood). The socioeconomic status of these two areas was relatively equal.

Fifteen resumes were distributed for each of the 16 possible combinations of the four independent variables. Helping consisted of facilitating the delivery of the resume. Therefore, the dependent variable was the frequency of resumes returned, indicating an altruistic response. Coding on the

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inside of the envelope enabled the researchers to determine the combination of the independent variables of each resume received at the address depicted on the envelopes.

RESULTS

A loglinear analysis yielded likelihood ratio chi squares on the frequency of resumes returned. A 2 (sex) x 2 (race) x 2 (location) x 2 (cost to helper) design produced a significant main effect for cost to helper, $\chi^2(1) = 56.93$, $p = .0000$. Delivery of the resumes was facilitated when there was no cost to the helper at a rate of 45.1% as opposed to 7.3% when there was the cost of supplying a stamp. There was an interaction between race and location, $\chi^2(1) = 6.59$, $p = .0103$. Delivery of resumes belonging to the white applicant was facilitated more by individuals in predominantly white neighborhoods ($n = 29$) than by individuals in predominantly black neighborhoods ($n = 15$). Delivery of resumes belonging to the black applicant was facilitated more by individuals in predominantly black neighborhoods ($n = 24$) than by individuals in predominantly white neighborhoods ($n = 14$). There was also a marginally significant interaction between sex and cost to helper, $\chi^2(1) = 2.72$, $p = .0990$. When the elicitation of an altruistic response entailed cost to the helper, females ($n = 7$) were assisted more than males ($n = 2$). The overall rate of helping, determined by the number of resumes returned, was 34.2%.

DISCUSSION

As was hypothesized, delivery of the resume was facilitated more when there was a stamp on the envelope, indicating no cost to the helper, than when there was a stamp on the envelope, indicating that delivery of the resume required the helper to supply the postage. This is consistent with previous research (Shotland & Stebbins, 1983; Tipton & Jenkins, 1974; Wagner & Wheeler, 1969). In an experiment by Shotland and Stebbins (1983) which used a "wrong" telephone number as the method of investigation, it was found that when participants were implicitly asked to look up one telephone number, they were more likely to assist the individual in need of help than when they were asked to look up five telephone numbers. Looking up five telephone numbers as opposed to looking up one is of greater cost to an individual not only financially, but it also requires more time. When asked to drive a confederate to a location that is near (low cost) as opposed to a location that is relatively distant (high cost), individuals will help the confederate in the low cost condition most often (Shotland & Stebbins, 1983). In the present study, the absence of a stamp required the altruistic participant to supply postage, which only costs 32 cents. However, for the individual who does not carry stamps with him or her, there is also a time factor involved of having to go out of one's way, for example, by waiting in line at the post office to buy a stamp. When there was a stamp on the envelope, the participant need only place the resume in the envelope, seal it, and drop it in the nearest mailbox. There are other possible reasons for the cost difference in the present study. There is the prospect that the participants assumed that the person who lost the resume may come back looking for it. It is also possible that upon noticing there was no postage affixed to the envelope that the participants decided to leave it at the telephone booth, assuming someone else would come along and see that it was delivered.

The hypothesis that females would be assisted more than males was not confirmed in the present study. However, a marginally significant interaction was found between sex and cost to helper. Females were assisted more than males when the altruistic response entailed cost to the helper. This suggests that individuals are more likely to go out of their way to help a female than they are to help a male, or that females are assumed to be more in need of help.

It was also hypothesized in the present study that there would be an interaction between race and location, suggesting racial similarity in helping behavior. This hypothesis was confirmed. Individuals from the predominantly White neighborhood assisted the White applicant more than the Black applicant, and individuals from the Black neighborhood assisted the Black applicant more than the White applicant. Previous studies showed that White participants helped White individuals more than they helped Blacks, but there was no racial difference in the helping behavior of Black participants (Gaertner & Bickman, 1971). In early studies done by Hornstein (1976), the same results were evident. This suggests racial prejudices in the helping behavior of Whites, but no racial prejudices in the helping behavior of Blacks. Clark and Clark (as cited in Hornstein, 1976) investigated the doll preferences of young children, finding that Black children often preferred White dolls to Black ones, suggesting a preference of the majority outgroup over one's ingroup. However, later studies by Hornstein (1976) indicated a shift in the results. Whites continued to help other Whites more than they helped Blacks, but Blacks this time helped other Blacks more frequently than they helped Whites. This may be the result of the emergence of a new Black consciousness. It may also be a way for Blacks to cope with the discrimination they have suffered, by they themselves discriminating against a race that in our culture has shown to prejudge minorities. Another implication for this finding is the suggestion that individuals are more attracted to and tend to associate with others who are similar to them physically and share the same attitudes. This also carries over to helping behavior, with individuals helping others who are racially similar to themselves more than those who are different.

In conclusion, the effects of racial similarity, cost to helper, and sex were examined in the present study. Cost to helper affected the likelihood of eliciting a helping response, with the delivery of resumes being facilitated more often when there was no cost to the helper. Sex was marginally significant when it interacted with the cost variable, with females being assisted more than males when the helping response entailed cost to the helper. Racial similarity was another significant factor affecting helping behavior, with individuals embodying helping behavior more for individuals of their own race than others. Further research of racial similarity in helping behavior should also consider the possible effects of sex and race. The present study explored the sex of the individual in need of help, but the sex of the helper was not controlled. In a society where interracial relationships are increasing, and negative and even perhaps positive, attitudes about interracial dating and marriages exist, there may be an inclination for individuals to help others of another race only if they are of the opposite, or perhaps the same, sex.

REFERENCES

Bryan, J. A., & Test, M. A. (1967). Models and helping: Naturalistic studies in aiding behavior. *Journal of Personality and Social Psychology, 6*(4), 400-407.

Colaizzi, A., Williams, K. J., & Kayson, W. A. (1984). When will people help? The effects of gender, urgency, and location on altruism. *Psychological Reports, 55*, 139-142.

Feinman, S. (1978). When does sex affect altruistic response? *Psychological Reports, 43*, 1218.

Gaertner, S., & Bickman, L. (1971). Effects of race on the elicitation of helping behavior: The wrong number technique. *Journal of Personality and Social Psychology, 20*(2), 218-222.

Gentile, M., Naughton, A. M., & Kayson, W. A. (1986). Factors affecting altruism: Sex, urgency, and time of day. *Psychological Reports, 59*, 79-82.

Hornstein, H. A. (1976). *Cruelty and kindness: A new look at aggression and altruism.* Englewood Cliffs, NJ:

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Prentice-Hall, Inc.

Mallozzi, J., McDermott, V., & Kayson, W. A. (1990). Effects of sex, type of dress, and location on altruistic behavior. *Psychological Reports, 67*, 1103-1106.

Shotland, R. L., & Stebbins, C. A. (1983). Emergency and cost as determinants of helping behavior and the slow accumulation of social psychological knowledge. *Social Psychology Quarterly, 46*(1), 36-46.

Sileo, F. J., & Kayson, W. A. (1988). When will annoying calls be listened to?: Effects of sex, tone of voice, and time of day. *Psychological Reports, 62*, 351-355.

Simon, W. E. (1971). Helping behavior in the absence of visual contact as a function of sex of person asking for help and sex of person being asked for help. *Psychological Reports, 28*, 609-610.

Thibaut, J., & Kelley, H. H. (1959). *The Social Psychology of Groups.* New York: Wiley.

Tipton, R. M., & Jenkins, L. (1974). Altruism as a function of response cost to the benefactor. *The Journal of Psychology, 86*, 209-216.

Wagner, C., & Wheeler, L. (1969). Model, need, and cost effects in helping behavior. *Journal of Personality and Social Psychology, 12*(2), 111-116.

Sex Role Type and Effectiveness of Women Speakers at a Religious Presentation

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This study measured the perceived effectiveness of women speakers in making a religious presentation. Three basic sex-role types:1) masculine, 2)androgynous, and 3) feminine were presented to four independent groups of college students who were asked to rate speaker effectiveness. Masculine and androgynous speakers were preferred over feminine religious speakers. A feminine education speaker was preferred over feminine religious speaker.

A study of Fortune 500 companies found that women comprise 3.6% of board members and only 1.7% of senior executives (Morrison & Von Glinow, 1986; Sachs, 1992). There appears to be a bias against women in upper level executive positions. Why are women such a minority in this arena? Not only are women underrepresented in business, but also in religious leadership positions (Barna, 1993). The Catholic faith provides women the opportunity to serve in convents and some denominations allow women to preach. However, in the Southern Baptist Convention, the majority of vocational ministers are men. Is this because so few Southern Baptist women are motivated to seek leadership positions or is there a verifiable influence from structural factors?

Women as Managers

Researchers have been interested in the issue of women as managers and conducted experimental research to address questions of perception (Greenglass, 1993; Burke, 1994). At first glance, research results seems to suggest that there is not a significant difference between the ratings of male and female leaders (Shein, 1975; Hawkins, 1995; Eagly, 1995). However, included in these findings are two conditions that seem to be necessary to support the conclusions. One condition is that men are rated more effective at typically masculine tasks, and women at typically feminine tasks (Shein, 1975; Eagly, 1995). The inverse is also true, meaning that women and men are rated less effective at "cross-sex" tasks.

Organizational Hierarchy

A second condition Shein mentions is that the perceived

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effectiveness of the leader is dependent on the context and organizational hierarchy, or power structure (Ely, 1995; Shein, 1975). Ely's findings show that the strength of traditional stereotypes is inversely related to the number of women in senior level positions. In the present study, the Southern Baptist Convention will represent the organizational hierarchy in which few women hold leadership positions. The study of the women in SBC life is an important element for the future of the denomination. One important difference between the business world and the religious world is the aspect of scriptural authority. The religious world seeks to operate under the principles found in the Bible. There are verses of the Bible that seem to discount women in authority, however, interpreters continue to debate whether the discount is based on scriptural authority or tradition (Miles, 1983).

Sex-typed Roles

Bartol suggests that the concept of masculinity and femininity are dynamic, and changing as societies change. However, some stereotypes persist across generations. Women are generally considered more nurturing, understanding, gentle, and suited for tasks that require such traits. Men are typically achievers, tough, protective, and more suited for intitiating tasks (Bartol, 1976). Sandra Bem has designed a measure for masculinity and femininity. She added a third category, that of the androgynous person, an individual that has both masculine and feminine qualities (1974).

Men can be typed feminine and women can be typed masculine. Either can be androgynous. In the realm of management, androgynous and masculine types have been found to be more likely to emerge as leaders in group situations (Kent, 1994). Kent found that sex-type was a better predictor of leadership than gender. Therefore, a woman that can perform a masculine task using traditional male behaviors may be considered a more effective leader than a woman that performs in a more feminine way.

Extending previous research, the present study will examine the effectiveness of women in religious leadership roles. It will follow Burke's (1994) study of women managers except for the change of setting to a religious task rather than a task in the business world. The tasks of a religious leader, such as a pastor, include many areas, but this study will consider the verbal preaching task only.

Hypotheses

It is hypothesized that androgynous and masculine sex-typed women speakers will be rated more effective at a religious presentation than feminine sex-typed women speakers.

Secondly, feminine sex-typed women speakers will be rated more effective at a non-religious presentation than a religious presentation.

METHOD

Subjects

The subjects were 57 college freshmen in introduction to psychology classes receiving extra credit for participation. 70% of the subjects were 18 and 19 years old, and 30% were between 20 and 36. Thirty seven females and nineteen males participated.

Instruments

Bem's (1974) Sex Role Inventory (BSRI) uses the common perception of traits associated with masculinity, felinity, and androgyny. The sixty item test requires that subjects place the words they consider descriptive of themselves in a certain column. The purpose of the instrument is to suggest a certain gender-role type for an individual, not necessarily dependent on biological sex.

This master list of terms was used to design mock resumes and "reference letters" to be given to subjects as the first manipulation of the independent variable. This instrument also helped provide guidelines for the second manipulation, the speaker video.

The dependent measure that was used is an unpublished, objective five-point questionnaire for speaker effectiveness. The nature of the present study necessitated the construction of a relevant measure of leader effectiveness.

Procedure

Subjects were randomly assigned to four groups. Each group viewed a corresponding video. The four groups viewed masculine, androgynous, feminine religious, and feminine educational videos, respectively. The task of the subjects was to help select a speaker for the week-long chapel services. They were to watch one video and rate the speaker on effectiveness. Subjects reviewed the materials mentioned above, a resume, portion of a reference letter and a video clip. The hobbies and reference items were adjusted for the various sex-types of the three groups. The adjusted items followed characteristics listed on Bem's sex-role descriptions.

In order to test hypothesis two, concerning the feminine non-religious presentation, the Ss in the fourth group performed the task of selecting a Public Relations director for a new elementary school. The resume and letter were altered to account for this in the categories of "doctorate", "minor", and "hobbies".

In the second stage of treatment, the Ss viewed the video clips. One model performed all four clips to control for speaking ability. The speaker performed the same presentation each time behind a pulpit, except for the educational clip in a classroom. The speaker's dress and manner were adjusted in each clip to convey sex-role types. Androgyny consisted of casual attire such as blue jeans. The speaker was to be truthful, sincere, likable, and tactful. The Masculine dress was a pants suit. No make-up or jewelry was used. She was instructed to be aggressive, forceful, athletic, and competitive. The third and fourth presentations were alike in dress and manner, feminine. The speaker wore a dress, full make-up, hair and jewelry, and she conveyed a manner of soft-spokenness, compassion, warmth, and sympathy.

After viewing the video, each group received the appropriate questionnaire. The subjects then completed the task of evaluating the speaker effectiveness. A brief personal information section followed.

RESULTS AND DISCUSSION

Hypothesis one predicted that masculine(1) and androgynous(2) groups would have higher group means on question #6 "I would select this speaker" than feminine religious group(3). A tukey-HSD test conducted between groups 1, 2, and 3 found that pairs 1,3 and 1,2 differed significantly,($p<.05$). The sujects indicated a score between 0 and 4 on question #6.

Table 1: Tukey-HSD Group Means Comparison

Mean	Group	3	1	2
0.928	Feminine			
1.631	Masculine	*		
1.800	Androgynous	*		

Hypothesis two predicted group four (feminine education) to have a higher mean than group 3 (feminine religious). The results of an independent t-test of group means demonstrated a higher score for group 4,(p<.001).

Table 2: Independent Groups T-test for Feminine Groups 3 and 4

Group	N	X
Religious	14	.929
Education	9	2.556

t=(-5.77), p=.000

A manipulation check asked the subjects to indicate whether they perceived the speaker as "more feminine than most women" or "more masculine than most women". The group means of the two questions were compared with-in groups. Group one (masculine) had a mean shown to be significant, (p<.001). The other three groups had no significant differences of the means.

Hypothesis one predicted that masculine and androgynous speakers would be preferred over a feminine religious speaker. This was stongly supported by the data, (p<.001). A speaker needed a score of 3 or 4 to be selected for the task, chapel speaker for the week. None of the four roles rated the speaker either a 3 or 4. Groups 1, 2, and 3 rated the speaker less than a two. However, of the first three groups, masculine and androgynous had higher group means on question #6 than the feminine religious, which did not even have a mean above 0.

According to hypothesis two, the feminine education speaker should have been preferred over the feminine religious speaker. This also was strongly supported by the data. Group 4 (feminine education) had no religious connections and the group mean was the closest to selecting the speaker.

The subjects had an opportunity to explain further whether or not the speaker should be selected. The most frequent comments indicated that the speaker spoke in an elementary manner, did not have enough passion, and would not appeal to a college audience.

One important element of the research was successful manipulation of the sex-role type on the speaker video. The results indicate that this happened. Only group 4 (feminine education) saw the speaker as more masculine when she was intended to be more feminine. Also important is that this group was found to have given the speaker the highest group mean of all four groups.

Implications

Results of this study suggest that a woman is rated more effective at a traditionally accepted role and less effective at the "cross-sex" task. Clearly, the subjects did not approve of the woman in a preaching role, but had less of a problem with her educational leadership role. Women of all sex types were considered more suitable for the traditionally feminine task. The organizational hiearchy of religious leadership is pre-dominantly male, therefore, strong stereotypes about women's roles are evident.

These results suggest that if a woman behaves in a more traditionally masculine pattern, she may be more likely to be accepted at a masculine task. Even when acting in the more masculine role, a woman is likely to find herself mistrusted and fighting this bias. The ideal of a "calling" in ministry is that one follows the inner sense they feel about the directions for his or her life. Ministry is a lifestyle of service in which one endeavors to help those that are hurting. The results suggest the existence of a bias toward women preachers that discourages those with sense of calling to serve in such a vocation. Often scripture is used to argue against women in leadership, but no scriptural reasons were offered by the subjects. Perhaps biased practices are based on tradition rather than scripture.

The traditional forms and methods of ministry will not work in the next century. The shape of the country and religious society begins now for the future. Researchers can help prepare people for changes, especially in the area of women's issues. Further studies and scriptural examination could encourage the progress of women in ministry.

REFERENCES

Barna, G. (1993). *Today's Pastors*. Venura, CA: Regal.

Bartol, K. & Butterfield, D. A. (1976). Sex Effects in Evaluating Leaders. *Journal of Applied Psychology, 61*, 446-454.

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42(2)*, 155-162.

Burke, R. J. (1994). Canadian business students' attitudes towards women as managers. *Psychological Reports, 75*, 1123-1129.

Eagly, A. H., Karau, S. J., & Makhijani, M. G. (1995). Gender and the effectiveness of leaders: A meta-analysis. *Psychological Bulletin, 117(1)*, 125-145.

Ely, R. J. (1995). The power in demography: Women's social constructions of gender identity at work. *Academy of Management Journal, 38(3)*,589-634.

Greenglass, E. R. (1993). Structural and social-psychological factors associated with job functioning by women managers. *Psychological Reports, 73*, 979-986.

Hawkins, K. W. (1995). Effects of gender and communication content of leadership emergence in small task-oriented groups. *Small Group Research, 26*, 234-249.

Kent, R. L. & Moss, S. E. (1994). Effects of sex and gender role on leader emergence. *Academy of Management Journal, 37(5)*, 1335-1346.

Miles, D. (1983). *Introduction to Evangelism*. Nashville: Broadman, 336-339.

Morrison, A. M. & Von Glinow, M. A. (1990). Women and minorities in management. *American Psychologist, 45(2)*, 200-208.

Sachs, R., Chrisler, J. C., & Devlin, A. S. (1992). Biographic and personal characteristics of women in management. *Journal of Vocational Behavior, 41(1)*, 89-100.

Schein, V. E. (1975). Relationships between sex role stereotypes and requisite management characteristics among female managers. *Journal of Applied Psychology, 60(3)*, 340-344.

ALPHA-GANZFELD

An Experimental Study on Alpha Rhythms Under the Ganzfeld Condition

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ABSTRACT

There has been interest in relaxation while under the Ganzfeld condition. The Ganzfeld condition consists of a subject receiving a constant stimuli in one or more senses. It has been suggested that the Ganzfeld condition aids relaxation (Sargent, 1982); however, this has not been reliably demonstrated. It is known that visual input is, although not exclusively, a determining factor in alpha blocking (Bohdanecky 1984). This study intended to empirically examine the relationship between the Ganzfeld condition and relaxation.

A within-subjects experiment measured electroencephalogram (EEG) rhythms on participants who experienced relaxation under normal conditions versus the Ganzfeld condition. The Ganzfeld condition consisted of the participants receiving static visual and auditory input (Braud, 1975). The control group experienced normal relaxation involving sitting motionless for the same amount of time without the Ganzfeld stimuli. It is possible that the introduction of the experimental variables would cause less eye movements; therefore, increasing alpha activity (Bunnell, 1978). It was hypothesized that more alpha rhythms (see Appendix A) will be detected under the Ganzfeld condition than under the control condition.

METHOD

Participants

Thirty eight students participated, but only thirty three subjects' data were used due to equipment malfunction during certain trials. The subjects consisted of fifteen males and twenty three females in the eighteen to twenty-four year old age group of college students who attend Hamline University. Time spent for the experiment was compensated with extra credit to be used for psychology courses.

Design and Procedure

The subject sample was randomly divided into two groups for this within-studies experiment by having each subject experience conditions in the reverse order of presentation relative to the previous subject. Group A participated in the experimental setting first and then participated in the control setting. Group B participated in the control setting first and then participated in the experimental setting.

The subjects were divided into two groups to offset any feeling of anxiousness or discomfort caused by the novelty of EEG recording that might have affected ability to relax during the first few minutes of the study. In this way, any ordering effects should have been counterbalanced.

Both the control setting and the experimental setting consisted of the subject sitting in a chair inside an enclosed bright room. In addition, the subject was monitored for cortical alpha rhythm activity by an EEG recorded by Super Scope software. The electrodes were placed on the scalp according to the 10-20 system of electrode placement. The subject was read a prologue (see Appendix B) on how to relax to this situation and remained in this environment for a period of eight minutes after the prologue was read. Two 1000 ms EEG recordings of the subject were taken under each condition at four minute intervals.

The experimenters introduced the influence of Ganzfeld through use of halved white ping pong balls placed over the subjects eyes. White noise was provided by previously recorded radio static (Braud, 1975). The white noise was introduced to help drown out any auditory distractions during the experimental eight minute segment.

After each subject had experienced both conditions, a debriefing statement (see Appendix C) was read and any questions were answered.

The recorded alpha rhythms were independently calculated for frequency by each experimenter. The frequency of the alpha rhythms were determined by counting the number of waves starting from crest to crest or trench to trench depending on the experimenter. Alpha rhythms were discriminated from beta and theta activity by noting that an alpha rhythm must not have a frequency of less than 35 ms and an amplitude difference of no greater than 10 mv. The mean score between the experimenters' results were then added into the database. The results from the EEG's were analyzed in a two tailed T-test for paired samples with a p of .05 or less.

RESULTS

There was no significant difference between the control condition and the experimental condition.

DISCUSSION

The results revealed no significant differences between the control and the Ganzfeld condition. Some subjects reported feeling more uncomfortable under the experimental condition than under the control. Also, some subjects reported having trouble relaxing in general. These reports may point to possible confounding variables in the study. Other factors that may have influenced the results could have been noises in the classroom next door to the lab and occasional hallway vacuuming that could have been heard even over the white noise. The introduction of white noise noise for the experimental condition could have been more aggravating than soothing and relaxing, thus tainting the data. It is also possible that the subjects were anxious to get out of the study because many subjects ran during the day were in between classes and meetings. In addition, the very state of being attached to an EEG monitor might have introduced confounding variables (e.g., anxiousness, feelings of discomfort). For future research it may be recommended to either test subjects who are not in a rush, or to shorten the length of the test.

Careful consideration and time must be spent in order to eliminate these possible data corruptions. No firm conclusions should be drawn from a study of this nature without the presence of ideal conditions. Ideal conditions are those that have eliminated the possible confounding variables discussed earlier.

REFERENCES

Bohdanecky, Z, Indra, M, Lansky, P, Radil-Weiss,T. (1984) Alternation of EEG Alpha and Non-Alpha Periods does not Differ in Open and Closed Eye Condition in Darkness. Acta-Neurobiolagiae-Experimentalis,44(5), 229-232.

Braud, W, Wood, R, Braud, L. (1975) Free-Response GESP Performance During an Experimental Hypnagogic Induced by Visual and Acoustic Ganzfeld Techniques: A Replication and Extension. Journal-of-the-American-Society-for-Psychical-Research, 69(2), 105-113.

Bunnell, D, Manuck, S. (1978) Effects of Stimulus-Independant Oculomotor Activity on the Occipital EEG. Physiology-and-Behavior,20,(5),673-675.

Sargent, C. (1982) A Ganzfeld GESP Experiment with Visiting Subjects. Journal-of-the-American-Society-for-Psychical-Research, 51(790), 222-232.

Appendix A

ALPHA RHYTHM

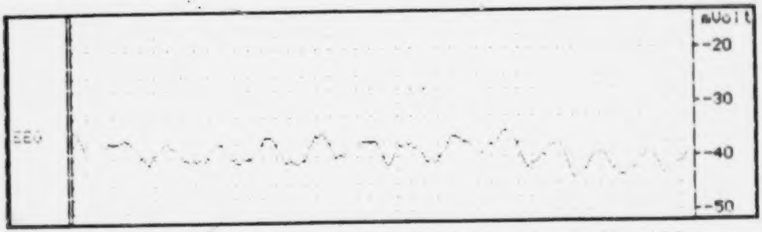

Figure 1: Alpha rhythm recording taken from a subject under the Ganzfeld condition.

Appendix B

PROLOGUE

You will experience a series of relaxing sessions for this experiment. There will be a break between each session. For each session we ask that you focus on your breathing, become aware of it and focus on every inhalation and exhalation. Try not to let your mind wander and detour you from your focus on breathing. We also ask that you do NOT shut your eyes any long periods of time. When I shut this door, you may begin your relaxation session and I will open the door when the first session is over.

Appendix C

DEBRIEFING STATEMENT

Thank you for your participation in this study, your help is greatly appreciated. Your name will be given to the instructor you have chosen for extra credit. All data will be kept confidential as there might be publicational and/or educational uses for these results. If you have any further questions regarding this study, you may contact the supervising faculty member, Dr. Dietrich at 641-2333.

THE RELATIONSHIP BETWEEN THE EXTENT TO WHICH ADOLESCENTS ARE TAUGHT NOT TO TRUST STRANGERS DURING CHILDHOOD AND INTERPERSONAL SKILLS

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This study examined the relationship between being taught not to trust strangers during childhood and interpersonal skills among adolescents. A total of 106 male and female college students and their parents were administered a background information questionnaire, the Revised UCLA Loneliness Scale, the Self-report Trust Scale, the Interpersonal Competence Questionnaire, and the Social Avoidance and Distress Scale. Late adolescents, ages 18 to 21, who were taught as children not to trust strangers displayed higher levels of social anxiety and lower levels of emotional support. Females tended to have higher levels of social avoidance and mistrust relative to males regardless of whether they were taught not to trust strangers during childhood.

Background

In response to the perceived increase in the number of abductions and molestations, many parents have decided to educate their child about his safety. The safety rules that parents teach not only contain information about how their child can protect himself, but also the message that strangers are not to be trusted. In teaching a child that strangers are not trustworthy, the parents are not allowing their child to learn the importance of trust. Erikson (1955) points out that trust is fundamental to further psychological development as well as future interpersonal skills. According to Erikson these children who fail to develop a "basic" sense of trust during the early years will view the world as hostile in later life. Also, these children will most likely develop into insecure individuals with low self-esteem who feel lonely, isolated, and unloved (Mitchell, 1990).

Unknowingly, by teaching children not to trust strangers, parents may be eroding the basic foundation for future interpersonal relationships. Trust is where all interpersonal relationships begin, whether it is with strangers or loved ones, and without a foundation of trust cooperation, planning, caring, and sharing cannot be developed (Mitchell 1990).

Given that trust is the basis for all interpersonal relationships, it is necessary to clarify how "trust" is defined. On a broad scheme, trust is defined by Deutsch (1973) as the confidence that one will find what is desired from another, rather than what is feared (Rempel, 1985). While on a more personal scheme, Rotter (1980) defines it as a generalized expectancy held by an individual that the word, promise, or statement of another individual can be relied on (Rempel, 1985). Studies done by Into (1969); Katz & Rotter (1969) show that this barrier of who or what people trust develops over the years mainly from watching what their parents say and do. By modeling their parents, children learn the basic of self-disclosure. According to Jourard (1958), self-disclosure is the process of making the self known to others. Studies done by Snoek & Rothblum (1979) show that the structure and child-rearing practices of the family do influence self-disclosure, by providing a model for interpersonal relationships. Their studies also show that a child who is taught to disclose thoughts and feelings at home will generalize to others (Snoek &Rothblum, 1979). Jourard (1959) claims that the amount of disclosure that a person is willing to disclose could be seen as a measurement of the closeness of a relationship. In turn, the closeness could also be seen as an indicator of the amount of trust between two people (Jourard, 1959).

Intimacy, according to Erikson (1963), is the capacity to commit (one)self to concrete affiliations. Intimate relationships are characterized by openness, sharing, and

794

mutual trust (Raskin, 1986), and are shown in varying degrees by three manifestations: verbal, nonverbal, and physical. Each manifestation is comprised of different levels. For example, physical manifestations range from a casual handshake to sexual fireworks, while verbal manifestations are measured in the amount of self-disclosure (Lowenthal &Weiss, 1976). Therefore, if what Jourard says is true, that self-disclosure is able to measure the degree of trust in a relationship, then trust, self-disclosure, and intimacy must be interrelated. A person cannot have an intimate relationship without some form of trust which is displayed through the amount of self-disclosure.

Studies done by Raskin (1986); and Orlofsky, Marcia, & Lesser (1973) show that trust, self-disclosure, and intimacy are interrelated as well as hierarchial. Trust is the basis for the other two; however, the three cannot exist without each other. Therefore, if one of these concepts is influenced, either negatively or positively, by another then the interaction of the two could either hinder or help the end product. Based on this, then if a child lacks trust in strangers then his ability to become intimate with others could be seriously hindered in turn causing him to become isolated, depressed, and to have low-self esteem. Thus, the present study looks at the effects on young adults'/ late adolescents' intimacy caused by teaching children at an early age not to trust strangers. If the young adults were taught not to trust strangers, then they should be more likely to be depressed, show an increased feeling of loneliness, show a lack of trust in others, and generally be low in interpersonal skills.

Method

Subjects

Subjects were 210 young adults between the ages of 18-21. The sample consisted of an equal number of girls and boys. Subjects also were 210 primary caregivers, with each young adult having one to represent him/her. All the young adults were psychology volunteers who received extra credit upon the completion of all the questionnaires.

Measures

Both the primary caregiver and the student filled out a background questionnaire designed to determine what and how they were taught about strangers. Also, each student filled out four questionnaires: The Lagace & Gassenheimer (1989) Trust and Suspicion Scale, the Hays & DiMatteo (1978) UCLA Loneliness Scale, the Cole & Milstead (1969) Social Avoidance and Distress Scale, and the Buhrmeister (1990) Adolescent Interpersonal Competence Questionnaire.

Trust and suspicion: The Lagace & Gassenheimer (1989) Trust and Suspicion Scale is a ten-item questionnaire measured by a four point Likert scale. It was used to measure trust and suspicion by self-report.

Loneliness: UCLA Loneliness Scale-Revised is a twenty-item questionnaire measured by a four-point Likert scale. It was used to measure the subject's level of loneliness.

Anxiety: Social Avoidance and Distress Scale (SAD) is a twenty-eight item questionnaire measured by the subject choosing either true or false. It was used to measure the level of anxiety that the subject experiences in social situations.

Competence in interpersonal skills: Adolescent Interpersonal Competence Questionnaire (ICQ) is a forty-item questionnaire measured by a five-point Likert scale. It was used to measure the subject's interpersonal competence.

Procedure

As mentioned previously, college students and their primary caretakers were asked to participate in this project. Participants were recruited by visiting introductory psychology courses and asking students to volunteer. Those who volunteered were informed that in order to receive experimental credit, they needed to obtain consent from the individual who was responsible for raising them during the first five years of their life to agree to fill out a background questionnaire requiring approximately thirty minutes. Only the data from those students whose biological mother or father was responsible for raising them was used. Students and care givers were asked to fill out the questionnaires without consulting each other.

After the questionnaires of both the student and the care giver was returned, those care givers and students who indicated that they were taught not to trust strangers were used to form one group. Similarly, only those students and their care givers that were taught to trust strangers were used to form a second group. Thus, where disagreement existed between students and care givers regarding whether they were taught to trust strangers were not included.

Results and Discussion

The data was analyzed by using a 2x2 (gender x trust vs. mistrust) MANOVA. The independent variables consisted of males vs. females and whether adolescents were taught by parents to trust strangers during childhood. The outcome measures consisted of scores on The Interpersonal Competence Questionnaire (ICQ), The Social Avoidance and Distress Scale (SAD). The means and standard deviations on all scales are presented in Table 1.

Table 1
Means And Standard Deviations For All Groups On All Measures

	High Trust				Low Trust			
Measures*	male		female		male		female	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
SAD	42.89	2.03	44.00	1.97	40.75	2.77	42.54	2.15
ICQ	140.33	26.02	149.39	20.46	136.94	18.75	148.24	17.94
In	28.11	6.77	27.28	6.44	26.81	6.75	28.10	5.84
NA	27.33	4.64	29.00	6.54	25.75	5.04	29.33	5.60
Dis	28.11	6.28	28.61	6.00	25.13	4.84	28.06	5.20
ES	30.33	5.05	36.50	3.09	31.44	4.12	34.57	4.05
CM	26.44	6.41	28.00	5.39	27.81	4.78	28.18	4.87

* SAD=Social Avoidance Scale, ICQ=Interpersonal Competence Questionnaire, In=Initiation, NA=Negative Assertion, Dis=Disclosure, ES=Emotional Support, CM=Conflict Management

Significant differences were found for the main effects of both trust (Wilk's Lambda (2, 101= .006; approximate F=5.48, p<.05) and gender (Wilk's Lambda (2, 101= .004; approximate F=5.86, p<.05). Univariate F tests and studentized t-tests were next used ti identify specific group differences. Significant differences were found as a function of whether adolescents were taught to trust on the SAD (F(1, 102)=10.75, p<.05). Significant differences were found as a function of gender on the SAD (F(1, 102)=6.98, p<.05); Emotional Support subscale (F(1, 102)=22.01, p<.05).

Protected t-test analysis revealed differences between the females that were taught not to trust strangers (x=42.54) versus those who did not receive training (x=44.00) on the SAD (p<.01). Additionally, differences were found between females who were not instructed by their caretakers (x=44.00) and males taught not to trust strangers (x=40.75) on the SAD (p<.001). Also, females taught not to trust strangers (x=42.54) had higher scores than males taught not to trust strangers (x=40.75) on the SAD (p<.01). Additionally, males taught not to trust strangers had lower scores (x=40.75) than males who did not receive instructions not to trust strangers (x=42.89) on the SAD (p<.02).

796

This study was taken to explore whether a relationship exists between the extent to which children were taught not to trust strangers during their childhood and their interpersonal skills during late adolescence. Our hypothesis that children taught not to trust strangers had poorer interpersonal skills as late adolescents, was supported. Adolescents who were taught as children not to trust strangers had higher levels of social anxiety and lower levels of emotional support. Overall females who were taught not to trust strangers displayed higher levels of social anxiety while males who were taught not to trust strangers had lower levels of emotional support.

One unexpected finding was that females tended to have higher levels of social avoidance and mistrust relative to males regardless of whether they were taught not to trust strangers during their childhood. However, this finding is consistent with previous research (Block, 1973). Heretick (1981 & 1984) found that college females tended to be less trusting than males. These authors theorized that the reason for these differences might be that parents tend to teach their female children to be less trusting in general, than boys. Thus, the significant differences found in this study as a function of gender may have been due to the fact that females are less trusting rather than simply being taught not to trust strangers. Although differences were found as a function of whether adolescents were taught to trust strangers, this study does have several limitations. Most important, our sample consisted of white, middle-class students residing in the southwest. Had adolescents of different ethnicities residing in other geographical regions participated, different results may have been obtained. Thus, additional research should be conducted prior to drawing any conclusions.

Assuming that future research is consistent with our findings, our results may have both practical and theoretical implications. At the theoretical level our results could lend support to Erikson's eight stages of development.

At an applied level, our results may also have some implications for child rearing practices. For example, parents might wish to consider modifying the instructions they give their children regarding trust of strangers. The parents might want to consider treating their children more androgynously. They might want to raise their girls to believe that competiveness, risk taking, and trusting others are acceptable in today's society. For boys, parents might want to raise them to believe that in today's society it is acceptable to be loving, emotional, and trusting. Parents might also want to consider guiding their children into activities that, today, are considered to be geared toward particular sexes.

References

Block, J. H. (1973). Conceptions of sex-role: Some cross-cultural and longitudinal perspectives. American Psychologist, 28, 512-526.

Buhrmester, D., Furman, W., Wittenberg, M. T., & Reis, H. T. (1988). Five domains of interpersonal competance in peer relationships. Journal of Personality and Social Psychology, 55, 991-1008.

Erikson, E. H. (1963). Childhood and Society. W. W. Norton & Company, New York.

Heretick, D. M. L. (1981). Gender-specific relationships between trust-suspicion, locus of control, and psychological distress. Journal of Psychology, 108, 267-274.

Heretick, D. M. L. (1984). Trust-suspicion and gender differences in interpersonal functioning. Journal of Research in Personality, 1984, 27-40.

Jourard, S. M. (1959). Self-disclosure and other cathexis. Journal of Abnormal and Social Psychology, 59, 428-431.

Jourard, S. M., & Lasakow, P. (1958). Some factors in self-disclosure. Journal of Abnormal and Social Psychology, 56, 91-98.

Katz, H. A. and Rotter, J. B. (1969). Interpersonal trust scores of college students and their parents. Child Development, 40, 657-661.

Lowenthal, M. F. and Weiss, L. (1976). Intimacy and Crises in adulthood. Counseling Psychologist, 6, 10-15.

MacDonald, Jr., A. P., Kessel, V., & Fuller, J. (1972). Self-disclosure and two kinds of trust. Psychological Reports, 30, 143-148.

Mitchell, C. E. (1990). Development or restoration of trust in interpersonal relationships during adolescence and beyond. Adolescence, 25, 847-854.

Orlofsky, J. L., Marcia, J., & Lesser, I. (1973). Ego identity status and the intimacy versus isolation crisis of young adulthood. Journal of Personality and Social Psychology, 27, 211-219.

Raskin, P. M. (1986). The relationship between identity and intimacy in early adulthood. The Journal of Genetic Psychology, 147, 167-181.

Rempel, J. K., Holmes, J. G., & Zanna, M. P. (1985). Trust in close relationships. Journal of Personality and Social Psychology, 49, 95-112.

Rotter, J. B. (1980). Interpersonal trust, trustworthiness, and gullibility. American Psychologist, 35, 1-7.

Rotter, J. B. (1971). Expectancies for interpersonal trust. American Psychologist, 26, 443-452.

Russell, D., Peplau, L., & Cutrona, C. (1980). "The revised UCLA loneliness scale: Concurrent and discriminant validity evidence." Journal of Personality and Social Psychology, 39, 472-480.

Snoek, D., & Rothblum, E. (1979). Self-disclosure among adolescents in relation to parental affection and control patterns. Adolescence, 14, 333-339.

Watson, d., & Friend, R. (1969). Measurement of social evaluative anxiety. Journal of Consulting and Clinical Psychology, 33, 448-457.

The Relationships Among Eating Attitudes, Loneliness, and Self-Monitoring

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Relationships among eating attitudes, loneliness, and self-monitoring in male and female college students were explored. The surveys used included the EAT-26 (Garner & Garfinkel, 1979), the UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1977), and the Snyder's Revised Self-Monitoring Scale (Lennox & Wolfe, 1983). Significant relationships were found between: (a) four factors of the EAT-26 Scale (dieting attitude, awareness of food content, food preoccupation, and total score); (b) between dieting attitude and ability to modify behavior; (c) between EAT total score and ability to modify behavior; and (d) food preoccupation and loneliness. Strong relationships were found between eating attitudes and self-monitoring, yet, a very strong relationship did not exist between eating attitudes and loneliness.

INTRODUCTION

Research on eating patterns has shown that they can change for a number of reasons, especially during the college years. Hesse-Biber and Marino (1991) conducted a study on women making the transition from high school to college to see if there were any changes in their self-concepts or eating patterns. Their study found that college students experience significant changes in their transition from high school to college. The results showed a pattern of diminishing self-concept over time and revealed a connection between self-concept and eating problems. They found that those participants who remained or became abnormal in eating patterns showed a pattern of diminishing self-concept over time compared with the participants who remained normal or got better.

Studies on loneliness have shown that when college students feel lonely they tend to withdraw more into themselves by participating in solo activities, which could include eating, as suggested by Ondercin's (1989) study that found a relationship between compulsive eating and loneliness. The goal of Ondercin's study was to determine the characteristics behind binge eating. It was found that high compulsive eaters reported significantly more frequent eating in response to unpleasant emotional states, such as boredom, loneliness, sadness, anxiety, and anger, than either the medium or low compulsive eaters. These results support past research that found eating is a response to negative affect and may have a stress-reducing function (Ondercin, 1989).

Studies on self-monitoring show that behavioral intentions and attitudes play a large role in actions, as found in a study conducted by Prislin and Kovrilja (1992). The results of their study support the idea that "low self-monitors tend to regard their attitudes as relevant guides to actions. In contrast, high self-monitors tend to form their behavioral intentions by relying on their perception of what relevant others think of whether or not they should perform a certain behavior" (Prislin & Kovrilja, 1992, p.1136). These findings suggest that both loneliness and self-monitoring can be related to eating attitudes. In the present study, it was hypothesized that there are strong correlations between loneliness and eating attitudes, and self-monitoring and eating attitudes.

METHOD

Participants

The participants in this study were 51 undergraduate students (18 male, 31 female and two who failed to indicate their sex) at Xavier University in Cincinnati, Ohio.

The average age of the participants is 19. Participation was strictly voluntary and all APA ethical guidelines were followed.

Materials

Three different scales were used to measure personality attributes of the participants in the present study. The first scale, the Eating Attitudes Test (EAT-26) (Garner & Garfinkel, 1979), included 20 items from the original 26 on the EAT-26. Five questions on body image and one demographic question were omitted, because they were irrelevant to the present study. The questionnaire is scored using a Likert scale ranging from zero (rarely) to three (very often). The scale is scored using the sum of the responses. The questionnaire measures four different factors: (a) dieting attitudes; (b) oral control; (c) awareness of food content; and (d) food preoccupation. Using Cronbach's coefficient alpha, the determined reliability of this scale was r=.83, and the test has concurrent or criterion validity (Koslowsky, Scheinberg, Bleich, & Solomon, 1992).

The second scale, the UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1977), included 20 items to determine the degrees of loneliness in the participants. The items were answered using a Likert scale ranging from one (never) to four (often). The scale is scored using the sum of the responses. The UCLA Loneliness Scale is fairly reliable with a "test-retest correlation over a two-month period of r=.73" (Russell et al., 1977, p. 292).

The last scale, the Snyder's Revised Self-Monitoring Scale (Lennox & Wolfe, 1983), contained 13 items and was answered using a Likert scale ranging from (false) to five (true). Scores are developed from the sum of the answers. This scale is "face valid and has enough internal consistency to merit further examination" (Lennox & Wolfe, 1983, p. 1363).

The data for this experiment was collected in several different group settings. The participants were first given a consent form to read that explained the basic design of the experiment. After signing the consent form, they were given a questionnaire containing the three scales stapled together in a particular order. They were told not to spend too much time on one answer, because their responses would be more valid when based on their first reactions. The participants then placed their completed questionnaires into a folder to assure anonymity.

RESULTS

The means and standard deviations for EAT factors one through four, EAT total score, loneliness, ability to modify behavior and sensitivity to others are found in Table 1. Inspection of this table indicates that females have higher means in every category, but large differences between males and females occurred in only half of the categories. In dieting attitudes, females have a mean score of 8.10, while males have a mean of 3.67. In the EAT total scores, the females have a mean score of 17.77, while the males have a mean score of only 9.11. There were no significant differences between the scores of males and females of the Self-Monitoring scales or the loneliness scale.

Correlations between variables are presented in Table 2. Inspection of the table indicates that the following relationships were statistically significant: (a) dieting attitude and awareness of food content; (b) dieting attitude and food preoccupation; (c) dieting attitude and EAT total score; (d) dieting attitude and ability to modify behavior; (e) dieting attitude and sensitivity to others; (f) awareness of food content and food preoccupation; (g) awareness of food content and EAT total score; (h) awareness of food content and ability to modify behavior; (I) food preoccupation and EAT total score; (j) EAT total score and ability to modify behavior; and (k) food preoccupation and loneliness.

DISCUSSION

The findings of this study show strong correlations between four of the factors on the EAT-26 Scale, which is to be expected since they are included within the same scale. The strongest of these correlations are between dieting attitude and EAT total score with r=.94, between awareness of food content and EAT total score with r=.79, and between dieting attitude and awareness of food content with r=.68. These results suggest that an individual who has a high score on dieting attitudes and/or awareness of food content would also have a high EAT total score. The results also suggest that an individual with

800

a strong dieting attitude would be aware of the content of food that is eaten. The third factor of the EAT-26 Scale, oral control, was not found to be strongly correlated to any of the other factors of the scale. This may suggest that oral control is not related to the other factors on the scale and should not be included on the EAT-26.

Dieting attitude is found to be correlated with both self-monitoring scores, ability to modify behavior and sensitivity to others. This finding supports Hesse-Biber and Marino's (1991) study on self-concept and eating disorders. They found that dieting attitude has a relationship to how individuals think they are perceived by others. Both awareness of food content and EAT total score are correlated with ability to modify behavior. This correlation may mean that individuals with high EAT scores are able to adjust the amount of food they intake.

As was hypothesized, a correlation was found between eating attitudes and loneliness. The study shows a correlation of $r=.37$ between food preoccupation and loneliness. This correlation is not a very strong correlation, but it does suggest a relationship between giving too much time and thought to food and feeling lonely. The correlation is not strong enough to suggest a causal relationship but further research in this area could provide that information.

Some problems in this study include the limited generalizability of the participants. Because Xavier is a private, Catholic institution, this study is not representative of all college students. Other problems arise from the fact that females make up nearly 61 percent of the participants in this study, which could present some gender biases. Also, sophomores make up nearly 55 percent of the participants, while only 25 percent of the participants are from the freshman or senior classes. Having so few subjects from the freshman and senior classes could have limited the findings of the study. Hesse-Biber and Marino's (1991) study found that eating attitudes change during the freshman year and are different in the senior year. Thus, had more participants from these two classes been included stronger correlations may have been found.

Another problem with the study is that not every item on the EAT-26 Scale was included. Five questions concerning body image and one demographic question were omitted, because they were irrelevant to the present study. This may affect the reliability and validity of the scale and the results.

Further research should be conducted in the areas of eating attitudes and loneliness before causal relationships are suggested. The research should also include participants that better represent the population being studied. Also, all items on the EAT-26 could be used to ensure reliability and validity.

Overall, this study was somewhat effective in examining the hypothesis. The findings did indeed show correlations between eating attitudes and self-monitoring, as well as a relationship between eating attitudes and loneliness. However, the correlations were not very strong. Thus, more research should be conducted on these three factors before further conclusions can be drawn.

REFERENCES

Garner, D.M., Olmstead, M.P., Bohr, Y., & Garfinkel, P.E. (1982). The Eating Attitudes Test: Psychometric features and clinical correlates. Psychological Medicine, 12, 871-878.

Hesse-Biber, S. & Marino, M. (1991). From high school to college: Changes in women's self-concept and its relationship to eating problems. The Journal of Psychology, 125, 199-216.

Koslowsky, M., Scheinberg, Z., Bleich, A., & Solomon, Z. (1992). The factor structure and criterion validity of the short form of the Eating Attitudes Test. Journal of Personality Assessment, 58, 27-35.

Lennox, R.D. & Wolfe, R.N. (1984). Revision of the Self-Monitoring Scale. Journal of Personality and Social Psychology, 46, 1349-1364.

Ondercin, P.A. (1979). Compulsive eating in college women. Journal of College Student Personnel, 19, 153-157.

Prislin, R. & Kovrilja, N. (1992). Predicting behavior of high and low self-monitors: An application of the theory of planned behavior. Psychological Reports, 70, 1131-1138.

Russell, D., Peplau, L.A., & Ferguson, M.L. (1978). Developing a measure of loneliness. Journal of Personality Assessment, 42, 290-294.

TABLES

Table 1: Means and Standard Deviations of Variables

VARIABLE	MEANS	SD
EatF1	6.61	4.94
Males	3.67	3.25
Females	8.10	5.14
EatF2	2.25	1.60
Males	2.11	1.60
Females	2.35	1.66
EatF3	2.55	2.44
Males	1.28	1.90
Females	3.26	2.48
EatF4	3.31	2.14
Males	2.06	1.31
Females	4.06	2.25
EatTot	14.73	8.50
Males	9.11	5.41
Females	17.77	8.62
Lonely	34.84	12.95
Males	34.56	14.06
Females	35.55	12.71
SMS1	22.10	4.05
Males	21.22	3.78
Females	22.32	4.07
SMS2	20.76	3.93
Males	20.44	4.71
Females	21.00	3.57

Note. Sgend=gender; Class=grade in school; EatF1=dieting attitudes; EatF2=oral control; EatF3=awareness of food content; EatF4=food preoccupation; EatTot=EAT scale total score; Lonely=loneliness scale score; SMS1=ability to modify behavior; SMS2=sensitivity to others

Table 2: Correlation Coefficients

	Sgend	Age	Class	EatF1	EatF2	EatF3
Sgend	1.00	.02	.17	.27	-.01	.16
Age	.02	1.00	.57**	.12	-.18	.07
Class	.17	.57**	1.00	.09	.02	.08
EatF1	.27	.11	.09	1.00	-.02	.68**
EatF2	-.01	-.01	.02	-.02	1.00	-.05
EatF3	.16	.16	.07	.68**	-.05	1.00
EatF4	.11	.12	.15	.68**	.04	.48**
EatTot	.23	.08	.11	.94**	.17	.79**
Lonely	-.11	-.15	.04	.20	.20	-.08
SMS1	.24	.15	.21	.37**	-.07	.39**
SMS2	-.02	-.03	.01	.28*	-.06	.22

*-signif. LE p=.05 **signif. LE p=.01 (two-tailed)

Table 2 Continued

	EatF4	EatTot	Lonely	SMS1	SMS2
Sgend	.11	.23	-.11	.25	-.02
Age	.12	.08	-.15	.15	-.03
Class	.15	.11	.04	.21	.01
EatF1	.68**	.94**	.20	.37**	.28*
EatF2	.04	.17	.20	-.07	-.06
EatF3	.48**	.79**	-.08	.39**	.22
EatF4	1.00	.79**	.37**	.03	.02
EatTot	.79**	1.00	.22	.32*	.22
Lonely	.37**	.22	1.00	-.17	-.14
SMS1	.03	.32*	-.17	1.00	.15
SMS2	.02	.22	-.14	.15	1.00

*-signif. LE p=.05 **-signif. LE p=.01 (two-tailed)

Readability Of Websites With Various Foreground/Background Color Combinations, Font Types And Word Styles

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We are depending more and more on computers everyday. We can receive our mail, read our newspapers and magazines, do our research and shopping all on our computers. The Internet is greatly responsible for these capabilities. Today, anyone can make a website and have it put on the Internet. The result of this freedom may often be very creative webpages, but also frequently hard to read webpages. Many novice designers may feel that if they can read their display, so can everyone else. This can be a problem, especially when the designers are young and the readers are older. More specifically, younger viewers usually manage to read even the worst video display terminal (VDT) designs, but this is not always true for the older readers (>45 years) or those with a color-perception deficiency (colorblindness).

Legibility, and in turn readability, of the VDT is very important for efficient communication. Legibility depends on many factors: color combinations, background texture, font, font size, word style (bold, italicized, etc.), computer pixel size, along with many others. There are plenty of opinions, preferences, observations, and even proposed algorithms related to legibility, but very little published, objective data that directly relates to webpage style screen displays. Despite the small amount of objective data, several legibility factors are acknowledged by books discussing on-screen displays. Unfortunately there is often little, if any, agreement across different publications. For example, although many of the design books do agree in their recommendations for "high contrast," there is very little agreement regarding other variables that influence good screen design.

Contrast is very important in any written text. Whether in print or on screen displays, low contrast can be irritating and fatiguing to young readers, but for older readers and the colorblind it can be impossible to read. Contrast is the value (intensity) difference between two areas; the value is the amount of lightness or darkness in a color. For example, black on white has a high contrast, while black on gray has a lower contrast. There is much confusion when discussing contrast and color. Saturated green (little white light) on saturated red has a very low contrast, but green on red could have a high contrast. For example, one can place a fully saturated green on a red that is almost pink by adding white light.

Also, when discussing color, one must acknowledge difficulties when presenting information using short wavelengths (i.e. blues). First, short wavelengths have lower resolution because they are blurred by the ocular media, and there is lower sampling by the cone mosaic. Thus, readability of any text presented in short-wave light will be decreased. Second, it is inadvisable to mix colors that are on the extreme ends of the color spectrum (i.e. blues and red). When the spectrally extreme colors are mixed they quickly fatigue the eyes, because these wavelengths have different focal lengths. Reds have long wavelengths, and they are focused farther back in the eye, unlike blues which have short wavelengths and are focused closer to the middle of the eye. This causes a sort of 'tug of war' in the eyes between focusing on the red and focusing on the blue. (For an excellent discussion of human color vision and how it affects computer displays, see Galitz, 1994).

For the novice designers, contradictory information in books written for professional designers can pose difficulties for their design process. For example, Powell (1990) suggests "avoid sharp contrast between foreground and background...," but Rivlen, et al. (1990) suggests "choose a text colour/background colour combination which maintains a high contrast..." Dumas (1988), warns us to stay away from "placing shades of blue beside each other," yet in another text, cyan text on a blue background is listed as a good color combination (Rivlin, et al, 1990). One text even listed such foreground/background color combinations as green on red, "bright white" on white and yellow on white as "good choices" (Powell, 1990). Powell also said that black text on white background was only acceptable "when used in a limited area;" however black on white has been the most recommended color combination found across all books. Pace (1984) found that blue on white had low error rates, but Powell regards blue text as a "poor choice." These are just a few of the many contradictions that can be found in design books. These contradictions are very confusing and quite overwhelming, and make it difficult to answer a simple question such as "what colors do I use on my webpage?" Even worse, what if someone only refers to one book (which most people would do), and that one book is the one that suggests green on red or yellow on white?

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Information on paragraph style, word style, and font type of VDT's is a little harder to come by than information on color and color combinations; but fortunately this information is less contradictory and less vague than that regarding color use. Most of the information on font type and style came from research using printed text on paper. VDT design books still refer to this research. However, Kruk and Muter (1984), found that text displayed on VDT's is "20-30 percent slower" to read than printed text (reading speed is used to infer legibility).

Regarding paragraph style, left justification is favored to right justification. Justification simply means to be lined up, and text can be either lined up on the left margin, right margin, both or neither (if text is centered). Trollip and Sales (1986) found a 10% increase in reading time with text that was both justified. This finding was attributed to "uneven spacing between words and/or frequent hyphenation;" plus, right justification makes it harder for a reader to find their place when they lose it (Dumas, 1988).

Several word style factors (letter case, bold, italicized, etc.) may also affect readability. For example, text displayed in mixed upper and lower case letters is faster and easier to read (Tinker, 1963). This increase in speed is due to a person's tendency to recognize the shape of the word as opposed to each individual letter in a word. When text is in all upper case letters, it takes away the characteristic shape of words. The reader is forced to identify the individual letters of each word, which slows the reader down.

Additionally, font type can affect readability, depending upon if the letters contain serifs or have proportional spacing. Serifs are the little marks at the end of letter strokes; hence, serif fonts have serifs and sans serif fonts do not have serifs. Some examples of serif fonts are Times New Roman and Courier New, and an example of sans serif font is Arial. There is some contradictory research regarding the use of serifs. Horton (1990), warns against serif fonts in smaller font sizes, but Tinker (1964) says that fonts with serifs can be read more easily. Much of this contradiction comes from the generalization of research conducted for legibility of text on paper, to the legibility of text on VDT's.

Finally, letter spacing, proportional or non-proportional, can influence readability. A non-proportional font gives the same amount of space for an 'i' that it gives for an 'o,' while proportional fonts give an 'i' a smaller space than an 'o.' Courier New is a non-proportional font, and Times New Roman and Arial are proportional fonts. Helander et al. (1984) found that proportionally spaced type is read faster than "fixed-width" font.

As mentioned earlier, there are very few objective studies published on this topic, especially with respect to interactions among the factors which influence readability. It is not feasible to test every combination of variables, and since there has been so little prior research, we will start with a few basic variables: foreground/background color combinations, font type, and word style. The foreground/background color combinations chosen for this experiment are black on white, yellow on blue, black on gray, white on blue, green on yellow, and red on green. Times New Roman (Times NR), Courier New, and Arial were used for font type, and italicized and Roman (plain) were used for word style. The current experiment placed these variables in a webpage style design in order to be more generalizable. Due to previous research we predicted that text with higher foreground/background color contrast would have faster reaction times. Text written in plain word style and sans serif proportional font were also predicted to have faster reaction times. Overall, it is predicted that as legibility increased, reaction time would decrease. Although interactions of some sort are expected, no particular trends are predicted.

METHODS

Participants

Forty-three participants were included in the current experiment. All participants except two, the advisor and the experimenter, were naive to the hypotheses. All participants were tested for normal color-vision, and all participants had 20/20 or corrected to 20/20 vision. Participants were informed of the required procedure and completed a consent form.

Apparatus

Macintosh Power PC 7200/120 computers were used in the experiment. The stimuli were created in B/C Power Laboratory (an experiment application), which also presented the stimuli and collected the data. Data analysis was performed using Statistica (a statistics application).

Stimuli

A nation-wide Internet survey was used to help chose the foreground/background color combinations (for the results of this survey, refer to http://www.thecube.com/color/). Six color combinations were selected: yellow on blue (Y/BL), white on blue (W/BL), red on green (R/GN), black on gray (BK/GY), black on white (BK/W), and green on yellow (G/NY). These color combinations were chosen for a few basic reasons. First, basic colors that are available on most monitors were selected. Second, the experimentor selected two light on dark color combinations (W/BL and Y/BL), two dark on light color combinations (BK/W and GN/Y); the fifth color combination, red on green, is not easily classified as light or dark. Finally, black on gray was chosen because it is commonly used on webpages. The RGB value of the colors used in this experiment are as follows: red-R(56797), G(0), B(0); blue- R(0), G(0), B(56797); yellow- R(65535), G(65535), B(0); green- R(0), G(34952), B(0); gray-R(30538), G(30538), B(30538); black- R(0), G(0), B(0); white- R(65535), G(65535), B(65535).

Within each color combination, there were three font types (Arial- sans serif/proportional; Courier New- serif/non-proportional; Times NR- serif/proportional), and within each color/font variation, there were two word styles (italicized and plain). Thus, there were six font/word style variations within each color combination. Each font/word style combination within each color combination was presented five times, so that there were thirty trials per color combination, and a total of 180 trials in the experiment.

Thirty text stimuli were presented in each color combinations. Within each color combination condition the thirty texts were counter-balanced across each of the font type/word style combinations. More specifically, the text stimuli consisted of thirty text excerpts that were imported from the Internet into B/C Power Laboratory. The thirty text pages ranged in length from 130 to 150 words (some text were edited to fit within the word range). A target word was placed within each text; the placement was carefully randomized across all trials. At the bottom of each stimulus screen, there were five shapes that corresponded to each of the five target words (circle, triangle, star, diamond, and square).

Procedure.

All participants were screened for normal color vision. Then, they read instructions on the computer screen, and they signed their consent form. They were given ten practice trials, and they were allowed to ask questions at any point throughout the experiment. The order of the practice trials and the 180 actual trials were randomized by the computer.

Participants were instructed to scan a screen of text and find a target shape word. Once they found the target word, they clicked on (using the mouse pointer and mouse) the corresponding shape at the bottom of the screen. The start of each trial was self-paced, and each trial ended when the participant clicked the target-word shape. Participants were instructed to respond as quickly and accurately as possible. It took participants anywhere from 45 minutes to 2 hours (average time was one hour) to complete the experiment. After the experiment, all participants were debriefed.

RESULTS

The data were sorted by each variable for each participant, and the mean for each condition was calculated (only RT's from correct responses were used). All participants with an overall accuracy rate of at least 95% were used. However, the data of two of these participants were not used due to RT patterns that implied that they were not diligently attending to the task. Figure 1 illustrates means for all conditions.

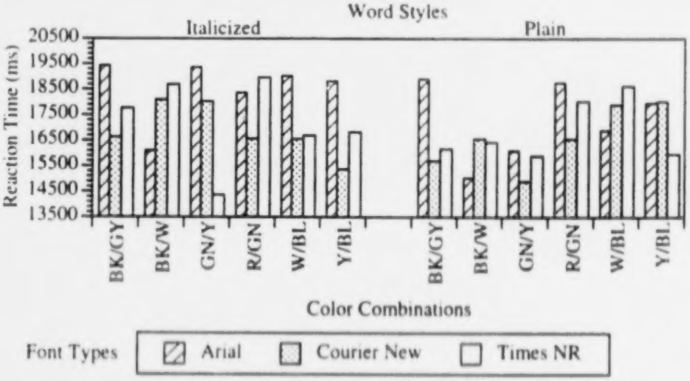

Figure 1: A 3-way interaction between color combinations, font types, and word styles. Notice how the performance on one variable is dependent on other variables.

Results of a 3-way with-in groups ANOVA showed a significant main effect of color combination (F (5,200) =2.27, p<.05). GN/Y had the fastest RT (x=16457.98), and R/GN had the slowest (x=17894.07); all other color combinations fell between with close RT's. Times NR font type (x=16746.87) was significantly faster than Arial (x=17700.85; F (2,80) =3.19, p<.05).

There was a significant two-way interaction between color combination and font type (F (10,400) =3.07, p<.001); GNY/Courier New (x=15252.84) and GNY/Times NR (x=15411.96) had the fastest color/font interaction RT's, with GNY/Arial (x=18709.13) and RGN/Courier New (x=18883.66) having the slowest RT's. The reaction time of other font types also depended upon color combination. The interaction between font type and word style was also significant(F(2,80)=5.25, p<.01). Arial/italicized (x=18517.42) was significantly slower than Times NR/italicized (x=16637.74), Times NR/Arial (x=16856), and Arial/plain (x=16884.28).

Finally, there was a significant three-way interaction between color combination, word style, and font type (F(10,400)=3.25, p<.01; see Figure 1). These results show that there is no one font or one color combination to use, but rather there are certain fonts that work better with certain color combinations. Although word style shows some interaction with other variables, generally plain word style is faster than italicized word style. An interest in the black on gray color combination developed once the data for the experiment was analyzed. Black on gray is the default for a popular Internet browser, and the question was posed if black on white would be a more "user friendly" color combination.

In an attempt to answer this question, a control experiment was setup to compare black on white to black on four variations of gray. The colors combinations used were black (RGB=0) on white (RGB=65535), black on light gray (RGB=56797), black on medium gray (RGB=48059), black on dark gray (RGB=30538), and black on very dark gray (RGB=21845). "Medium gray" is the Netscape default, and "dark gray" is the gray used in the original experiment. This experiment used the exact same setup as the previous experiment, with the exception of not using Courier New font type, and 10 of the 30 text selections were eliminated. There were twenty-one participants, and it took them thirty minutes to one hour to complete the experiment. The means for each condition are illustrated in Figure 2.

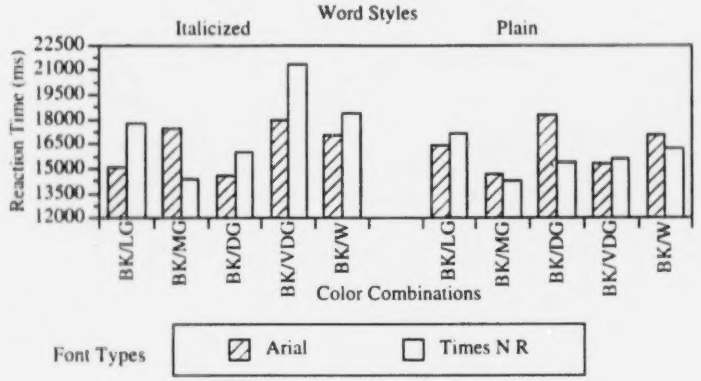

Figure 2: Means for all conditions (gray combinations, font types, and word styles). Plain text conditions are significantly faster than italicized. Again, performance on one variable is dependent on the other variables.

Surprisingly, black on medium gray (x=15215.21) and black on dark gray (x=16088.70) had significantly faster RT's than black on white (x=17176.3; F (4,80)=3.37, p<.01). Plain word style (x=16052.53) was still significantly faster than italicized (x=17025.69; F (1,20)=5.22, p<.03), and unlike before, there was no significant difference between the two fonts. There were significant two-way interactions between color combinations and font types (F(4,80)=2.46, p<.05). Times NR had more variability across color combinations than did Arial font type. The medium gray/Times NR combination had the fastest RT (x= 14350.80), yet very dark gray/Times NR had the slowest RT (x=18505.95). There were also significant interactions between color combinations and word styles (F(4,80) =3.06, p<.02). Very dark gray/italicized had the slowest RT (x=19647.46), and medium gray/plain (x=14497.40), and dark gray/italicized (x=15347.57) has the fastest RT's.

DISCUSSION

As predicted, significant main effects and interactions were found for font type, word style, and color combination. For example, plain text is consistently responded to more quickly than italicized. These main effects suggest that one can make general recommendations to screen display designers. However, the significant interactions highlight the fact that there is no one color combination, font type, or word style to use, but rather all conditions affect one another. In Figure 2, compare the results of Arial/italicized to Arial/plain. Notice how within each of the gray combinations, the results "flip-flop" between italicized and plain. This type of interaction was true of other variable combinations across conditions, which means a designer must consider a variable's influence on all other variables. This interaction of variables is not mentioned in current manuals; hopefully, future manuals will address such interactions.

From these results, one can say that contrast affects legibility, but unfortunately, it does not seem to be as simple as high contrast being better than low contrast. In the main experiment, GN/Y had the fastest RT's, and in the control experiment, medium gray, and dark gray had the fastest RT's. In neither experiment did the BK/W condition show the fastest RT's. These results show that these participants had faster response times when more median contrasts were used. These results supported Powell (1990), who suggested avoiding sharp contrasts, but did not fully support Rivlen et al (1990), who suggested maintaining high contrast.

According to a manual by AT&T (1989), the direction of the contrast (dark on light, or light on dark) might also affect legibility. When light text is placed on a dark background the text may seem to glow and become blurred; this is referred to as halation, and it may make the text harder to read. Some evidence for an effect of halation was found in the current experiment. The mean RT for light text on a dark background was $x=17559.24$, while the mean RT for dark text on a light background was $x=16909.33$. This finding might also be attributable to a subject experience factor due to the frequency of dark text on light backgrounds; more research is needed on this topic before any strong recommendations can be made.

Several of the contradictions discussed in the literature review were addressed in this experiment. Powell (1990) suggested the color combination of red on green, and warned against black on white. Yet in the main experiment, red on green was found to be the worst color combination, and black on white to be one of the best. The results show significant main effects between the serif and sans serif fonts; which supports Horton (1990) and Tinker (1964). However, the results contradicted those of Helander et al. (1984), who found that proportionally spaced font was faster. In this experiment, Times NR (proportionally spaced) was faster than Courier New (non-proportionally spaced), while Arial (proportionally spaced) was slower than Courier New. There is no simple explanation for all the current findings, but, hopefully this research and further research on this topic can and will be beneficial to webpage designers.

REFERENCES

AT&T. "OPEN LOOK: Graphical User Interface Application Style Guidelines." Sun Microsystems, Inc. New York. 1989.

Chinell, David F. "System Documentation: The In-Line Approach." John Wiley & Sons. New York. 1990.

Dumas, Joseph S. "Designing User Interfaces for Software." Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 1988.

Galitz, Wilbert O. "It's Time to Clean Your Windows: Designing GUIs That Work." John Wiley & Sons, Inc. New York: 1994.

Helander, Martin G., Patricia A. Billingsley, and Jayne M. Schurick. "An Evaluation of Human Factors Research on Visual display Terminals in the Workplace." The Human Factors Review. Santa Monica, CA: Human Factors Society, 1984, 55-129.

Horton, William K. "Designing and Writing Online Documentation." John Wiley & Sons. New York, NY, 1989.

Kruk, R. S. and P. Muter. "Reading Continuous Text on Television Screens." Human Factors, 26,3 (1984): 339-345.

Powell, James E. "Designing User Interfaces." Microtrend Books. San Marcos: 1990.

Rivlin, Christopher, Lewis Robert, & Rachel Davies-Cooper. "Guidelines For Screen Design." Blackwell Scientific Publications. Oxford: 1990.

Schmandt, Christopher. "Color Text Display in Video Media." In Color and the Computer. Boston: Academic Press, 1987: 255-266.

Trollip, S.and Sales, G., "Readability of computer-generated fill-justified text." Human Factors, 1986, 28, 159-164.

Tinker, M. "Legibility of Print." Ames, IA: Iowa State University Press, 1969.

The Relationship Between the Protestant and Catholic Religions and Guilt

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The theological and philosophical differences between Catholic substance and Protestant principle are well documented. The attitudes and belief systems propagated by each have much to do with the way guilt is perceived by individuals within these two styles of worship. The hypothesis of this study is that Catholics have higher guilt scores than Lutherans, and higher religiosity results in more guilt. Thirty nine college students completed a Situational Guilt Scale and a Religion Scale. In partial support for the hypothesis, higher religiosity scores correlated with higher guilt scores for Lutherans, r=.58, p=.006. Discussion will focus on limitations of the sample and implications for understanding these results.

BACKGROUND

The theological and philosophical differences between Catholic substance and Protestant principle are well documented. The attitudes and belief systems propagated by each have much to do with the way guilt is perceived by individuals within these two styles of worship.

The Protestant principle involves the idea of questioning everything. It takes no definite form, except the Gospel, and encourages free thought. It contains ambiguity, relativism, diffusion and autonomy. Protestant scholars have tried to wrestle with the possibility of autonomy within the realm of Christian thought (Adams, 1965). The implication here is that humanity has been granted a certain autonomy by God and if given enough insight a person could control one's own destiny, to sin or not to. The concept of sin from an autonomous standpoint questions the legitimacy of guilt and the acknowledgment of the judgment. If a person commits an act that is deemed sinful by the church, others, or oneself, then additional emotions or behaviors may be acknowledged as guilt. With rational thinking and individual focus these issues can be easily addressed. The idea here is that the aim of Protestantism is to not get caught up in the means but instead to look toward the purpose, Heaven.

Catholic substance, on the other hand, has definite content and form. There is certainty, absolutism, and foreclosure (Adams, 1965). Catholic church rules are designed to alleviate guilt through penance, and to further this concept, the act of forgiveness is administered through a church official. Faith in its rituals may give Catholics a propensity to dwell on their sin and guilt. Since it is true of Catholic life that a person need not commit a sinful act to be a sinner, and just the thought of such acts are transgressions unto themselves, then this seems to be the inherent psychic dilemma for the Catholic faith. An unquestioning devotion to the church combined with an emphasis that all sins be confessed would lead to an unequal fixation on sin and guilt.

Within these two differing bodies of Christian philosophy, many questions have been raised relating to feelings of culpability as manifested in guilt. Although there is not a precise definition of guilt, self reproach, self punishment and remorse seem to be a central theme.

These two religious philosophies offer extensive avenues for contemplation, be it autonomous thought or deeply rooted ritual.

A comparative analysis of Protestant and Catholic guilt association has yet to be done. As has been discussed, adherence to the Catholic faith allows many instances of guilt preoccupation, therefore it is proposed that adherence to the Catholic faith will result in higher guilt than adherence to the Lutheran faith. Further predicted is that overall Catholics will have higher guilt scores than Lutherans, and higher religiosity with either faith will result in more guilt.

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METHOD

Subjects

Subjects in the study were male and female students enrolled in classes at a Liberal Arts College in the upper midwest. Information was requested voluntarily from three introductory psychology classes, a third level psychology class, and a third level religion class to ensure a large sample size. There were 58 students given the opportunity to participate voluntarily in this study. Their ages ranged from 19 to 28.

Apparatus

Subjects were asked to answer survey questions to measure guilt association with the Situational Guilt Scale (Klass 1983, 1987). Attitude toward the value of and acceptance of a religious way of life were measured using The Religion Scale (Bardis, 1961). In addition, subjects were asked what religious background they were brought up in. Those specific subjects who indicated Lutheran or Catholic were used in the comparative study.

The Situational Guilt Scale, or (SGS) is a self reported survey that measures the degree of anticipated guilt feelings for a wide range of naturally occurring stimulus situations (Klass 1983, 1987). Subjects are presented with 22 separate situations and are asked to imagine themselves in that particular situation. Then they indicate the intensity of their emotional reaction on four dimensions (regret, self-disappointment, guilt, and shame) using a 1 to 5 Likert scale. Higher scores indicate higher guilt. The measure yields a Total Guilt Score and several subscale scores including Interpersonal Harm Guilt, Norm Violation Guilt, and Self-Control Failure Guilt (Klass 1983, 1987). The (SGS) reported a Cronbach Alpha coefficient of .92 and a test-retest reliability of .90 for Total Guilt as well as acceptable construct, convergent, and discriminant validity (Klass-1983, 1987).

The Religion Scale is a 25-item, Likert type scale developed to measure positivity of attitude toward religious faith and other religious referents (Bardis, 1961). The measure reports a split-half reliability of .90, based upon an N of 130. The items were selected to discriminate between high and low scorers, high scores indicate positive attitudes toward religion. This scale has test-retest reliabilities of .94 and .84 based on samples of 52 subjects.

Scales were piloted on nine people to examine for time duration and problems including clarity, clerical errors, misinterpretations, ambiguity, and bias. Only one problem was identified. The Religion Scale (Bardis, 1961) lacked negatively phrased items. Accordingly, three items were reversed to discourage response sets. Confederates needed twenty minutes to complete surveys.

Analysis

Subjects were split out on the basis of their indication of Lutheran or Catholic background. The Situational Guilt Scale (Klass 1983, 1987) yields a total range of scores from 22 to 110 on each of the four dimensions (regret, self-disappointment, guilt, and shame). A t-test was used to determine significance between the Catholic and Lutheran mean scores on Total Guilt.

The Religion Scale has a total range of scores from 0 to 100. A comparison of correlation was used to determine adherence and explore the relationship between Catholic and Lutheran scores on Total Guilt. In this analysis, guilt scores were correlated with religious adherence for each of the two groups.

The last comparison involved differentiating between the two significant observed values of "r" for the Catholic group and the Lutheran group. If the observed value of "r" for the Catholic group was not significantly different from the observed value of "r" for the Lutheran group, I would not have support for my hypothesis that adherence to the Catholic faith would result in higher guilt than adherence to the Lutheran faith, and I would fail to reject the null and reason that these groups were similar distributions in the population.

RESULTS

Individual survey questions were intercorrelated to determine their reliability in measuring guilt and religiosity in the subjects I surveyed. Item intercorrelations were done for each scale to determine if specific questions were well designed for this study. Three questions were thrown out of each survey because they did not correlate significantly with the rest of the questions in the scales, $p > .05$. On the Situational Guilt Scale (Klass 1983, 1987), survey questions 2, 10, and 14 were omitted, and on The Religion Scale (Bardis, 1961), survey questions 9, 22, and 23 were dropped.

Survey information was compiled from five different classes to attain the representative sample. An analysis was done to compare the diverse data for congruity. T-tests for data relating to individual classes affirmed their similarity for combining.

Table 1

Comparison of Means and Standard Deviations by Class
t-tests for Independent Samples on guilt

	Catholic			*Lutheran*		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Class one	(3)	64.67	16.56	(6)	70.17	12.34
Class two	(5)	67.30	11.00	(7)	68.43	12.21
Class three	(5)	58.60	19.01	(2)	61.00	15.56
Class four	(5)	59.80	23.66	(5)	61.40	25.24
Class five	(0)	-----	-----	(1)	71.00	-----
Overall	(18)	62.36	17.08	(21)	66.67	15.43

(across classes)

An analysis for a difference in guilt between means of Catholics and Lutherans was done with a t-test. Significance was not established, $t = -.83$, $p = .41$. With the Catholic mean at 62.4 and the Lutheran mean at 66.7, the trend appeared to be in the wrong direction from what I predicted.

A correlation for the relationship between religiosity and guilt was done for Catholics and Lutherans. In partial support for my hypothesis, significance was found for Lutherans, $r = .58$, $p = .006$, indicating higher religiosity scores correlated with higher guilt scores for Lutherans. Significance was not found for Catholics in this sample, $r = -.12$, $p = .63$.

The last comparison was not performed to determine if adherence to the Catholic faith would result in higher guilt than adherence to the Lutheran faith, because
there were not two significant correlations to differentiate between.

DISCUSSION

I reasoned that in light of particular instances of guilt preoccupation in the Catholic faith, adherence to the Catholic faith would result in higher guilt than adherence to the Lutheran faith. I could not provide credible empirical support for this prediction in the analysis of this data. In this sample, I did not find significance within the Catholic scores
on religious adherence relating to higher guilt to find support for higher guilt adherent Catholics in comparison to higher guilt adherent Lutherans. I believe I did not find support for the assumption that adherence to the Catholic faith would result in more guilt than adherence to the Lutheran faith because of the limited range of Catholic adherence in this study.

I further anticipated that Catholics would have higher guilt scores than Lutherans with an analysis of means between Lutherans and Catholics. Although without significance at $p > .05$, I found that Catholics did not have higher guilt scores in my study than Lutherans, rather they appeared about the same. Again I believe I did not find support for this assumption because of the limited range of Catholic adherence in this study.

Table 2

Descriptive Statistics for Catholics and Lutherans on Religious Adherence (range 0-88)

	Catholic	*Lutheran*
Mean	40.39	53.12
Standard Deviation	18.22	15.94
Minimum	10.00	18.00
Maximum	67.00	80.00
N	18	21

I additionally predicted that higher religiosity would result in higher guilt for both religions. Higher religiosity did correlate with higher guilt for Lutherans, but I did not find support for Catholics. I actually found, although insignificantly, contrasting patterns in this data suggesting a difference in adherence patterns between Lutherans and Catholics.

The data for this study came from one source, a private Lutheran college. The sample included a good number of adherent Lutherans, but unfortunately adherent Catholics were relatively underrepresented in this study.

To continue this study I would like to find a more diverse sample in which a range of adherence for Lutherans and Catholics conceivably would be included. I could make use of a public university where a more diverse sample could possibly be found and repeat the study, or give the Situational Guilt Scale (Klass 1983, 1987) and the Religion Scale (Bardis, 1961) to a private Catholic college, similar in characteristics to the college this sample was drawn from, and compare the additional data.

Future directions to build on would be age as an additional variable. Different stages of growth affect religious adherence. Young people tend to positively accept their parents' religious views unquestionably at an early age. On the other hand, adolescence appears to be a time for individual personhood and development of personal autonomy when peers may become more important and parents less influential. Do patterns of adherence vary between these two religious backgrounds, and if so is age the determining variable? Similarly, college adjustment involves diminished parental influence and increased peer influence. Could a pattern of diminished adherence between these two religions result in varying instances of guilt? Therefore college adjustment could also be tapped into as an additional factor in assessing guilt between these two religious backgrounds.

REFERENCES

Adams, J. (1965). Paul Tillich's Philosophy of Culture, Science, and Religion, 26.

Adams, J. (1948). The Protestant Era, 165, 289.

Bardis, P.D. (1961). A Religion Scale. Social Science, 36, 120-123.

Hailparn, D., & Hailparn, M (1994). Treating the Catholic patient: Unique dynamics and implications for psychotherapy. Journal of Contemporary Psychotherapy, 24, 271-279.

Klass, E. T. (1986). Situational approach to assessment of guilt: Development and validation of a self-report measure. Journal of Psychopathology and Behavioral Assessment, 9(1), 35-47.

Rickner, R., & Tan, S. (1994). Psychopathology, guilt, perfectionism, and family of origin functioning among Protestant clergy. Journal of Psychology and Theology, 22, 29-38.

Robertiello, R. & Gangier, T. (1990). Shame, Shame. Journal of Contemporary Psychotherapy, 20, 118.

Shaw, M.E., & Wright, J.M. (1967). Scales for the Measurement of Attitudes, 341-342.

Worthen, V. (1974). Psychotherapy and Catholic confession. Journal of Religion and Health, 13, 275-284.

Locus of Control and Superstitious Behavior: A Visit to the Putting Green

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Forty-two college students were required to successfully sink six five-foot putts on an indoor, astro-turf covered plywood putting green. Prior to each attempt, students chose one of five different colored balls from a bucket. The color of the balls used for each successful putt and for the subsequent attempted putt were recorded. Superstitious behavior was defined as choice of the same color ball following a successful putt. Based upon similar research focusing on chance orientation (Van Raalte et al., 1991) it was predicted that individuals internal in locus of control (Rotter, 1966) would be more likely to exhibit superstitious behavior. Directional support for the hypothesis was found. Alternative interpretations of the data are considered, based upon superstitious avoidance of balls following missed putts.

BACKGROUND

The employment of superstitious behavior is a common practice across a variety of cultures. In ançient times, individuals were sacrificed to appease the gods. This ritualistic act was deemed necessary in order to increase chances of survival. While today's society has abandoned the ritualistic act of human sacrifice, many less extreme forms of superstitious behavior still exist. Many people are afraid to walk under a ladder or to have a black cat cross their paths. Athletes employ a number of rituals to "enhance" their performances. However, it is difficult to point to specific reasons for believing in the efficacy of superstitious behavior.

A number of factors can be taken into account when investigating superstitions. One possible factor is locus of control. Individuals who are internal in locus of control believe they possess the abilities and skills to influence their surroundings. People who are external in locus of control attribute situational occurrences to chance, luck, or some factor outside of their control. The extent to which an individual believes to control one's life could influence whether or not the person practices superstitious behavior.

Superstitious behavior also can serve as positive reinforcement by allowing individuals to function better. Several previous studies have examined superstitious behavior. Wyrostok (1995) examined the use of rituals as a form of therapy to help individuals cope with grief and anxiety. Becker (1975) found that athletes who use superstitious behavior have a greater sense of confidence and control in a sporting event. Neil (1980) also researched the use of rituals among athletes and found that superstitious behavior lowered anxiety and helped athletes manage stressful situations. The use of rituals as a therapeutic device can help individuals gain a sense of control and reduce feelings of anxiety.

Additional studies have explored the downfalls associated with superstitious behavior. Tobacyk and Shrader (1991) found that individuals measuring high in superstitious beliefs also had low self-efficacy scores. Berman (1991) found that many people have rituals against boasting because these individuals are afraid to tempt fate. White and Liu (1995) examined the behaviorist view on superstition and found that a superstitious response can be reinforced and maintained by associating superstitious behavior with inappropriate events. Individuals can be misled into thinking their rituals influence events occurring in another place.

Locus of control also has been examined in several previous studies. Burger (1991) found that lottery players measuring high in desire for control were more likely to choose their own lotto numbers than have a machine select their numbers. Matute (1994) conducted an experiment to examine learned helplessness in participants when exposed to uncontrollable noise. While Matute expected to observe learned helplessness in an uncontrollable situation, participants employed superstitious behaviors and illusion-of-control effects. Superstitious behaviors allowed the participants to believe they had control in the situation.

The relationship between chance orientation and superstitious behavior was examined by Van Raalte, Brewer, Nemeroff, and Linder (1991). Individuals who are low in chance orientation are similar to people who are internal in locus of control. Low chance orientation individuals believe their actions can influence outcomes. However, individuals who are high in chance orientation, much like people who are external in locus of control, believe that events in life are beyond their control.

Van Raalte et al. (1991) found that participants low in chance orientation were more likely to practice superstitious behavior than individuals high in chance orientation. Participants who believed they could control chance events attributed a successful golf putt to a lucky ball, an example of superstitious behavior. The Van Raalte et al. study further confirms that a positive correlation exists between the perceived ability to control events and the use of superstitious behaviors.

The purpose of this study was to examine the relationship between locus of control and superstitious behavior. When performing in an activity, individuals who are internal in locus of control would be more likely to believe they can influence the outcome of the activity. In order for internally controlled individuals to perform with greater confidence and control, these individuals may use superstitious behavior. However, people who are external in locus of control would believe that their fate is already determined when they are asked to participate in an event. Therefore, these individuals would have no use for superstitious behaviors that could possibly reduce feelings related to a lack of control.

The independent variable in this study was a participant's measure in locus of control. The dependent variable was the measure of superstitious behavior the participant employed in a golf ball putting activity. Superstitious behavior constituted the use of the same color ball following a successful putt. It was predicted that individuals internal in locus of control would be more likely to exhibit superstitious behavior than individuals external in locus of control.

METHOD

Participants

Forty-two Hendrix College General Psychology students (24 women and 18 men, mean age = 19.1 years) participated in the study. Participants volunteered to take part in the study, and the participants signed up in groups of two. Each individual received bonus points in exchange for participation.

Materials

An astro-turf covered plywood sheet measuring 4 feet in width and 8 feet in length served as the putting area. The hole or "cup" was positioned 5 feet away from the area where participants stood when attempting a putt. Two 12-inch bricks also were wrapped in astro-turf and placed in a "V-shaped" position behind the hole. The bricks served as deflectors and helped to make the task less difficult. Participants could make the balls deflect off the bricks and into the hole or putt the ball directly into the hole to complete a successful putt. A two-way putter was used as the golf club so that both left-handed and right-handed participants were able to attempt the putts. Golf ball colors were red, yellow, blue, silver, and brown. The brand labels on all of the balls were covered, and a ball's color was the only way to distinguish one ball from another ball. A total of 30 balls, 5 of each color, and 6 small buckets also were required. At the conclusion of the putting task, participants answered demographic questions, completed the Rotter Internal - External Scale (Rotter, 1966), and filled out a post-experiment reaction inventory. Demographic information included gender, age, and classification. The post-experiment reaction inventory served as a

814

manipulation check, and it allowed the participants to express their views about the study. Participant numbers appeared on all pages of the questionnaire packet.

Rotter Internal - External Control Scale. Rotter (1966) constructed this scale to measure locus of control. This inventory consisted of 29 forced-choice items. Six of the items were filler items, and scores could range from a high of 23 to a low of 0. A high score indicated that an individual was external in locus of control, and a low score predicted that an individual was internal in locus of control. This inventory has a test-retest correlation between .49 and .83 and an internal consistency rating from .65 to .79.

Procedure

Participants reported to the designated research site in groups of two. Six participants took part in the study each hour. When participants arrived at the research location, they were greeted by the experimenter. The experimenter told participants that they were going to take part in a study designed to measure hand-eye coordination. This explanation was necessary to serve as incentive for participants to perform as well as possible on the task. Participants putted until they had sunk 6 successful putts. Each successful putt had to be made using a ball from each of the 6 buckets.

The experimenter stood near the hole. After each putting attempt, the experimenter recorded the color of the ball and if the putt was or was not successful. Following a successful attempt, the experimenter allowed the participant to choose a ball from the next bucket of balls. After an unsuccessful attempt, the experimenter placed the missed ball back into its original bucket. The participant then chose any ball to putt from the same bucket. This process continued until each participant had made 6 successful putts with a ball from each bucket. Superstitious behavior was considered if the participant selected the same color ball following a successful putt more frequently than chance selection would suggest. Superstitious behavior scores could range from a low of 0 to a high of 5, and each participant was assigned a superstitious behavior score based upon this 6-point Likert scale.

After each participant completed the putting task, the experimenter explained to the participant that his or her hand-eye coordination was normal. Then, each participant was instructed to complete the questionnaire packet. A full debriefing occurred at a later date after all participants completed the experiment. The experimenter addressed the entire group of participants and explained the purpose of the study and answered questions.

RESULTS

The primary mode of analysis involved independent t tests, and an alpha level of .05 was used to assess statistical significance in all analyses. The hypothesis received directional support, but no statistical significance was evident in any analysis.

Participants were divided into an internal or external group according to their locus of control scores. Scores higher than 11 were counted as external, and scores of 11 and below were recorded as internal. Superstitious behavior scores were matched with the corresponding participant in either the external or internal group. Table 1 includes the mean superstitious behavior scores for participants who were external and internal in locus of control. The difference between superstitious behavior scores for externals and internals was not significant, t (34) = .25, p = .80. Directional support for the hypothesis was evident.

Table 1: Mean Superstitious Behavior Scores and Locus of Control

Locus of Control	Superstitious Behavior
Internal	1.50 (1.29)
External	1.39 (1.46)

Note. Numbers in parentheses represent standard deviations. Data consist of scores obtained from all 42 participants.

In order to more adequately assess locus of control, participants whose locus of control scores ranged from 8 to 15 were eliminated, and separate t tests were performed. Table 2 illustrates the mean superstitious behavior scores for 12 participants who scored most external and 12 participants who scored most internal. The difference between superstitious behavior scores for these externals and internals approached marginal significance, $t(22) = 1.65$, $p = .11$. Directional support for the hypothesis was revealed.

Table 2. Mean Superstitious Behavior Scores and Most Extreme Locus of Control

Locus of Control	Superstitious Behavior
Internal	2.08 (1.38)
External	1.17 (1.34)

Note. Numbers in parentheses represent standard deviations. Data consist of scores obtained from highest 12 locus of control scores (external) and lowest 12 locus of control scores (internal).

At the conclusion of the study, a different type of superstitious behavior was examined. This type of superstitious behavior involved avoidance of the same color ball following an unsuccessful putt. A chi square comparison with the basic two cell design containing locus of control (internal and external) and same color after an unsuccessful putt (yes and no) was conducted. Locus of control scores were used for 12 participants with highest external scores and 12 participants with the highest internal scores. Table 3 illustrates the relationship between locus of control and superstitious avoidance behavior. Externals displayed greater avoidance superstitious behavior, $\chi^2(1, N = 39) = 3.12$, $p = .08$.

Table 3. Superstitious Avoidance Behavior and Locus of Control

Avoidance Behavior	Internal	External
Yes	17 (19.23)	13 (10.77)
No	8 (5.77)	1 (3.23)

Note. Numbers in parentheses represent expected frequencies. "Yes" in avoidance behavior indicates a participant avoided balls following missed putts, and "No" in avoidance behavior indicates a participant did not avoid balls following missed putts.

Results from this study also indicate no gender difference in superstitious behavior or locus control. Males and females appear to measure similarly in both superstitious behavior and locus of control.

DISCUSSION

The results indicate both directional support and rejection for the hypothesis. When superstitious behavior is defined as choice of the same color ball following a successful putt, directional support is provided for the hypothesis. However, if superstitious behavior is defined as the avoidance of the same color ball following an unsuccessful putt, the hypothesis is rejected.

The initial means of measuring superstitious behavior was a participant's selection of the same color ball after a successful putt. When superstitious behavior is defined in this manner, internally controlled individuals demonstrate more superstitious beliefs than externally controlled individuals.

This relationship between locus of control and superstitious behavior is evident to a greater extent when an individual is highly internal or highly external. When locus of control scores clearly place an individual into the internal or external category, internals appear to be much more superstitious than externals. This finding provides support for the Van Raalte et al. (1991) study, which defined superstitious behavior in a similar fashion. Both the Van Raalte et al. finding and the results obtained in this study provide evidence that internals practice more superstitious beliefs than externals when superstitious behavior involves maintaining good luck.

However, when superstitious behavior is based upon the avoidance of balls following unsuccessful putts, results indicate an alternative explanation for the relationship between locus of control and superstitious behavior. This study has indicated that externals are much more superstitious than internals when superstitious behavior involves avoiding bad luck.

The Van Raalte et al. (1991) study did not mention any results pertaining to superstitious avoidance behavior. Therefore, this study may be the first to assess locus of control and type of superstitious behavior employed by individuals. Internals appear to be more superstitious in a situation where the maintenance of good luck is desirable, and externals seem to be more superstitious in a situation where the avoidance of bad luck is beneficial. However, more research is necessary to support this finding on locus of control and superstitious behavior.

Potential problems in this study also may have contributed to confounded results. The 5 golf balls did not lie evenly at the bottom of each bucket. One ball was positioned higher than the others, and the participants may have selected the top ball because it was at the top of the bucket. However, a participant's fondness or dislike for a particular color should have allowed this individual to choose a ball located at any position in the bucket.

Another potential problem could involve the participant's knowledge about the study. If a participant knew the underlying purpose of the study, this individual's data could have skewed the results. However, the post-experiment reaction inventories revealed that the majority of the participants who believed something more than hand-eye coordination was being measured did not believe superstitious behavior was involved. Many participants thought perseverance was being assessed. Therefore, a participant's knowledge about the study can be eliminated as a possible problem.

This study provides evidence of some type of relationship between superstitious behavior and locus of control. However, more research between these concepts is necessary in order to make a valid statement as to the exact nature of the relationship between superstitious beliefs and locus of control.

REFERENCES

Becker, J. (1975). Superstition in sport. International Journal of Sport Psychology, 6, 148 - 152.

Berman, D. (1991). Freud on endopsychic superstition. Irish Journal of Psychology, 12, 66 - 75.

Burger, J.M. (1991). The effects of desire for control in situations with chance-determined outcomes: Gambling behavior in lotto and bingo players. Journal of Research in Personality, 25, 196 - 204.

Matute, H. (1994). Learned helplessness and superstitious behavior as opposite effects of uncontrollable reinforcement in humans. Learning and Motivation, 25, 216 - 232.

Neil, G. (1980). The place of superstition in sport: The self-fulfilling prophesy. Coaching Review, 3, 40 - 42.

Rotter, J.B. (1966). Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 80, 1 -28.

Tobacyk, J.J., & Shrader, D. (1991). Superstition and self-efficacy. Psychological Reports, 68, 1387 - 1388.

Van Raalte, J.L., Brewer, B.W., Nemeroff, C.J., & Linder, D.E. (1991). Chance orientation and superstitious behavior on the putting green. Journal of Sport Behavior, 14, 41 - 50.

White, A.P., & Liu, W.Z. (1995). Superstitious learning and induction. Artificial Intelligence Review, 9, 3 - 18.

Wyrostok, N. (1995). The ritual as a psychotheraputic intervention. Psychotherapy, 32, 397 - 404.

817

Effects of Long-Term *Ad Lib.* Feeding on the Weight and Health of Differentially-Reared Laboratory Rats

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Excessive eating is considered to be the primary factor that contributes to weight gain in many organisms. We assume that the more food that is presented to an animal, the more the animal will eat, and the heavier the animal will become. The current study investigated the effects of *ad lib.* feeding for 14 months on weight and health of 48 Long-Evans hooded rats raised under different handling and grouping conditions. The results indicated that long-term *ad lib.* feeding resulted in excessive weight gain in male subjects but not in female subjects, regardless of rearing conditions. Results suggested that the fitness of laboratory animals may be compromised when animals are fed on a free-feeding basis.

INTRODUCTION

Laboratory rats serve as subjects for a wide variety of behavioral studies. In this role as experimental subjects, rats are frequently tickled, scratched, petted, carried to and fro, and handled extensively during the course of an experiment. Such handling may sometimes have profound and unanticipated effects on the subject (Davis & Perusse, 1988). Researchers are aware that maintaining a high level of health in their laboratory animals is essential for acquiring valid data during experimental manipulations. Both the rate of development that is present early in the animal's life and the total weight of the animal throughout its life are considered good measures used to assess the health of the laboratory rats. However beyond the first 4 months of life for laboratory rats, limited growth data have been published (e.g. Charles Rivers Laboratory (CRL), 1997; Poiley, 1972).

The growth of animals, both functionally and structurally, is determined partly by genetics and partly by environment (Roubicek & Ray, 1971). Past research suggests that weight gain in rats may be affected by the conditions under which it is raised (Bernstein, 1952; McClelland, 1956; Denenberg & Karas, 1959; Ruegamer, Bernstein, & Benjamen, 1954; Sobel, Zuppinger, & Joss, 1979). Weininger, McClelland, & Arima (1954) stated that rats that were "gentled" by being held and stroked for a few minutes each day increased their rate of growth compared to those not gentled. Other investigators found that gentled animals showed a significant increase in body weight and skeletal length over non-gentled animals (Winokur, Stern, & Taylor, 1959). King (1969) reported no differences between handled and nonhandled rats. The reason for the possible effect of handling on growth is not known; however, metabolic or stress related factors may be involved (Ruegamer et al., 1954).

Another factor that may influence the weight gain of laboratory rats is the housing conditions in which the animals are raised. Weininger et al. (1954) reported that albino mice housed in group cages were heavier than mice

818

individually housed. They found that mice isolated in separate cages failed to grow as fast as those that were grouped two, four, or six in a cage. On the other hand, Fiala, Snow, & Greenough (1976), reported that isolated animals weighed more than grouped housed animals and suggested that the isolated animals may simply eat more to relieve the boredom of their situation.

Therefore, the purpose of the present study was to acquire growth data on laboratory rats over an extended period of time and to evaluate the effects of *ad lib.* feeding and environmental manipulations on the weight gain of male and female rats. In addition, we were interested in documenting weight gain over a long period of time. This study extends the findings of Lawrence, Doraiswami, & Stahl (1996), which reported the first 6 months of growth data from these animals.

METHOD

Subjects

Subjects were 48 Long-Evans hooded rats who were offspring of one of five timed-pregnant rats obtained from the Charles Rivers Laboratory (Portage, MI). They were studied from 21 to 441 days of age.

Materials

Food (Purina rodent pellets #5001), water, poly-carbonated cages, sawdust, and a weighing scale were the only materials required for this project. The animals were housed in an animal facility with a 12/12 light/dark cycle.

Procedures

Litter Consolidation. On the day after birth, pups were separated from their mothers and redistributed using a modified split-litter design. Litters were consolidated on day 1 so that each of the 4 mothers had 12 pups (6 male and 6 female). At the age of 14 days, dry food chow was placed inside of each cage to get the pups used to solid food.

Separation. On day 21, pups were separated from their mother (or foster mother), placed in poly-carbonated cages, and housed either individually or in same sex triads. Animals in group cages received ear clips for identification purposes.

Handling and Weighing. All animals were weighed every 3 days for 14 months. Twenty-four animals were handled every day for 4 weeks immediately after separation from their mother. The animals that were handled included 12 males and 12 females. Of the 24 animals in each handling condition, 12 were grouped into 4 groups of 3 rats, and the remainder were individually caged. Handling consisted of picking the subject up by the base of its tail or its body and holding it in the left hand. The experimenter's left arm was placed against his or her chest, so that the subject was secure, and the rat was stroked gently with the right thumb for 5 minutes continuously from the rat's head to the base of its tail. All handling and weighing took place during the middle of the light cycle. At 411 days of age, the group-housed individuals were separated and individually housed for the last stage of the study in which food intake was measured and then animals were transferred to a veterinary facility for necropsy and health assessment.

RESULTS

The results for male rats indicated that a combination of handling and environmental enrichment (group caging) resulted in the highest amount of weight gain while the combination of handling and non-enriched environment (single caging) resulted in the lowest amount of weight gain (shown in Figure 1). There was also a small difference in the weight gain between male group-caged and handled rats and male single-caged and handled rats. Differences are not significant with the exception of male grouped handled rats, and this may be compromised by litter effect; all males from the lowest weight litter happened to be assigned to the two low-weight handling and grouping conditions.

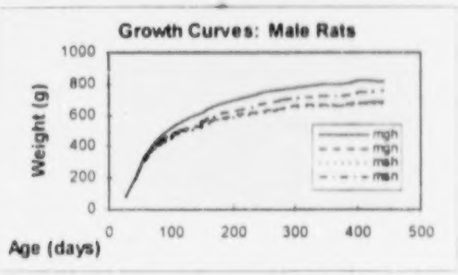

Figure 1. Growth curves for male rats in different rearing groups. In the legend titles, "m" = male, "g" = grouped housed, "s" = single housed, "h" = handled, and "n" = non-handled.

The results for female rats indicated that the single-caged handled rats weighed more than the other animals. In contrast to the findings with the male rats, the results for female rats (shown in Figure 2) indicated that the group-caged non-handled rats and single-caged handled rats had identical weights and demonstrated the highest weight gain while single-caged non-handled rats had the lowest weight gain. Surprisingly, there were no significant difference among the female rats.

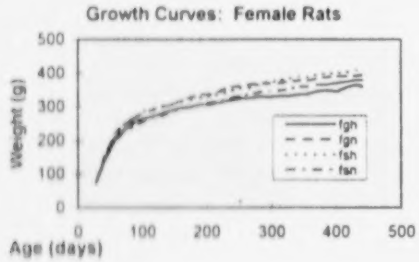

Figure 2. Growth curves for female rats in different rearing groups. In the legend titles, "f" = female, "g" = grouped housed, "s" = single housed, "h" = handled, and "n" = non-handled.

Other Health Related Findings. Although animals in our groups did not differ from one another, male rats gained more weight faster than those raised under comparable conditions at other facilities (CRL, 1997). As a result, the males as a group were quite obese by the end of the study. Necropsy revealed excessive adipose tissue in nearly all male subjects.

Females, on the other hand, maintained a rate of growth similar to that published by the animal supplier (CRL), although they developed more tumors and other related problems than did their male counterparts (see Table 1). One tumor was 8x8 cm and weighed 113g, severely impairing this individual's mobility. Beyond these findings, the rats exhibited no unusual pathology.

Examination of food consumption per unit body weight revealed that, at the end of the study, females ate significantly more food than males (5.0% vs 3.8% of body wt. daily; $F = 94.76$, $df = 1$, $p < .05$), indicating metabolic differences between the sexes at this time.

Table 1. Pathology report for selected rats.

Rat ID	Sex	Weight 1/7/97	Veterinary pathology report
1332	F	456 g	113 g mammary fibroandenoma
1334	F	389 g	streptococcal skin abscesses
1344	F	412 g	unidentified yellow nodules, excessive adipose tissue
1346	F	325 g	mild mammary gland cysts
1349	M	838 g	nephropathy, excessive adipose tissue
1351	M	940 g	nephropathy, excessive adipose tissue (largest male)
1355	F	326 g	nephropathy
1356	F	459 g	alopecia (hair loss)
1357	F	415 g	nephropathy
1358	F	488 g	excessive adipose tissue (largest female)
1362	M	746 g	excessive adipose tissue
1367	F	326 g	excessive adipose tissue
1369	F	330 g	nephropathy
1370	F	377 g	excessive adipose tissue

DISCUSSION

Handling and grouping, as we did there, did not have a significant impact on the growth rate of the animals; several rats appeared to be robust. The most impressive result of the study was that *ad lib* feeding, carried out over an extended period of time (14 months), resulted in extreme obesity in nearly all male rats, but not female rats. Whether the metabolic differences found at the end of the study were cause or effect of obesity, obesity is not known and will require further study. The results to date demonstrate that the health of laboratory animals is compromised when animals are fed on a free-feeding basis and suggest that researchers should control the daily diet of experimental subjects.

REFERENCES

Bernstein, L. (1952). A note on Christie's "experimental naiveté and experiential naiveté." Psychological Bulletin, 49, 38-40.

Davis, H., & Perusse, R. (1988). Human-based social interaction can reward a rat's behavior. Animal Learning and Behavior, 16, (1), 89-92.

Denenberg, V. H., & Karas, G. G. (1959). Effects of differential infantile handling upon weight gain and mortality in the rat and mouse. Science, 130, 629-630.

Fiala, B., Snow, F. M., & Greenough, W. T. (1976). "Impovished" rats weigh more than "enriched" rats because they eat more. Developmental Psychobiology, 10, (6), 537-541.

King, D. (1969). The effects of early experience and litter on some weight and maturational variables. Developmental Psychology, 1, (3), 576-584.

Lawrence, G. L., Doraiswami, A. K., & Stahl, J. M. (1996). Handling and caging influence the growth of laboratory rats. Poster presented at the Tenth National Conference of Undergraduate Research, Asheville, NC.

McClelland, W. J. (1956). Differential handling and weight gain in the albino rat. Canadian Journal of Psychology, 10, (1), 19-22.

Poiley, S. M. (1972). Growth tables for sixth-six strains and stocks of laboratory animals. Laboratory Animal Science, 22, (5), 759-779.

Roubicek, C. B., & Ray, D. E. (1971). Direct and transfer response of rats selected for growth at two environmental temperatures. Growth, 35, 1-10.

Ruegamer, W. R., Bernstein, L., & Benjamen, J. D. (1954). Growth, food utilization, and thyroid activity in the albino rat as a function of extra handling. Science, 120, 184-185.

Sobel, E. H., Zuppinger, K. A., & Joss, E. E. (1979). Effects of isolation, handling, and restraint on growth of rats. Growth, 43, 1-6.

Winokur, G., Stern, J., & Taylor, R. (1959). Early handling and group housing: effect on development and response to stress in the rat. Journal of Psychosomatic Research, 4, 1-4.

Weininger, O., McClelland, W. J. & Arima, R. K. (1954). Gentling and weight gain in the albino rat. Canadian Journal of Psychology, 8, (3), 147-151.

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Drug State Dependent Performance of Rats on a Hampton Court Maze

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State dependent learning (SDL), or dissociated, is demonstrated when information learned in one chemical state fails to transfer or only partially transfers when an organism is tested in a different chemical state. In the present study 12 naive male Long-Evans hooded rats learned the Hampton Court Maze under the influence of saline or one of various doses of morphine and then were tested in the other chemical condition. Results provided evidence of state dependent learning only at 15 mg/kg doses of morphine and saline. Most subjects demonstrated significant increases in the time it took to run the maze when changed either from the saline to morphine state or from the morphine to the saline condition.

BACKGROUND

State dependent learning (SDL), or dissociation, is exhibited when behavioral responses learned while an animal is under the influence of a centrally acting drug are performed most efficiently only when the same drug condition is reestablished (Combe, 1835, Overton, 1984). Research suggests that memory retrieval is impaired during tests performed without the drug or when the animal is under the influence of drugs different than the original drug and that the degree of the effect is usually related to the drug dose (Barry, 1974). Girden and Culler (1937) reported the first experimental demonstration of SDL while investigating the ability of dogs to acquire a conditioned leg flexion responses when paralyzed with curare. They noted that not only could such responses be learned, but that their subsequent performance was state dependent. More recently, Stahl and Pieper (1989) found evidence of SDL when they investigated the performance of rats on the Maier Three-Table Reasoning Problem. They found that rats that were given saline, morphine, or methadone for the two experiences and the test performed well on the task. However, rats given the two experiences in different drug states performed poorly.

In the past, the SDL phenomenon was tested using tasks that could be quickly learned by the rat such as step-through tasks, runway mazes, and T-mazes (Overton, 1974, 1991, Nishimura, Shiigi, & Kancto, 1990). Because these tasks are quickly learned and relearned, they may not be as sensitive to state-dependent changes in learning as a more complex task that entails an extended learning curve; therefore, we chose Small's Hampton Court Maze (Small, 1901). In Small's words, the Hampton course maze was developed to make observations upon the "free expression of the animal's mental processes, under as definitely controlled conditions as possible, and at the same time, to minimize the inhibitive influences of restraint, confinement and unfamiliar or unnatural circumstances (Small, 1901, p. 93)." Although many textbooks make reference to the Hampton Court Maze, very few experiments have been published using the maze. Furthermore, literature suggests that there are several unsolved problems with experimental design and methodology when it comes to state-dependent learning studies (Overton, 1974). Other plausible conclusions include significant behavioral effects, other than SDL, that can be produced by the drugs. Drug-induced SDL has not been investigated at length since about 1980 when it was concluded that the doses of psychoactive drugs normally used for outpatient treatment do not produce the phenomenon to an convincing degree (Eich, 1980, Lowe, 1982). Therefore, the present study was designed to expand upon past SDL studies by using the Hampton Court Maze, a task that is more difficult for the subject to learn.

METHOD

Subjects

Twelve experimentally-naive male Long-Evans hooded rats obtained from the Charles Rivers Laboratories (Portage, MI) served as subjects for this study. They were 94-107 days old and weighed between 309 to 349 gm at the start of the testing. The subjects were fed sufficient Laboratory Rodent Diet (#5110, PMI Feeds, Inc.) to maintain their weights at 85% of their *ad lib.* weights and were given water *ad lib.*

Apparatus

The Small (1901) Hampton Court Maze was modified for use in this study by placing a block at the one point at which Small's maze provided two correct paths to the goal. The maze, shown in Figure 1, had one correct route, requiring 42 turns and 7 decision points to reach the central goal box. The maze was 150cm long, 100cm wide, and 15cm tall, constructed of 1cm thick Thermasheth, making the apparatus lightweight to facilitate cleaning between subjects. Alleyways were 7cm wide, the central goal box was 25cm wide by 30cm long, and surfaces visible to the animal were painted flat black.

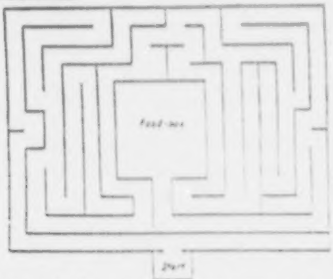

Figure 1. Revised Hampton Court Maze

Procedures

Handling and Adaptation. For five days prior to their first run of the maze route, subjects were familiarized with both the experimenter and the maze. The first 2 days each animal was handled and petted for 5 minutes each day. On the final 3 days, animals were carried to the test room in groups of 4, handled for 5 minutes, and then placed at the entrance of the maze. They were allowed to explore the entire apparatus for 30 minutes. The amounts of time that each animal urinated, defecated, squealed, and the percentage of the maze that each animal explored was recorded. No food was available during the adaptation period.

Drug Administration. Prior to the start of the maze-running sessions, each subject was given a 1ml injection of saline or morphine sulfate at doses of 6 , 10, and 15 mg per kg body weight. The subject was then placed in a holding box for 30 minutes before being put in the maze by a second experimenter for the first trial of the day. The animal tester did not know the dose of morphine or saline (0, 6, 10, or 15 mg/kg) that the animal had received.

The study functioned under an ABA design, with some subjects initially learning the maze after being injected with saline and others after receiving a dose of morphine. The criteria performance to change chemical conditions was defined as three consecutive days (15 trials) completing the maze with a stable running time (under 30 seconds) and no more than one error. After this level of performance was achieved, the injection experimenter switched the subject to another dosage level that was unknown to the animal tester.

Maze-Running Trials. Upon removal from the holding box, each subject was carried to the goal box of the maze and allowed to eat for 30 seconds. It was then retrieved from the goal box and placed in the start box. After 30 seconds had passed and the animal was facing the door, the experimenter lifted the door giving the rat access to the maze paths. If after 1 minute the animal had not left the start box, it was coached out of the box and the door was closed behind it. The animal was then given 5 minutes to reach the food in the goal box. The animal was given 5 sequential trials per day, five days per week. The amount of time it took the animal to reach the goal box, up to a maximum of 5 minutes, constituted a trial. If the animal did not reach the goal box within 5 minutes, it was retrieved from the maze, replaced in the start box, and the next trial began. At the end of the fifth trial, the animal was returned to its home cage and fed. Each animal was tested individually and at the same time each day. After each animal completed testing, the paper under the maze was removed and the floor was mopped.

Data Recording. As each subject ran the maze, the animal tester traced its route on a 4 ½ by 6 inch photocopied representation of the maze. Incorrect turns and paths that were retraced (errors) were marked with an "X" and then totaled at the end of the trial. The experimenters also noted (in seconds) latency to leave the start box once the door had been opened and running time from the start box to the goal box.

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RESULTS

After completion of the experiment, data representing drug dose, latency, running time, and errors for each trial were analyzed using SPSS for Windows. Descriptive analysis consisted of within-subject comparisons of performance before and after dose changes as well as between-group comparisons of animals who were in the different ABA conditions. The results demonstrated no evidence of state dependent learning at low doses; subjects tested on 6 mg/kg doses performed similarly on drugged and nondrugged states. However, at 15 mg/kg doses, the subjects demonstrated increases in the time it took to run the maze when changed either from the saline to morphine state or from the morphine to the saline condition (Figure 2). Their running times increased from an average of 18.6 seconds to an average of 73.2 seconds to complete the maze.

As shown in Figure 3, the average amount of time it took the subjects to learn the maze and complete it with the minimal amount of errors was about 14 days regardless of the drug condition under which that initial learning occurred. In addition, re-learning the maze after the initial state change took four to five days, which was more than the minimum amount of days required to meet criteria. Figures 4a, 4b, and 4c depict individual cases that contributed to these results.

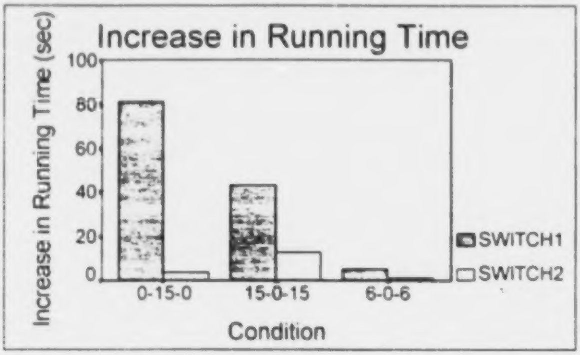

Figure 2. SWITCH 1 reflects average running time after the first condition change, SWITCH 2 reflects average running time after the second condition change. In Figure 2 and Figure 3, 0-15-0 indicates that animals were switched from saline to morphine to saline, 15-0-15 indicates that the animals were switched from morphine to saline to morphine, and 6-0-6 indicates that the animals were switched from a lower dose for morphine to saline to morphine.

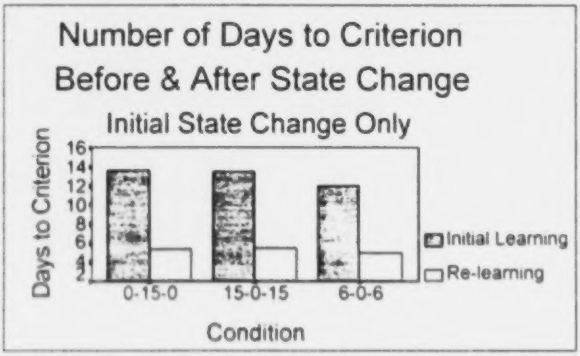

Figure 3. Initial Learning refers to the average number of days for subjects to perform to criteria before the initial state change. Re-learning refers to the average number of days for subjects to perform to criteria after the initial state change.

Figure 4a

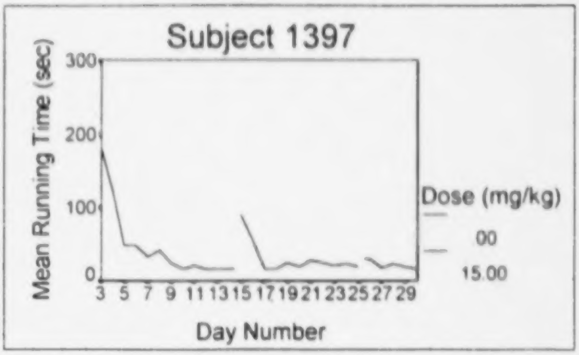

Figure 4b

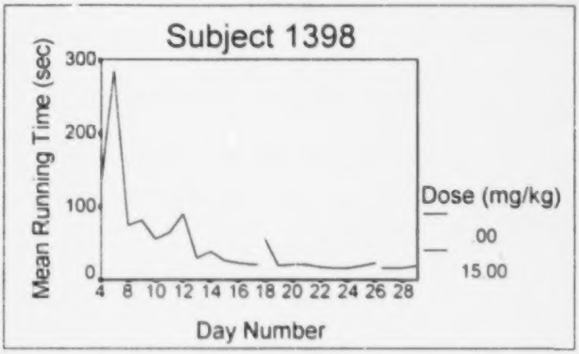

Figure 4c

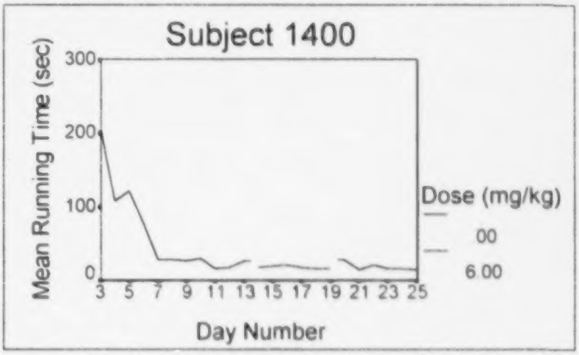

Figure 4a-4c. Figures reflect only the days in which subjects completed the maze.

DISCUSSION

The findings in the current study supported our hypothesis that the subjects' performances would suggest state-dependent learning. The increases in running time for subjects on high doses (15 mg/kg) were concluded to be the effect of state-dependent learning rather than more generalized drug effects because the change was just as significant going from morphine to saline as it was going from saline to morphine In addition, state-dependent learning appeared to be evident in that the subjects' running times and days to criterial performance after the second switch were considerably less than they were during initial learning and after the first switch However, the results did not support our hypothesis for subjects that were given low doses (6 mg/kg) which suggests that 6 mg/kg is not discriminable from saline

Twelve subjects have been tested in the first experiment We do not consider our findings to be conclusive until we test an addition 12 subjects with additional doses of the drug Future research can be done to make some detailed analysis so as to understand more about the role of neurotransmitter systems in specific processes involved in learning and/or retrieval

REFERENCES

Barry, H , III (1974) Classification of drugs according to their discriminable effects in rats Federation Proceedings, 33, 77, 1814-1824

Combe, G (1835) A system of phrenology Boston, MA Marsh, Capen, & Lyon

Eich, J (1980) The cue-dependent nature of state-dependent retrieval Memory and Cognition, 8, 157-173

Girden, E R , & Culler, E A (1937) Conditioned responses in curarized striate muscle in dogs Journal of Comparative Psychology, 23, 261-274

Lowe, G (1982) Alcohol-induced state-dependent learning Differentiating stimulus and storage hypotheses Current Psychological Research, 2, 215-222

Nishimura, M , Shiigi, Y , & Kancto, H (1990) State dependent and/or direct memory retrieval by morphine in mice Psychopharmacology, 100, 27-30

Overton, D A (1991) Historical context of state dependent learning and discriminative drug effects Behavioural Pharmacology, 2, 253-264

Overton, D A (1984) State dependent learning and drug discriminations In L L Iverson, S D Iverson, & S H Snyder (Eds) Handbook of psychopharmacology, Vol 18, (pp 59-127) NY Plenum

Overton, D A (1974) Experimental methods for the study of state-dependent learning Federal Proceedings, 33, 1800-1813

Small, W S (1901) Experimental study of the mental processes of the rat American Journal of Psychology, 12, 206-239

Stahl, J M , Pieper, W A (1989) Limitations of existing theory in explaining state-dependent performance of rats on the Maier three-table reasoning problem Drug development research, 16, 209-213

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Child Abandonment in St. Petersburg, Russia: Effect of Early Intervention

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The problem of child abandonment has long been neglected by society and preventive measures of this phenomenon remain poorly investigated. This study examined the rate of infant abandonment in two Maternity Hospitals in St. Petersburg, Russia from 1990 to 1995. Initially, both hospitals followed the traditional Russian practice of separating the mother and infant for 6-7 days after delivery. When one of the hospitals changed its practices to encourage early mother-infant contact, the abandonment rate at that hospital decreased by 34%. The abandonment rate in the control institution increased by 32% during the same period. Our results suggest that establishing early mother-infant contact may have a significant effect on infant abandonment.

BACKGROUND

Recent welfare reform has attracted strong attention to the problem of parental inadequacy and the phenomenon of infant abandonment (Frank, Klass, Earls & Eisenberg, 1996; Markel, 1995; Ralph, 1995). The rate of infant abandonment in the United States remains poorly investigated, although it has been estimated to be as high as 2% in some parts of the country (Abedin, Young & Beeram, 1993). International studies have shown that infant abandonment ranges from 0.4% in France (Dumaret & Rosset, 1993) and Thailand (Buranasin, 1991) to 4% in Romania (Johnson, Edwards & Puwak, 1993).

Numerous studies have shown that abandoned infants are at an increased risk for nosocomial infection (English, 1983; Frank et al, 1996), failure to thrive (Johnson et al, 1993), developmental delay, decline in IQ scores (Kaler & Freeman, 1993; Frank et al, 1996), permanent damage to personality and severe psychological disturbance (Burnstein, 1981). Despite the importance of the problem of child abandonment, research regarding possible preventative measures of this phenomenon has been very limited. Several reports have shown that establishing early mother-infant contact may reduce maternal inadequacy, including the rate of child abandonment (O'Connor, Viettze & Sherrod, 1980; Buranasin, 1991; Klaus, Kennel & Klaus, 1995).

This study compares the abandonment rate at two hospitals in Russia that follow different systems of mother-infant interaction during the early neonatal period. Both hospitals originally followed the strict Russian tradition of separating the mother and infant immediately after delivery and keeping them separated for the first week of life. One hospital, however, recently changed its practices to encourage early and prolonged interaction between the mother and her infant. The other hospital, acting as the control institution of this study, continues to separate the mother and infant at birth.

The problem of child abandonment has never been studied in the Soviet Union and post-communist Russia. The existence of the problem was denied and banned from discussion and publication for several decades (Lubimenko, 1996). The second goal of this study was to find reliable data on the rate of infant abandonment in the city of St. Petersburg and compare this to the rate of abandonment in other countries.

METHODOLOGY

The rate of child abandonment was studied at two large "Maternity Houses" of St. Petersburg, Russia over a six year period from 1990 to 1995. Maternity House #16 was chosen as the control institution because it continues to follow traditional Russian practices of separating the mother and infant at the time of delivery. Delivery service at Maternity House #16 follows the strict regulations of the Administration of Maternal and Infant Health of the Ministry of Public Health in Moscow. Six to eight mothers labor and deliver together and room together in the postpartum period. Immediately after birth, the infant is separated from the mother and taken to the nursery for an eight hour "stabilization period". The mother cannot see the infant during this time because she is in her "recovery period". If after eight hours of stabilization, the condition of the infant is considered satisfactory, the child is taken to the mother's room for a 30 minute feeding period under strict nurse supervision and then returned to the nursery. All feeding periods last only 30 minutes and occur six times per day. The infant remains in the nursery the remainder of the

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time (21 hours per day). Rooming-in is not permitted and fathers and other family members are not allowed to visit the mother or infant.

The abandonment rate was compared to Maternity House #11, which recently changed its practices regarding mother-infant interaction. Until mid-1992, Maternity House #11 followed the same system with six to eight mothers laboring, birthing and rooming together and keeping the mother and infant separated during their hospital stay without family visitation. By the end of 1992, with the help of a Swedish medical team, the hospital converted its services to comply with the UNICEF Baby Friendly Initiative. All patient's rooms were converted to private and semiprivate. Delivery services were changed so that each mother would deliver in separate rooms and the baby would not be separated from the mother following delivery. The regular nursery was closed. Rooming-in is maintained from birth to the time of discharge. The mother takes complete care of her child and breast feeding is encouraged. Fathers and family members are allowed to visit. The rate of abandonment at both institutions was studied three years prior and three years following the implemented changes at Maternity House #11.

Maternity Houses #11 and #16 are both state-run hospitals. They are 2.8 miles apart and serve similar socioeconomic communities. Mothers are sent to the Maternity House that is in their residential district.

According to Russian law, an infant is considered to be abandoned when the mother leaves the Maternity House after signing a release transferring custody of her child to the state. The number of births per year and the number of abandoned infants was taken from the log books kept by the Chief Doctors at both Maternity Houses. Separation time of the mother and infant was investigated using the log books of the corresponding nurseries. The rate of abandonment was calculated per 1000 deliveries per year at each hospital. The number of abandoned infants and the number of births in St. Petersburg was obtained from the Central Statistics Board of the Department of Public Health of the City of St. Petersburg and was provided by the Chief Neonatologist of the city, Dr. V. Lubimenko.

RESULTS

Table 1 presents the number of deliveries, number of abandoned infants, and the abandonment rate calculated per 1000 births at Maternity Houses #11 and #16. The table shows that the abandonment rate at Maternity House #16 remained stable at 44-52 abandoned infants per 1000 births until 1993 and then increased by 32% from the 1990 level. At Maternity House #11, the abandonment rate remained stable until the end of 1992 and then decreased by 34% in 1993-95. This significant decrease in the rate of infant abandonment corresponds to the time of conversion to the Baby Friendly System.

According to the Central Statistics Board of the Department of Public Health of St. Petersburg, there were 34423 births in St. Petersburg in 1995 and 1997 infants were abandoned. In 1995 the abandonment rate in St. Petersburg was 58.1 per 1000 deliveries.

Table 1. Number of births and abandonment rate at Maternity Houses #11 and #16

Year	Maternity House #11			Maternity House #16		
	Number of Births	Number of Abandoned Infants	Abandonment per 1000 births	Number of Births	Number of Abandoned Infants	Abandonment per 1000 births
1990	2539	12	4.7	3810	177	46.4
1991	1842	10	5.4	3670	192	52.3
1992	2035	12	5.9	3368	176	52.3
1993	1835	6	3.3	3098	138	44.5
1994	1646	6	3.6	3824	219	57.3
1995	1981	7	3.5	3872	268	69.2

DISCUSSION

The high rate of infant abandonment has been a significant problem in Russia for many centuries. Social programs established during the era of Catherine the Great, including paying large fees to women to find abandoned infants and care for them actually encouraged the practice of abandonment and helped make it socially acceptable (Ransel, 1976). We found that the abandonment rate in St. Petersburg, Russia in 1995 was 5.8%, which is higher than the rates that have been reported in other countries.

Despite the importance of the problem of child abandonment, studies of possible preventive measures are very limited. It has been debated whether the first hours and days of life are a sensitive period for the mother (Klaus et al, 1995). O'Connor et al (1980) showed that increasing mother-infant contact by six hours on days one and two of life decreased child abuse in the first 17 months of life. Siegel et al (1980) however, did not find a significant difference in the frequency of child abuse in a study with a similar design, but did observe parenting differences at a later age. When the initial mother-infant separation time was reduced from 6.3 to 1.6 hours and rooming-in instituted in a Thai hospital, child abandonment declined from 33 infants per 1000 to one in 1000 (Buranasin, 1991). A similar decrease in abandonment was also described when early contact and rooming-in was introduced in Costa Rica (Mata, Saenz & Araya, 1988). R. Fuchs (1987) found that if indigent women in the seventeenth century France breast fed their infants for the first eight days or longer, the abandonment rate was significantly reduced.

While abandonment at hospital #11 dropped by 34% following implementation of early mother-infant contact, the abandonment rate at hospital #16 dropped by 14% during the same time period and then rose briskly in 1994-95. In hospital #11, the abandonment rate held steadily during these years. Since in Costa Rica and Thailand simply closing the newborn nursery and having all mothers room-in with their infants significantly reduced the abandonment rates, it is our impression that close and continual early contact for mother and infant with rooming-in is responsible for the drop in abandonment.

Our results suggest that institutional policies can have a significant effect on the development of mother-infant interaction and as a result can change a phenomenon as profound as infant abandonment. Encouraging early and prolonged mother-infant contact may provide a possible low cost intervention to the urgent problem of infant abandonment.

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REFERENCES

Abedin M, Young M, Beeram M R. Infant abandonment: Prevalence, risk factors, and cost analysis. American Journal of Diseases of Children. Vol 147 (1993), pg 714-715

Buranasin B. The effect of rooming-in on the success of breast feeding and the decline in abandonment of children. Asia-Pacific Journal of Public Health. Vol 5 (1991), pg 217-220

Burnstein M H. Child abandonment: Historical, sociological and psychological perspectives. Child Psychiatry. Vol 11 (1981), pg 213-220

Dumaret AC, Rosset DJ. Trisomy 21 and abandonment. Infants born and placed for adoption in Paris. Arch. Francaises de Pediatre Vol 50 (1993), pg 851-57

English PC. Pediatrics and the unwanted child in history: Foundling homes, disease, and origins of foster care in New York City. Pediatrics. Vol 73 (1983), pg 699-711

Fomufod AK, Street AA. Rearing children in hospital facilities ("Boarder Babies"). Pediatrics. Vol 85 (1990), pg 137

Frank DA, Klass PE, Earls F, Eisenberg L. Infants and young children in orphanages: One view from pediatrics and pediatric psychiatry. Pediatrics. Vol 97 (1996), pg 569-578

Fuchs R. Legislation, poverty and child abandonment in nineteen-century France. Journal of Interdisciplinary History. Vol 18 (1987), pg 55-80

Hrdy SB. Fitness tradeoffs in the history and evolution of delegated mothering with special reference to wet-nursing, abandonment, and infanticide. Ethology and Sociobiology. Vol 13 (1992), pg 409-442

Johnson AK, Edwards RL, Puwak H. Foster care and adoption policy in Romania: suggestion for international intervention. Child Welfare. Vol 72 (1993), pg 489-506

Kaler SR, Freeman BJ. Analysis of environmental deprivation: Cognitive and social development in Rumanian orphans. Journal of Child Psychology and Psychiatry. Vol 35 (1993), pg 769-781

Klaus M, Kennell J, Klaus PH. Bonding. New York: Addison-Wesley; 1995

Lubimenko S. Chief Neonatologist, City of St. Petersburg. Personal contact, June, 1996

Markel H. Orphanages revisited. some historical perspectives on dependent, abandoned, and orphaned children in America. Archives of Pediatric and Adolescent Medicine. Vol 149

(1995), pg 609-610

Mata L, Saenz P, Araya JR, et al. Promotion of breast feeding in Costa Rica: The Puriscal study. Programmes to promote breast feeding. Oxford: Oxford University Press;1988

O'Connor S, Viettze PM, Sherrod KB, et al. Reduced incidence of parenting inadequacy following rooming-in. Pediatrics. Vol 66 (1980), pg 176-182

Pidcock FS. Child welfare: The phantom of the health care system. American Journal of Diseases of Children. Vol 145 (1991), pg 843

Ralph JC. Beyond orphanages. Pediatric News. Vol 2 (1995), pg 20
Ransel D. Abandoned children of imperial Russia: Village fosterage. Bulletin of the History of Medicine. Vol 50 (1976), pg 501-510

Siegel E, Bauman K, Schaefer S. Hospital and home support during infancy: Impact on maternal attachment, child abuse, and neglect, and health care utilization. Pediatrics. Vol 66 (1980), pg 183-190

Stephenson P, Wagner M, Serbenescu F. The public health consequences of restricted induced abortion - Lessons from Romania. American Journal of Public Health. Vol 82 (1992), pg 1328-1331

Parent and Adolescent Relationships as Predictors of Post Divorce Functioning

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While divorce research had typically focused on the emotional and behavioral problems of the children involved, recent studies have found many of these problems to be eliminated if the adolescent has a positive relationship with one or both of their parents. The present study extends this research by studying the effects of parent child relationships on adolescent functioning with in two years of a parent's divorce and following up their functioning five years later. Results found parent-child relationships to be better predictors of adolescent functioning than parental marital status for life satisfaction, self-esteem. Marital status only affected the adolescent's security with romantic partners.

BACKGROUND

How a parent's divorce effects adolescent functioning is a widely studied area. Much research has found divorce to place added difficulties on adolescent functioning, such as behavioral problems in school and emotional distress (Wallerstein, 1983a, 1983b; Hetherington, Cox, & Cox, 1985). While these studies are accurate in predicting the outcomes in some families, there are adolescents who continue to function normally after their parent's divorce (Barber & Eccles, 1992). Researchers often take divorce as a single factor in adolescent development and group all children who have undergone a divorce together, without looking at individual family circumstances. Normal functioning is more apparent when additional factors involved in the divorce, such as the parent-child relationships, are investigated (Hess and Camera, 1979; Forehand, Middleton, & Long, 1987; Wierson, Forehand, Fauber, & McCombs, 1989; Black & Pedro-Carroll, 1993).

Hess and Camera (1979) demonstrated the need for researchers to look beyond whether a child's parents were simply divorced or married in predicting functioning. They examined participants from divorced and intact families on school and social behaviors and on their relationships with other family members. Hess and Camera found that the family relationships were more valid predictors of the child's behavior than marital status, and that positive relationships resulted in lowering the detrimental effects commonly associated with divorce.

Wierson, Forehand, Fauber, & McCombs (1989) also examined whether good parent-child relationships can help buffer the detrimental effects often associated with divorce in boys between the ages of 10 and 15. Wierson et al. found that the adolescents in the divorced group had significantly higher levels of functioning if they had a good relationship with at least one parent as compared to a poor relationship with both parents. When comparing adolescents from divorced and married families, there were no significant differences in functioning as long as the adolescent had a good relationship with at least one parent. These results suggested that parent-child relationships can serve as a buffer against the detrimental effects of divorce, and can be better predictors of the functioning of adolescent than the martial status of the adolescent's parents.

Along with Hess & Camera and Wierson et al. a number of other researchers have also found the parent-child relationship to be a more adequate predictor of adolescent functioning than parental marital status (Peterson & Zill, 1986; Forehand, Middleton, & Long, 1987; Black & Pedro-Carrol, 1993). While these studies have contributed immensely to the knowledge about divorce, they do contain many limitations. For example, many divorce studies involve very small sample sizes, making it difficult to generalize the results to a larger population (e.g., Hess & Camera, 1979). Some sample populations are also drawn from clinical support groups (Wallerstein, 1983a, 1983b). These participants may exhibit more difficulties than participants who were randomly assigned because they have already indicated problem behaviors that need to be changed.

Additional problems in the existing research on adolescent functioning after a parent's divorce lie in the lacking of longitudinal studies. While the long-term effects of divorce have been investigated, (e.g., Hetherington, 1989; Wallerstein, 1983a, 1983b), few of these studies look beyond marital status when predicting adolescent functioning. Also, few studies provide a control for functioning prior to the divorce to determine if the adolescent's always exhibited problem behaviors or if these behaviors are a result of the added stress and pressures after the divorce.

Using a longitudinal approach, the present study hoped to address many of the limitations in current divorce research by examining parent-child relationships as predictors of adolescent functioning. There were two main hypotheses in this study. First, it was predicted that adolescents who have close relationships with at least one parent will have better adjustment in young adulthood than adolescents who are not close with either parent, regardless of whether the adolescents' parents are married or divorced (Wierson, & Forehand, 1992). Second, it was predicted that adolescents who have close relationships with both parents will have better adjustment in young adulthood than adolescents who are close only with one parent, regardless of whether the adolescent's parents are married or divorced (Hess & Camera, 1979).

Participants were 311 young adults and their biological mothers, sampled from the community. These individuals were assessed during the target child's early to middle adolescence (adolescent phase), with a follow-up assessment when the child was one year post-high school or at least 19 years of age (young adult phase). At the time of the initial assessment, all subjects from divorced families had experienced the recent divorce (less than 12 months) of their biological parents, as resided with their mother following the divorce. Ninety-nine of the participants had parents with intact marriages. Approximately six years after completing the adolescent phase of the project, participants were contacted and asked to participate in the young adult phase. Relationships were grouped according to whether the adolescents had close relationships at the time of first assessment with both parents, one parent, or neither parent. Functioning was controlled for at time one through the general and social sections of the teacher RSCC Harter (Harter, 1982) and the Revised Behavior Problem Checklist (Quay & Peterson, 1987).

RESULTS

Separate 2(married v. divorced) x 3(good relationship with none, either or both) Analysis of Variance were performed with life satisfaction, security with romantic partners and the BSI positive symptom distress index as dependent variables. For life satisfaction, there were main effects for relationships (F=4.551, p<.05). A univariate analysis reveled that having a good relationship with both parents was better for life satisfaction than having a good relationship with just one or neither parent (t=2.37, p<.05) There were no significant effects based on whether the adolescent's parents were married or divorced for life satisfaction. For the Positive Distress Symptom Index, there were also significant main effects for the parent-child relationships (F=3.512, p<.05). There were no differences between having a good relationship with one or both parents. Again there were no significant main effects based on the marital status of the parents. For self-esteem, there was a main effect for parent-child relationships (F=3.819, p<.05). There were no differences between having a relationship with one or both parents or based on parental marital. For the security with romantic partners, there was a main effect concerning parental marital status with the children from married families being more secure in their relationships (F=10.620, p<.05). There were no reliable effects between parents-child relationships and the security level of the adolescents with romantic partners.

DISCUSSION

The results did provide some support for our hypotheses. Our first hypothesis predicted that adolescents who have close relationships with at least one parent will have better adjustment in young adulthood than adolescents who are not close with either parent, regardless of whether the adolescents' parents are married or divorced. Our results supported this for life satisfaction, distress symptoms, and self-esteem. For security with romantic partners, however, there were no significant differences for parent-child relationships, but the participants with married parents were significantly more secure with romantic partners than those from divorced families. These results are consistent Wierson, Forehand, Fauber and McCombs (1989) who also found close parent-adolescent relationships to act as a buffer against the detrimental effects of divorce.

Our second hypothesis predicted that adolescents who have close relationships with both parents will have better adjustment in young adulthood than adolescents who are close with only one parent, regardless of whether the adolescent's parents are married or divorced. The results only supported this concerning life satisfaction, where having positive relationships with both parents related to increased life satisfaction as compared to having a positive relationship with only one parent. The importance of parent-adolescent relationships on life satisfaction is consistent with the findings of Hess and Camera (1979) that having a good relationship with both parents is more beneficial than having a good relationship with just one parent. As far as distress symptoms and self-esteem, there were no significant differences between a positive relationship with one or both parents, and parent-child relationships again had no effect on security with romantic partners.

These results demonstrate the importance of parents maintaining good relationships with their children, regardless of their marital status. As far as life satisfaction, distress symptoms, and self-esteem, children from both divorced and married families functioned similarly as long as they had a good relationship with at least one parent, which provides support for results previously found by Wierson, Forehand, Fauber, and McCombs (1989). When children receive the adequate support and attention they need from their parents, parental marital status becomes less of an issue.

Despite there being significant differences between having a positive relationship with one and both parents in relation to life satisfaction, there were no differences concerning distress symptoms or self-esteem, contrary to what was previously found by Hess and Camera (1979) regarding the importance of positive relationships with both parents. While the children may have more satisfaction in their lives when they maintain good relationships with both parents, our study suggests that a good relationship with one just parent may provide the necessary support to alleviate distress symptoms and to help them maintain good levels of esteem. These results are similar to those found by Forehand, Middleton, and Long (1987) who found three stressors (divorce, poor relationship with mother, and poor relationship with father) to be indicative of more difficulties for adolescents than zero, one or two stressors. It seems that as long as the adolescent does not have to deal with all of these stressors at once, their functioning and distress symptoms will not be effected or impaired.

Our results did not support our hypotheses concerning the adolescent's security with romantic partners because the adolescent's relationships with their parents had no effect on their levels of security. Security with romantic partners did depend, however, on whether the adolescent's parents were married or divorced, with those from married families being more secure in their relationships. These results may indicate that adolescent's from divorced families approach romantic relationships with more caution because they have seen that not all marriages end happily. Wallerstein (1985) also found adolescents to be cautious in their own relationships to prevent a divorce in their own life. While being too insecure in relationships is not necessarily healthy, being cautious can help people think more when they are making decisions about life long commitments.

CONCLUSION

In conclusion, parents-child relationships seem to be better predictors of adolescent functioning than parental marital status as far as life satisfaction, self-esteem, and distress. Marital Status affected the child's security with romantic partners, but did not impair day-to-day functioning. This seems to show that a positive relationship with parents can eliminate many of the detrimental functioning problems often associated with divorce.

REFERENCES

Barber, B. L., & Eccles, J. S. (1992). Long-term influences of divorce and Single parenting on adolescent family-and work-related values, behaviors, and aspirations. Psychological Bulletin, 111, 108-126.

Black, A. E., & Pedro-Carroll, J. (1993). Role of parent-child relationships in mediating the effects of marital disruption. Journal of the American Academy of Child and Adolescent Psychiatry, 32, 1019-1027.

Forehand, R., Middleton, K., & Long, N. (1987). Adolescent functioning as a consequence of recent parental divorce and the parent-adolescent relationship. Journal of Applied Developmental Psychology, 8, 305-315.

Harter, S. (1982). The Perceived Competence Scale for Children. Child Development, 53, 87-97.

Hetherington, E. M. (1989). Coping with child's perspective. American Psychologist, 34, 79-95.

Hetherington, E. M, Cox, M., & Cox, R. (1985). The long-term effects of divorce and remarriage on the adjustment of children. Journal of the American Academy of Child Psychiatry, 24(5), 518-530.

Hess, R. D., & Camera, K. A. (1979). Post-divorce family relationships as mediating factors in the consequences of divorce for children. Journal of Social Issues, 34, 79-96.

Peterson, J. L. & Zill, N. (1986). Marital disruption, parent-child relationships, and behavior problems in children. Journal of Marriage and the Family, 48, 296-307.

Quay, H. C., & Peterson, D. R. (1987). Interim manual for the Revised Behavior Problem Checklist. Unpublished manuscript, Psychology Department, University of Miami.

Wallerstein, J. S., (1983a). Children of divorce: Stress and developmental tasks. In N. Garmezy and M. Rutter (Eds.), Stress, coping, and development. New York: McGraw-Hill, Inc., 265-302.

Wallerstein, J. S. (1983b). Child of divorce: The psychological tasks of the child. American Journal of Orthopsychiatry, 53, 230-243.

Wallerstein, J. S. (1985). Children of divorce: preliminary report of a ten-year follow-up of young children. American Journal of Orthopsychiatry, 24, 545-553.

Wierson, M., Forehand, R., Fauber, R., & McCombs, A. (1989). Buffering young male adolescents against negative parental divorce influences: The role of good parent-child relations. Child Study Journal, 2, 101-115.

Wierson, M., & Forehand, R. (1992). Family stressors and adolescent functioning: A consideration of models for early and middle adolescents. Behavior Therapy, 23, 671-688.

Doing Field Research in an Electronic Environment

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Ethnography is the study of a people and their culture. Doing ethnography is compiling and researching according to specific ethnographic methods. It grows out of the field of cultural anthropology. The primary element in doing ethnography is direct contact with the people to study their belief systems, economic systems, social engagement and interaction rules, dispute settlements, human behaviors, religion, educational systems and how they go about their daily lives. It has gone from being a speculative enterprise to doing field research. In the early days of ethnography, distant cultures were studied by talking to the missionaries who had been with them upon their return. So the ethnographic study was done in the office at a desk. This led to a biased study - biased both by the person reporting the behaviors, and by the person interpreting the report and writing the study. Eventually, as ethnography became more important, it was figured out that the only way to do a true ethnography is to go out into the field and live with the people being studied.

Robert Redfield was the first American anthropologist to do this in Mexico. In the 1930's he published two books as a result of his studies which discussed his theory of the folk urban continuum. That continuum's subject was how folk villages interact with, and become dependent on, close urban communities. That theory could not have been properly developed without doing field work.

With field work being so important in doing a successfull ethnograhic study, how does one learn field methods in the classroom? Well, you can read books on research methods and you can practice these methods by doing local community studies. But in both of these cases, you remain in a familiar environment without the obstacles that would be encountered in a foreign setting. Now there is a way to experience a foreign ethnography, without incurring the costs of money and time it would take to travel to another country. The way to do this is by utilizing an ethnographic simulator. The military uses simulators to play out a war and the different solutions, and now the field of ethnographic research is able to use a simulator to study an entire population.

I have been using just such a simulator to study an indiginous population in the state of Queretaro, Mexico. The simulator offers not only the interesting components of doing field research, such as interviews with new and interesting people, but also obstacles such as language barriers, and different answers for different gendered interviewers, and a limited budget.

As the simulation began, I arrived at the bus station in Queretaro City. My first assignment was to familiarize myself with public transportation. I found the bus station to be very large and clean with many terminals and travel destinations and comparable to an American airport. There was a place to pray for safe travel and for the safe arrival of friends and relatives. There were also food stands as well as a small market. There is a choice of two types of buses to travel on - a luxury bus and an economy bus. The luxury bus is large and very clean with leather seats, a television, a restroom, snacks and attendants. The people who travel on the luxury liners are wealthy citizens and tourists. The economy bus seemed comfortable enough and it was fairly clean, but the seats were well worn and marked with scratches and graffiti. The most common passengers on the economy bus are the people who live in the rural areas and are carrying their goods to and from market places. Many of them are the indigineous Otomi people who are distinguishable by their clothing. The Otomi women usually wear long colorful skirts and blouses, aprons and rebozos, which are rectangular pieces of cloth used to cover their shoulders or their heads. Many of them as well as the men, also wear straw hats. As I traveled on the economy bus, I was serenaded by a man singing and playing the guitar up and down the bus aisle, which is very common in Mexico and a way to earn money through tips.

The biggest problem I encountered, and probably would have encountered had I actually been in the field, was using up all of my budget and alloted time because I was having so much fun and went on to do more than my assignmet asked of me. So in this case I learned that an important part of doing an ethnographic study, is sticking to the task at hand.

My next assignment was to take a walking tour of the city of Queretaro, writing an ethnographic description of the public places, people, urban life, and material culture. I found the streets of Queretaro to be a very divers scene. Most of the buildings are constructed of stone or brick, or some other concrete material. The architecture is mostly of a Spanish style with a lot of iron ornamentation. There is not much built in a more modern style, not even the newer buildings. The people on the streets presented a full range of style and dress. There were casually dressed people, who could be students or people who work in a job where casual dress is appropriate. There were also more formally dressed people, who could be people that hold office jobs or people of a higher social class. There were also many people dressed in well worn clothing and hats, who could be field workers, as well as many traditionally dressed Otomi people. I found many arts and craft stands on the streets selling hand made items which ranged from religious items to touristy dolls and souveniers. The plaza's were very beautiful and well kept with flower gardens, gazebos and fountains. In these plaza's, I found people chatting with friends, lounging around, and people watching while the children played and enjoyed the fountain. The modes of transportation appeared to be mainly walking, and there were a lot of buses and people at the bus stops. I didn't notice too many older persons walking along the streets, but I did notice them sitting in the plaza's and selling arts and crafts. The median age of the general "street populating", and this is not to be confused with "homeless street people," seemed to be in the early 20's.

The biggest problem I encountered with this assignment was that I had no way of knowing what time of day it was. I would have preferred to have done this at specific hours of the day, such as early morning, late morning, lunch, late afternoon, evening and night time in order to do a comparison.

My next assignment was to visit the headquarters of the National Institute for Indigenous Affairs, which will be referred to as the INI, and describe the programs and functions. The INI is in charge of dealing with problems that the indigenous population faces. For example, as a result of NAFTA, the peasants have sustained a substantial loss with fertilizer use, so the INI helps them by covering some of the costs of fertilizer. They are also taking a loss with corn, so the INI is trying to get the producers to diversify their production by extablishing programs for floriculture, livestock raising and the production of fish, and it is the INI engineers who are assisting them. Another project of the INI is direct commercialization of the crops by establishing an agreement through which the producers of the area will supply grains to other indigenous communities. They are promoting arts and crafts like textiles and pottery and in the last few years, the INI has financed up to 65 of these projects. With one of the biggest problems of indigenous people being alcholohism, the INI has established a health care program in eight communities. The program includes first aid classes, illness prevention measures and others. There has also been an attempt to train a number of translators to help diminish unemployment due to discrimination. They provide funds for cultural projects such as the construction of monuments, traditional dance and musical group promotion. One of the main problems of the INI is the lack of support from the staff. It seems that many have forgotten that they are there to help the people and only work for personal gains.

This information was obtained by conducting an interview with the head of the INI, and so the problem I encountered was having to pay an interpreter to translate for me. I also would have liked to have visited some of the health centers, but this was not offered to me in the simulator.

My next assignment was to travel to Tixtha, locate a folk healer named Dona Severiana and interview her in order to make an inventory of curative plants and the ailments they cure. I found Dona Severiana to be an old woman who lives in seclusion and is paid minimally by the government to raise these very interesting curative plants. She learned the secrets of the trade from her mother and recieved training from the government that she had to pay for, which in turn enabled her to be paid by them. The following table illistrates the names of the plants and there cures.

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Epaote, Wormwood, Chenopoduim ambrosoides	Cures susto, the fright, amebiasis, amenorrhea, anemia, arthritis, asthma, colic, fever, stomach aches and rheumatism. Also used as a spice.
Sauco, Elderberry, Sambucus Mexicana	Cures coughs, colds, rheumatism, bronchitis and is used sudorific.
Poleo, Pennyroyal, Hedeoma Pulgiodes	Cures stomach cramps.
Cedron, Simba Cedron	Cures stomach cramps.
Topozan	Used to make soap and cures stomach cramps.
Manrubia, Horehound, Marrubium Vulgare	Cures cramps
Romero, Rosemary, Rosemarinus Officinalis	For bone and muscle aches
Hierbabuena, Spearimint, Hedoma Piperita	Cures stomach aches.
Hinojo, Fennel, Foeniculum Vulgare	Cures "air"
Trementina, Pinus Edulis	Cures bone fractures.

Figure 1: Curative Plants

I found this assignment to be very interesting because of the colorful pictures of the different plants and the interesting ailments they cure. Also Dona Severiana presented a very interesting character.

My next assignment was to take a taxi to the State Council of Population in the downtown area of the city, locate and access data on population to find the five largest and five smallest counties in the state of Queretaro. The following table illistrates this information.

Largest Counties	Population
Amealco de Bonfil	46,358
El Marques	55,258
Queretaro	456,458
San Juan Del Rio	126,555
Cadereyta	44,944

Smallest Counties	Population
San Joaquin	6,229
Arroyo Seco	13,112
Penamiller	16,155
Toliman	17,990
Landa de Matamoros	17,964

Figure 2: County Populations

This was a very easy assignment to complete and probably the most boring. However, the important thing to remember when doing an ethnographic study is the boring stuff is just as important as the fun and interesting components.

My last assignment was to locate to key informants named Don Jose and Don Miguel, interview them, and report on their different views of religion, farming activities, housing and dress. Don Jose is an Otomi social leader who is involved in organizing festivals and events, which includes things such as, finding dancers and people to cook the food and provide the alcohol. He exchanges favors with different people in the community for food, alcohol and other things for the festivals. He believes in a social status way of life, customs and ceremonies and feels it is all interconnected. Don Miguel is a Mestizo political leader in the community. He feels that there is a degree of seperation between civil and religious events. He also feels that everybody gets along fine and that there is no prejudice among the Otomi and Mestizo population, which I have found to be untrue.

This was another interesting assignment to complete because of the views of the leaders from two different groups. I also found it interesting that it was the man from the dominating group that felt there is no prejudice. The problem I had in completing this assignment was that once again I had to pay a translator in order to conduct the interview. Because of this, the information that I recieved was a little different than what I would have recieved had I spoken and understood the language myself.

The wonderful thing about using this simulator is that I was able to do a fairly thorough ethnographic study without having to incur the expense or time that would have been spent had I actually gone to Queretaro, Mexico. Equally great is the fact that I was able to learn how to do an ethnographic study while doing it.

REFERENCES

Carlos. Dr. Manuel, Electronic Field Research Simulator One
1996

Carlos, Manuel L., Philip C. McCarty, Melody Knutson, and Juan JosÈ Gutierrez.
1994 Undergraduates as Ethnographic Field Researchers of Mexican Peasant Communities: The Application of Classroom Skills to Field Settings. Paper prepared for presentation at the 93rd Annual Meeting of the American Anthropological Association, Atlanta, GA, and November 30 - December 4, 1994.

Carlos, Manuel L. and Melody L. Knutson.
1993 A Multidimensional Computer-Assisted Approach to Training Undergraduates in Ethnographic Field Research Methods at the University of California, Santa Barbara. Paper prepared for presentation at the 92nd Annual Meeting of the American Anthropological Association, Washington, and D.C. November 16-20, 1993.

Carlos, Manuel L., Juan Jose Gutiérrez, and Melody L. Knutson.
1992 Ethnographic Field Research in the Age of Computers: Development of an Electronic Multimedia Ethnographic Databank and its Application in the Queretaro Research Project. Avances (Journal of the University of Queretaro), July, 1992.

Carlos, Manuel.
1996 The Application of Computer Technology to Undergraduate Curriculum in Cultural Anthropology: Simulated Ethnographic Field Research"presented by Manuel L. Carlos, Juan José Gutierrez and Phil C. McCarty at the1996 Annual Meetings of The Society for Applied Anthropology, March 27, 1996

Irrelevant Speech Eliminates the Word-Length Effect

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The working memory model has been used to explain word-length effect: short words are easier to remember than long words. According to the working memory model, the word-length effect occurs because of subvocal rehearsal in the articulatory loop. There should be no interaction between the word-length effect and irrelevant speech, according to the working memory model. An experiment was conducted to test this prediction. Contrary to the prediction, there was an interaction. Irrelevant speech eliminated the word-length effect for auditory items in the experiment and visual items when the experiment was modified. The current experiments do not support the predictions of working memory; rather, they are best interpreted as supporting an alternative model such as the feature model.

BACKGROUND

The word-length effect describes the finding that individuals can better remember words that take less time to pronounce than words that require a longer pronunciation time (Neath, Surprenant, LeCompte & Byun, 1996). This effect is observed with free and serial recall for both auditory and visual items (Watkins & Watkins, 1973). Baddeley's working memory model and Nairne's feature model offer competing explanations for this phenomenon (Neath & Surprenant, 1996).

In the working memory model, the "phonological loop" is of primary importance (Neath & Surprenant, 1996). It contains two main components: the phonological store and the articulatory control process. Speech-based information is retained in the phonological store for a short period of time. Traces within the store are assumed to degenerate in approximately one to two seconds, if they are not used (Neath, et al, 1996). The articulatory control process translates visual information into a speech-based code and refreshes decaying traces in the phonological store to offset the decay process. If rehearsal of a particular item does not occur within a certain time, the memory trace for that particular item will have decayed too far to be usable.

Thus, the amount of verbal information that can be retained is dependent on the rate of decay and the covert rehearsal rate. According to the working memory model, an item that takes longer to pronounce will take longer to be covertly rehearsed, because the articulatory control processes are related to the covert speaking rate. Thus, short items are more likely to be rehearsed before decaying than long items, and this will result in better recall of short items (Neath et al., 1996).

Unlike the working memory explanation, the feature model holds that no one feature (e.g. length) in a word is meaningful (Nairne, 1990). According to the feature model, primary memory (storage of short term information) has no capacity limit, and items in primary memory do not decay. One function of primary memory is to construct and maintain cues that may indicate which items were presented on a particular list (Nairne, 1988, 1990).

Another main difference between working memory and the feature model is that, whereas the central forgetting process in working memory is time-based decay, the feature model states that loss of information is due completely to interference (Nairne, 1988, 1990). New items interfere and disrupt items that are already in primary memory.

The two models also make different predictions about recall performance against a background of irrelevant speech. According to the working memory model, the irrelevant speech items enter the phonological store and interfere with the information about the to-be-remembered items (Salame & Baddeley, 1982), which produces an overall decrease in performance. Irrelevant speech is not believed to have an impact on the word-length effect.

According to the feature model, the additional features from the irrelevant item-whether spoken or heard-increase the likelihood of a mismatch, and thereby reduce recall. The feature model predicts that irrelevant speech will eliminate the word-length effect for visual items (Neath et al., 1996).

In the current experiment, the objective was to examine whether irrelevant speech would eliminate the word-length effect as the feature model predicts. If this is the case, participants would demonstrate equal ability in recalling long and short words correctly, by matching the degraded primary memory traces with the appropriate intact trace in secondary memory.

MATERIALS/METHODS

Part 1. Forty participants were tested in one of two conditions: (a) Silent Condition and (b) Tea Time Condition. In the Silent Condition participants were asked to remember the order in which they heard eight different words through headphones. After the final word, the eight words appeared on a computer screen in alphabetical order, and the participants were to click on the words in the order in which they heard them (reconstruction of order task).

The Tea Time Condition consisted of the same procedure with the exception that the participants were instructed that, in order to increase the difficulty of the task the words "tea time" would be repeated continuously during presentation and recall. The to-be-remembered items were audible in one ear, while the interference (tea time) was audible in the other ear. The participant's task was to filter out the interfering stimuli and recall the eight words presented in each list.

Part 2. An additional 40 students then participated in a modification of the above procedure. Word lists were presented visually and were reduced to five words per list. After viewing the words, participants were asked to write down the words in the order in which they were seen (written serial recall). The words "tea time," were presented over headphones for half of the lists for all participants.

Part 1 was a between subjects design, and Part 2 was within subjects.

RESULTS

With a quiet background, there was an overall advantage in performance of short over long words (0.538 vs. 0.517 respectively), $F(1, 34) = 4.30$, $MSE = 0.016$, $p < .05$. This was qualified by a significant Word Length x Background Condition interaction, $F(1, 34) = 4.21$, $MSE = 0.016$, $p < .05$. There was a typical main effect of serial position, $F(7,238) = 92.47$, $MSE = 0.018$, $p < .01$. The Word Length X Serial Position interaction was not significant. See table 1 for mean proportion correct and mean standard error.

Table 1: Auditory presentation
Long and short words manipulated within subjects
Silent versus irrelevant speech manipulated between subjects
Reconstruction of order task

CONDITION	MEAN PROPORTION CORRECT	STANDARD ERROR
SILENT SHORT	0.5903	0.0245
SILENT LONG	0.5498	0.0254
TEA TIME SHORT	0.4863	0.0287
TEA TIME LONG	0.4852	0.0252

N = 18 per group

842

For the visual presentation, there was an overall advantage in recall of short over long words (0.774 vs. 0.640, respectively), F(1, 17)= 72.78, MSE = 0.021, p < .01, the Word Length X Background Condition interaction was significant, F(1, 17) = 69.39, MSE = 0.016, p < .01. There was a typical main effect of serial position, F(4, 68) = 58.02, MSE = 0.025, p < .01. There was a significant interaction effect between Word Length and Serial Position, F(4, 68) = 4.26, MSE= 0.013, p < .01. There was no interaction between Background Condition and Serial Position, F(4, 68) = 1.56; MSE = 0.016, p > .19. The three-way interaction was significant, F(4, 68)= 4.54, MSE = 0.013, p < .01. See table 2 for mean proportion correct and mean standard error.

Table 2: Visual Presentation
5-item lists
Everything within-subjects
Written serial recall

CONDITION	MEAN PROPORTION CORRECT	STANDARD ERROR
SILENT SHORT	0.822	0.032
SILENT LONG	0.641	0.056
TEA TIME SHORT	0.665	0.057
TEA TIME LONG	0.064	0.052

N = 18 per group

CONCLUSIONS

With no irrelevant speech (Silent Condition), there was a significant increase in the number of correctly recalled short words as opposed to long words for both tasks. For the Tea Time Condition, there was no significant difference between the number of short words correctly recalled and the number of long words correctly recalled for both tasks. It is possible that the working memory model's interpretation of the word length effect or its interpretation of the irrelevant speech effect (or both) is incorrect. The feature model is supported.

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REFERENCES

Nairne, J.S. (1988). A framework for interpreting recency effects in immediate serial recall. *Memory & Cognition, 16*, 343-352.

Nairne, J.S. (1990). A feature model of immediate memory. *Memory & Cognition, 18*, 251-269.

Neath, I., & Nairne, J.S. (1995). Word-length effects in immediate memory: Overwriting trace decay theory. *Psychonomic Bulletin & Review, 2*, 429-441.

Neath, I., & Surprenant, A.A. (1996). Manipulations of irrelevant information: Suffix effects with articulatory suppression and irrelevant speech. Manuscript submitted for publication.

Neath, I., Surprenant, A.M., LeCompte, D.C., & Byun, E. (1996). Articulatory suppression, presentation modality, and irrelevant speech: Interactions with word length. Manuscript submitted for publication.

Watkins, M.J., & Watkins, O.C. (1973). The postcategorical status of the modality effect in serial recall. *Journal of Experimental Psychology, 99*, 226-230.

Activational Effects Of Testosterone On Sound-Guided Spatial Navigation

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Exposure of the brain to sex steroids during critical periods of development leads to many sex differences including those in spatial navigation ability. These organizational effects of hormones produce "male and female" brains that respond differently to sex steroids later in life. In this study,the activational effect of testosterone propionate (TP) on adult, Long-Evans rats' ability to navigate through Hebb-Williams mazes using sound cues to guide movement to a water reward was examined. Sexual differentiation was manipulated during early postnatal life to produce 5 groups of Long-Evans hooded rats that would exhibit different responses to TP during adulthood: females, masculinized females, males, demasculinized males, and castrated males primed with TP. As adults, rats navigated mazes after TP or control injections. Noise bursts were presented during maze trials to indicate the correct navigational path. TP improved maze performance for all groups except control males ($p < .05$). The results show that the sex steroid testosterone appears to have an activational effect on sound-guided spatial navigation in addition to the known organizational effect of this sex hormone on visuo-spatial learning.

INTRODUCTION

Males and females differ from one another in a variety of ways. These male-female differences begin early with the sexual differentiation process and are evident in features of the body, development of the brain, and sex typical behaviors. During early development the sexual differentiation of the brain is mediated by hormones secreted by the gonads (Breedlove, 1992). Levels of circulating hormones have a direct effect on the development of brain structures and result in a brain that is either masculine or femine. Testosterone and estrogens are hormones that act during development with resulting effects that are called organizational. Organizational effects transpire around the time of birth and can only occur during a critical or sensitive period and result in structural changes in the brain that are permanent and irreversible (Breedlove, 1992). For example, differences are apparent in certain sexually dimorphic areas of the brain such as the hypothalamus, which includes specialized nuclei that function as centers for regulation of the endocrine system. Specifically, the medial preoptic area (POA) of the hypothalamus contains a nucleus that is much larger in males than females. This difference is so apparent it can be observed without a microscope. Early exposure to testosterone, an androgen which is aromatized to estradiol (an estrogen), influences the size of this nucleus. Limiting androgens in males results in a smaller, less masculine POA, and females treated with an androgen or estrogen develop a larger POA. Other areas of the brain, including the hippocampus which is involved in the control of learning and memory, are also "organized" by early hormone exposure (Roof, 1993). This sexual dimorphism in brain regions results in sex typical behaviors. For instance, males often exhibit more aggressive behavior than females which can be related to hypothalamic differences, and males tend to be better at spatial learning and memory tasks than females which can be related to hippocampal sex differences.

While organizational effects occur at very specific times, sex steroids also influence behavior throughout the lifespan. Most of these effects can be called activational because the presence of a hormone intiates or modifies some behavior for a specific period of time only. Optimal activational periods occur when the testes and ovaries are active; for example, during puberty and adulthood (Zimmerberg & Farley, 1993). Activational effects are transient in nature, and often an animal's hormonal state at a specific time activates a particular behavior (Zimmerberg & Farley, 1993). Certain sex-related behaviors of males (e.g., mounting) and females (e.g., lordosis) are activated by the action of sex hormones in hypothalamic areas (Breedlove, 1992), and spatially organized, sexually dimorphic behaviors may be altered by the presence of sex steroids. For example, low testosterone levels in men and high testosterone levels in women are correlated positively with various spatial abilities (Kimura, 1993). Differences between male and female rats' behavior are observed in spatial navigational tasks particularly when the environment to be navigated, usually a maze, is familiar (Williams, Barnett, & Meck, 1990).

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Spatial ability can be assessed in a variety of ways, with the most common being an examination of animals' navigation within a maze. Navigation behavior in an expected maze, or a familiar environment, depends upon experience in the specific environment. When features of an environment remain constant, an animal is able to build a cognitive representation of the environment as a whole (Williams et al., 1990). Cognitive mapping requires an animal to interact with an environment while charting a course to some distant goal (O'Keefe & Nadel, 1978). A citical aspect of cognitive mapping is the neural source from which it is generated, the hippocampus. The hippocampus has been implicated in mediating spatial navigation abilites and also in the process of working memory (Olton, 1982). Successful navigation in expected environments can be measured as overall performance across testing sessions, as well as working memory performance which refers to animals' memory for learned navigational strategies within a session. Sex differences between males and females relate to the preferential use of available distal environmental cues, and males generally outperform females in expected environments from which cognitive representations may be formed (Williams et al., 1990).

Observed sex differences in spatial navigation strategies are attributed to the organizational effects of gonadal hormones on the hippocampus and other brain areas which mediate spatial learning and memory (Roof, 1993). Few studies have investigated the activational influence of sex steroids on spatial abilities (e.g., Kimura, 1993) and the results are inconclusive. Generally, spatial navigation tasks dependent on visuospatial cues are used to examine sex differences (e.g., Roof, 1993); however, Zrull, Dyche, and Bowman (1994) demonstrated that distal sound stimuli can be used as cues to aid in navigational behavior.

While research on hormonal manipulations (e.g., Roof, 1993; Williams et al., 1992) supports the idea that spatial learning and memory is organized by early exposure to sex steroids, the activational role of gonadal hormones on spatial tasks is less clear (e.g., Kimura, 1993). Investigations of both organizational and activational effects of androgens and estrogens on spatial navigation have almost exclusively used paradigms in which distal visual stimuli provide cues important for task completetion (e.g., Joseph et al., 1978). The goal of the present study was to examine the activational effect of an androgen, in this case testosterone, on spatial navigation through familiar mazes guided by distal sound cues.

METHODS

Long-Evans hooded rats ($\underline{N}$=33, Harlan Sprauge-Dawley) were subjects. Prior to weaning, the animals were housed with their dams, and as adults they were group housed in plastic shoe-box cages. Rats had free access to food and water until behavioral testing began when water was obtained during testing sessions and freely for 36 hr on the weekends. The animal colony was temperature-stable (23 °C) and provided a 12 hr-12 hr light-dark cycle.

Within 24 hr of birth all rats were anesthetized by hypothermia. After sex was determined, the females were allowed to warm and recover and were then returned to their dams. Female pups were injected (sc) with 10 µg estradiol benzoate in 0.02 mL sesame oil (FEST, $\underline{n}$=10) or sesame oil only (FCON, $\underline{n}$=8) on postnatal days 1, 3, 5, 7, and 9. Male pups were placed in a supine position and castrated bilaterally through an incision in wall of the abdomen between the umbilicus and the genital papilla or incised but not castrated (MCON, $\underline{n}$=7). Castrates received sesame oil injections after surgery (MCAS, $\underline{n}$=4) or received priming injections of testosterone propionate (MCTP, $\underline{n}$=4, 250 µg in 0.05 mL sesame oil, sc). Males were then allowed to warm and recover, and were then returned to their dams.

Behavioral testing was conducted when rats were adults (60 or more days old) in a sound-proofed room (32 dB re 20 $\mu N/m^2$ ambient noise level). A modified Hebb-Williams (Hebb & Williams, 1946) maze which consisted of a raised circular platform with start and goal platforms and moveable barriers of varying lengths was used to assess spatial navigational ability. The goal areas were equipped with stainless steel tubes through which a water reward could be delivered. Moveable speakers (Realistic 40-1289A), which were hidden from view, surrounded the maze and were used to present sound cues to guide navigation through the Hebb-Williams mazes. Sound cues always indicated the error-free route to navigate a maze and consisted of a series of noise burst pairs (2 X 100 ms, 2-16 kHz, 50 dB) controlled by the experimenter. Each navigation trial was monitored by the experimenter and a videotape record was made. Navigation was quantitified as the the number of blind-alley errors, or deviations from the most direct route between the start and the goal, made by each rat on each trial.

Behavioral testing was the same for all groups after exploration of the open maze (no barriers) and gradual introduction of barriers. After rats consistently left the start platform and navigated around two barriers to the goal, a series of 16 sessions of 4 trials through familiar mazes were run. In this condition, a single maze was used for 4 sessions of 4 trials, and the maze was changed for each subsequent block of 4 sessions. Distal sound cues were always avaliable to guide navigation. Subsequently, rats from each group were given injections of 250 µg TP in sesame oil or the oil vehicle only 72, 48, and 24 hr prior to a second series of 16 navigation sessions. Injections continued every 24 hr until completion of the this activational series of sessions through different familiar mazes. Table 1 summarizes the conditions of the experiment, and Figure 1 shows examples of Hebb-Williams maze patterns.

Table 1. Number of Rats Run in the Activational and Organizational Conditions

Activational	Organizational Treatment				
	Female		Male		
Injection	Control	Estradiol	Control	Castration	Castrate+TP
Testosterone	4	6	3	4	4
Control (oil only)	4	4	4	4	4

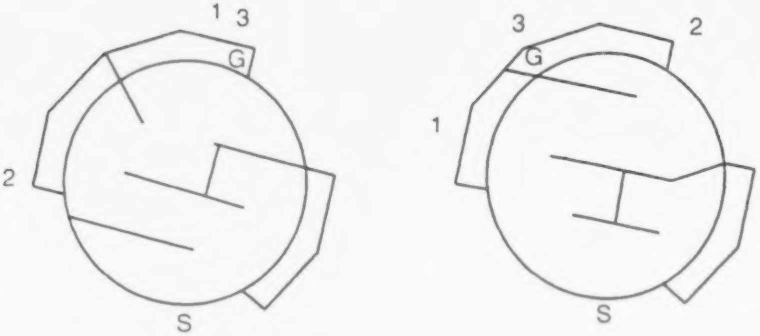

Figure 1. Diagrams of Hebb-Williams Mazes
This figure shows two examples of maze patterns used in the experiment. The numbers indicate the location and sequence of sound cues. S, start area; G, goal platform.

RESULTS

Two measures of performance were collected and analyzed for the experimental groups across the final 16 (i.e., activational) navigation sessions. The number of trials run with at least 1 error was used as a global measure of performance, and the percent of possible errors made on Trials 2 through 4 of each session was used as a spatial working memory variable. For each dependent variable, ANOVA was used to identify significant differences among the experimental groups relative to injections of TP and injections of oil only (i.e., no TP).

Overall navigation performance in the sound-cued familiar mazes was affected by the interaction of experimental group and TP injection, $F(4, 33) = 5.25$, $p < .01$. When injected with TP, female (FCON, -33%, FEST, -48%) and castrated male animals (MCAS, -63%, MCTP, -71%) ran fewer trials with at least 1 error than after oil vehicle injections (see Figure 2). In contrast, normal male rats (MCON) injected with TP averaged +100% more trials with error than male controls not injected with TP (see Figure 2).

Spatial working memory was affected by the interaction of experimental group and TP injection during Trials 2 through 4 of sound-cued navigation through the familiar mazes, $F(4, 33) = 8.97$, $p < .01$ (see Figure 3). When injected with TP, female rats (FCON) and female rats treated with estradiol showed -84% and -82%, respectively, decreases in the percentage of possible errors per trial. Similarly, both castrated male and castrated and primed with TP animals showed a decrease (-92%) in the percentage of possible errors across Trials 2 through 4 after TP injections relative to performance after oil vehicle injections. Like overall performance, normal male rats (MCON) injected with TP averaged a greater percentage of possible errors per trial than male controls not injected with TP (see Figure 3). For the working memory variable, the effect of TP was to increase the percentage of possible errors dramatically (+513%).

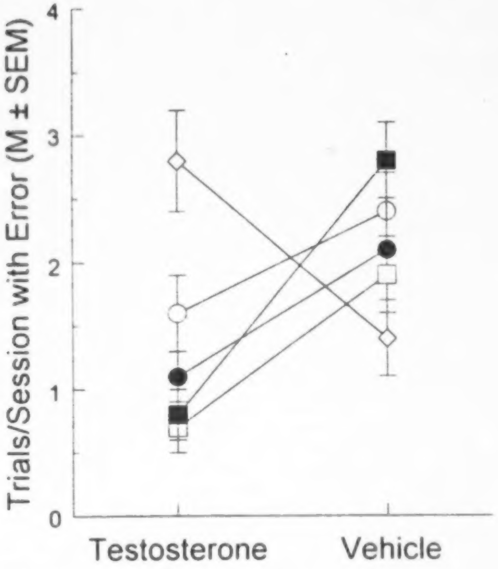

Figure 2. Overall Performance on the Sound-guided Navigation Task.
The graph shows the average number of trials with at least 1 error per session for rats in ○ female, ● female+estradiol, ◇ male, □ male castrate, and ■ male castrate+TP groups with and without activational testosterone propionate (TP) injections.

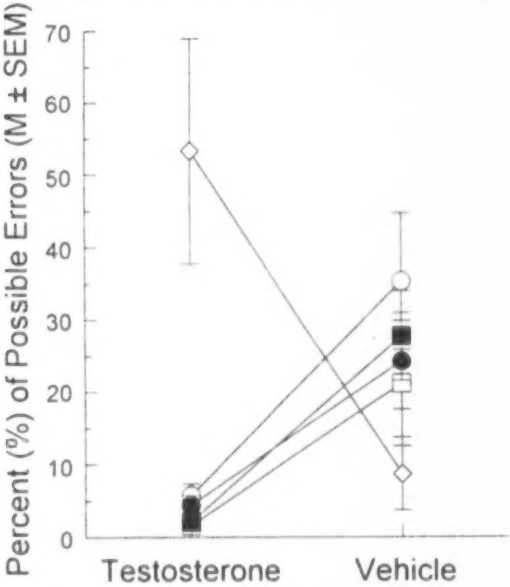

Figure 3. The Use of Spatial Working Memory in the Sound-guided Navigation Task.
The graph shows the average percent of possible errors on Trials 2 through 4 for rats in ○ female, ● female+estradiol, ◇male, □ male castrate, and ■ male castrate+TP groups with and without activational testosterone propionate (TP) injections.

DISCUSSION

The goal of this study was to examine the activational effect of testosterone exposure on an aspect of spatial learning and memory. Specifically, sex differences in developmentally manipulated male and female rats were examined for sound-cued spatial navigation through expected or familiar mazes. All animals, without regard to injections of TP, were capable of learning and completing the task indicating an ability of female, masculinized female, male, and demasculinized male rats to navigate mazes in a paradigm designed to facilitate cognitive representation or "mapping" (O'Keefe & Nadel, 1978; Williams et al., 1990). Like results of Zrull et al. (1994), distal sound cues in this study appeared to provide information that aided navigation. Performance was influenced by the sex of animals not exposed to testosterone with males, as expected (Joseph et al., 1978; Roof, 1993; Williams et al., 1990), out performing females and demasculinized males (see Figure 2).

Exposure to testosterone altered the overall task performance of all groups and had the greatest effect on MCTP rats which was indicated by the greatest decrease in trials with at least 1 error (-71%). Similarly, MCAS (-63%), FEST (-48%), and FCON (-33%) navigated with fewer errors after TP injections. Increasing the circulating testosterone in MCON rats also influenced spatial navigation performance. However, these activational effects of TP had an adverse outcome for the male animals with their performance characterized by a dramatic increase in the number of trials run with at least 1 error (100%). These results are consistent with past research (Roof, 1993) that demonstrated optimal levels of circulating testosterone, rather than excessive levels, are crucial for spatial navigation. Basically, an unusually low or high level of testosterone has an adverse effect on male spatial navigation performance and spatial ability in general (Kimura, 1993).

The activational influence of testosterone was also apparent for the spatial working memory component of the current spatial navigation task. With normal levels of circulating testosterone, male and masculinized female rats tend to make a lower percentage of possible errors when navigating a known environment than normal female rats (see Figure 3). Like overall navigation ability, spatial working memory was influenced by increasing the level of testosterone in an animal. Demasculinized male (MCAS, MCTP) and all female (FCON, FEST) rats decreased the percentage of blind alley errors made by at least 80% when given TP injections. MCON performance declined significantly with additional circulating testosterone (+513% of the possible errors per trial). The activational effects of testosterone on spatial navigation performance were expected to and did provide support for the hypothesis that there is a optimal level of this hormone with regard to spatial ability (Kimura, 1993). Too much testosterone causes males to exhibit poor spatial ability (Roof, 1993) particularly in this navigational task that is dependent on acousto-spatial cues.

REFERENCES

Breedlove, S.M. (1992). Sexual differentiation of the brain and behavior. In J.V. Becker, S.M. Breedlove, D. & Crews (Eds.), Behavioral endocrinology (pp. 39-70).

Hebb, D.O., & Williams, K. (1946). A method of rating animal intelligence. The Journal of General Psychology, 34, 59-65.

Joseph, R., Hess, S., & Birecree, E. (1978). Effects of hormone manipulations and exploration on sex differences in maze learning. Behavioral Biology, 224, 364-377.

Kimura, D. 91993). Sex differences in the brain. In Scientific American (Ed.) Mind and Brain (pp 79-89). New York: W.H. Freeman and Company.

O'Keefe, J.O., & Nadel, L. (1978). The hippocampus as a cognitive map. London: Oxford University Press.

Olton, D.S. (1982). Spatially organized behaviors of animals. In M. Potegal (Ed.) Spatial abilities: Development and physiological foundations (pp. 335-360).

Roof, R.L. (1993). Neonatal exogenous testosterone modifies sex difference in radial arm and Morris water maze performance in prepubescent and adult rats. Behavioural Brain Research, 53, 1-10.

Williams, C.L., Barnett, A.M., & Meck, W.H. (1990). Organizational effects of early gonadal secretions on sexual differentiation in spatial memory. Behavioral Neuroscience, 104, 84-97.

Zimmerberg, B., & Farley, M.J. (1993). Sex differences in anxiety behavior in rats: Role of gonadal hormones. Physiology and Behavior, 34, 1119-1124.

Zrull, M.C., Dyche, J., & Bowman, R. (1994). The utility of localized, brief broadband sound in spatial navigation task. Society for Neuroscience Abstracts, 20, 323.

Effects of Employment on College Students' Academic Performance and School Involvement

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Researchers disagree about whether part-time employment promotes or hinders college success. Questionnaire data from 99 Xavier University undergraduate students were used to investigate the relationship among students' employment status, academic performance, and school involvement. A self-report questionnaire that focused on four measures: (i.e. GPA, frequency of unexcused class absences, and average time spent on homework and school activities) was administered. Based upon previous research, it was hypothesized that academic performance and school involvement significantly decrease for students working more than 20 hours per week. A correlation coefficient indicated no relationship between academic performance and college employment; however, participation in school activities was related to hours employed per week.

BACKGROUND

There seems to be endless debates concerning the costs and benefits of an adolescent holding a part-time job during his or her high school years. Having advocated for high school employment, the President's Science Advisory Committee (1973) argued that the nation's academic school system does not include many of the needed learning opportunities for students. The committee claimed that employed high school students can learn not only vocational and social skills but also gain the opportunity to take on more individual responsibility. In addition, employed students are exposed to real-world workplace experiences that may complement their future goals and aspirations.

Research has found that in some instances employment while in school can have positive consequences. In one such study Steinberg, Greenberger, Jacobi, and Garduque (1981) found that high school adolescents with work experience may develop increased social sensitivity, insight, and better communication skills. D'Amico (1984) found that employment had no negative effects on high school class rankings. However, employment effects did seem to vary depending upon the intensity of the work involved.

Yet, there are many studies that have found that working seems to be in some instances associated with lower academic achievement and school involvement. Steinberg and Dornbusch (1991) indicated that high school students who work long hours tend to have lower grades, less involvement in school activities, and a general disinterest in school as is reflected in their frequent class-cutting. This significant drop-off in school performance occurred among those students working more than 20 hours per week. Long work hours also detracted from other important learning experiences such as participation in school activities.

Though there are numerous studies on how employment affects high school adolescents, there is fairly limited research revealing the effects of employment on full- time college students. Does intense employment (i.e. over 20 hours per week) promote a sense of autonomy, responsibility, and accomplishment? Or, is working long hours a hindrance to college students' academic life and already demanding schedule? The purpose of the proposed study is to examine the effects of no employment (0 hours per week), moderate employment (1-20 hours per week), and intense employment (over 20 hours per week) on college students' academic performance and participation in school activities.

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METHOD

Participants

Ninety-nine full-time undergraduate students (41 men and 58 women) from Xavier University volunteered to participate in this study.

Procedure

A questionnaire that took approximately five minutes to complete obtained background information on participants' sex, year of undergraduate study, age, and work intensity (i.e. number of hours worked per week). Of primary interest are two outcome measures in relation to employment status: 1) academic performance and 2) amount of participation in school related activities.

Academic Performance

Three indices of academic performance were assessed. Students provided information on their current overall grade point average based on a 4.0 scale, the average amount of time spent on homework daily, and their frequency of unexcused school absences per week (i.e. the average number of times he or she cuts class).

School Activities

Measuring of the amount of school involvement was based on the response to the following question: "On the average, what is the amount of time you spend weekly on school related extracurricular activities including clubs, athletics, school committees, or school related volunteer services?". Intervals for this question ranged from "0 hours per week" to "more than 6 hours per week".

RESULTS

As is evident, 84% of participants were employed, and almost 38% were working more than 20 hours per week. (See Table 1). The participants' average hours worked per week was between 16- 20 hours (M=4.363, SD=2.247). Because participants reported answers in terms of intervals, means and standard deviations were also reported in terms of interval level. Thus, a GPA overall sample mean of 3.854 represents an interval level of 3.1-3.5 as is described under "description and coding" in Table 2. The 4 outcome variables (i.e. GPA, time daily spent on homework, amount of weekly class-cutting and school activity participation) are also summarized by gender in Table 2.

Table 1
Work Intensity by Gender

	Male		Female	
Variable	n	%	n	%
Hours worked /week				
0	7	14.14	9	9.09
1-5	3	3.03	3	3.03
6-10	4	4.04	2	2.02
11-15	4	4.04	10	10.10
16-20	6	6.06	13	13.13
21-25	5	5.05	9	9.09
26-30	5	5.05	9	9.09
30 or more	7	7.07	3	3.03
	n= 41		n= 58	
Total cases = 99				

Table 2
Overall Means and Standard Deviation of Outcome Variable by Gender

		Male			Female	
Variable Description and Coding	M	SD	L	M	SD	L
GPA Overall grade point average on 4.0 scale. Intervals range from 1= (1.0-1.5) to 5= (3.6-4.0)	3.854	.8234	(3.1-3.5)	4.121	.7511	(3.1-3.5)
Homework Average time spent on homework daily. Intervals range from 1= (0.5 hrs/day) to 7=(more than 5.5 hours/day).	3.000	1.245	(2.0-2.5)	3.241	1.247	(2.0-2.5)
Class-Cutting Average time participant cuts class each week. Intervals range from 1= (0 times/wk) to 5= (4 or more times/wk).	1.756	.7994	(1 time/wk)	1.414	.7017	(0 times)
School Activities Weekly average participant spends on school related activities. Intervals range from 1= (0 hrs/wk) to 8= (more than 6 hrs/wk).	3.024	2.382	(1.5-2.0 hrs)	2.741	2.065	(1.5-2.0)

Note. "L" is the interval level that the mean and standard deviation represents.

Contrary to what was predicted, Pearson *r* analysis revealed that long work hours did not have a negative effect on academic performance. However, results did confirm the prediction that employment may detract from the amount of time spent in school related clubs and athletics ($r= -.35$, $p=.00$). In general, both male and female employed students who worked more than 10 hours per week, were less involved in school activities when compared to students who worked less than 10 hours per week or who were not employed.

DISCUSSION

As is indicated by conflicting results of previous research, working while in school proves to be a controversial issue. Contrary to the hypothesis that students who worked more than 20 hours per week have a low GPA, spend little time on homework daily, and cut-class frequently- all academic performance results for both male and female participants of the proposed study were not significant. However, a significant negative correlation was found between student employment and amount of involvement on school extracurricular activities. Specifically, the more the college student worked, the less time he or she was able to devote to school clubs, meetings, or athletics.

The number of hours worked per week was unrelated to grades obtained. How were students working long hours (i.e. over 20 hours per week) able to maintain their high grade point averages? There are several possible explanations. One common strategy employed by students is simply choosing easier professors, classes, or lighter class loads in general (McNeil, 1984; Steinberg & Dornbusch, 1991). Another possible strategy is that the participants may have made better use of the small amounts of time they did have available during each day (Hammes & Haller, 1983).

A maintained GPA could also be explained by the personality of the student worker. Perhaps the better student is conscientious and determined to do well; therefore, capable of taking on greater responsibilities. This may explain why the participants of the proposed study , who were initially good students (mean GPA= 3.1-3.5), were able to maintain their high GPA while working.

A negative correlation between work hours and amount of time in school related activities exists. Though no causal relationship can be drawn from this correlation, there is a possible explanation for the relationship between employment and involvement in school activities. Perhaps participants who worked long hours chose to spend their free time in academic pursuits (i.e. studying: thus, a high GPA), fearing extra time spent in school activities may jeopardize their grades.

Prior research has found working to be negatively associated with not only school involvement (Steinberg & Dornbusch, 1991), but also greater psychological distress (Greenberger, Steinberg & Vaux, 1981) and higher rates of drug use and delinquency (Steinberg & Dornbusch, 1991). Additional research is needed in these areas investigating any possible gender or racial differences. College is becoming an increasing financial burden on many college students. For many students who wish to continue their education, working is no longer an option, it is a necessity. Living in a world of yearly increasing tuition rates, forcing more students into the workplace, continued research on the effects of employment on college students' academic performance, psychological and social well-being would be directly beneficial.

REFERENCES

D'Amico, R. (1984). Does employment during high school impair academic progress? Sociology of Education, 57, 152-164.

Greenberger, E., Steinberg, L.D. Vaux, A. (1980). Adolescent who work: Effects of part-time employment of family and peer relations. Journal of Youth and Adolescence, 9 (3), 189-202.

Hammes, J.F., Haller, E.J. (1983). Making ends meet: Some of the consequences of part-time work for college students. Journal of College Student Personnel, 24 (6), 529-535.

McNeil, L. (1984). Lowering expectations: The impact of student employment on classroom knowledge. Madison, WI: Wisconsin Center for Educational Research.

President's Science Advisory Committee. Youth: Transition to Adulthood. Chicago: University of Chicago Press, 1973.

Steinberg, L., & Dornbusch, S.M. (1991). Negative correlates of part-time employment during adolescence: Replication and elaboration. Developmental Psychology, 27 (2), 304-313.

Gender Differences In Coping Strategies And Cardiovascular Responses To Stress

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The study investigated gender differences in hostility and perceived stress. Heart rate and blood pressure measurements were taken while participants viewed two racist scenes on videotape. One racist scene depicted an African American soldier being discriminated against, by another African American, because of his race. The other scene depicted an African American being discriminated against by Caucasians. Afterwards the Cook and Medley Hostility Scale and the Perceived Stress Scale were administered. A t-test was used to detect differences in cardiovascular reactivity between males and females. Significant differences in perceived stress scores were found, females scoring higher than males. With heart rate, females had higher reactivity than males in response to the white on black racist scene. Females also had higher diastolic blood pressure than males for the black on black scene. This study will help identify who is most susceptible to stress related diseases.

INTRODUCTION

Coping as a definition has changed from being as simple as a response to emotions to as complex as cognitive processes (Folkman & Lazarus, 1988). The focus has also changed to include information concerning the effectiveness of coping styles, validated through measures of cardiovascular reactivity, in response to an induced stressor. Assessing coping in blacks require a new diagnostic system that includes stress caused by racism and to account for differences in gender. Coping styles used must also be accounted for in understanding the linkage of personality, gender and cardiovascular responses (Harrell, 1979).

Hostility

Hostility is defined as a personality construct seen in people who are easily angered, have high levels of resentment and irritability, and are cynical and mistrusting of others (Smith & Frohm, 1990). This construct, which is more prevalent in males than females, is associated with high levels of systolic and diastolic blood pressure (Anderson, Meyers, Pickering & Jackson, 1989).

Perceived Stress

Perceived stress refers to the degree to which situations in one's life are appraised as stressful (Cohen, Kamarck & Mermelstein, 1983). An important part of this view is that the response is not based solely on the intensity or any other particular quality of the event, but rather is dependent on personal and contextual factors as well (Cohen et al., 1983). Cohen et al.,(1983) found that females have higher levels of perceived stress than males.

The present study examined gender differences in coping strategies and cardiovascular reactivity. It was hypothesized that males would score higher on the hostility scale and perceived stress scale. It was also hypothesized that males would have greater cardiovascular responses to stress.

METHOD

Participants

Twenty females and twenty males participated in the study. The students were between the ages of 18-26 and were screened for cardiovascular disorders.

Apparatuses

Prior to the experiment, each individual was given a screening form and an informed consent form. The screening form identified medical conditions that excluded the individual from participating in the study. The informed consent form was administered after an explanation of the nature of the study was given. The Cook and Medley Hostility Scale (Cook & Medley, 1954) - a measure of hostility, and the Perceived Stress Scale (Cohen et al., 1983) - a measure of stress were used.

The NCCOM3 impedance cardiograph and microcomputer system were used to assess heart rate. To obtain these measures, eight electrodes were placed on the neck and both sides of the body near the area of the xiphisternum. Blood pressure was taken by the Ohmeda Fina Pres Model 2300 blood pressure monitor. The psychological stressors used in the experiment were two racist scenes and one neutral scene on videotape. One of the racist scenes depicted black students being harassed by white students (white on black scene). The other racist scene depicted a black soldier of higher rank harassing another black soldier of lesser rank because of his race (black on black scene). The neutral scene, which served as a control, depicted a rabbit running in a field at sunset.

Procedure

Upon entrance of the laboratory, each participant was given a screening form and an informed consent form and two personality questionnaires. The two personality questionnaires were the Cook and Medley Hostility Scale a measure of hostility and the Perceived Stress Scale a measure of stress. After all questions were answered, the recording equipment was attached. After the presentation of each scene, the participants were asked to reflect on what they saw. They were asked to put themselves in the position of the victim and speak to the authority figure. Heart rate and blood pressure were measured before, during and after each scene.

Scoring of Physiological Measures

Measurements of heart rate and blood pressure were taken prior to the stimulus (pre-stimulus period), during the stimulus (stimulus period), while the subject reflected on the stimulus (reflection period), and while the subject recovered from the stimulus (post stimulus period). Each period lasted eighty seconds and measurements were taken every twenty seconds. The averages of the measurements were used in the analyses.

RESULTS

T-test analyses were used to analyze gender differences in hostility, perceived stress and cardiovascular responses to the racist stressors. Hypothesis #1 (that males will score higher on the Cook and Medley Hostility Scale) was not supported. Hypothesis #2 (that males will score higher on the Perceived Stress Scale) was not supported. Females ($\bar{x}$=26.9), had higher perceived stress scores than males ($\bar{x}$=21.1), $t(39)=2.59$, $p=.014$. Hypothesis #3 (males will have greater cardiovascular responses to the racist stressor) also was not supported. Females had higher heart rates ($\bar{x}$=83.8), than males (71.9), $t(40)=5.54$, $p=.000$ and higher diastolic blood pressure (females $\bar{x}$=77.2, males $\bar{x}$=69.9), $t(37)=2.00$, $p=.053$ during the white on black racist scene. In addition females, ($\bar{x}$=84), had higher heart rates than males ($\bar{x}$=67.7), $t(40)=4.92$, $p=.000$ during the black on black racist scene.

T-test analyses were also performed on the difference between the pre stimulus and stimulus period between the genders. Although not significant, females had greater systolic blood pressure differences between the pre stimulus and stimulus periods for both scenes. Females also had greater diastolic blood pressure differences between these periods. These t-values approached significance with a probability level of $p=.07$ and $p=.068$, respectively.

DISCUSSION

The results of the study did not support the hypotheses presented. There was no significant difference in systolic blood pressure, between males and females, for the white on black scene. Females also had higher diastolic blood pressure for the black on black scene.

This finding was supported by Baum and Grunburg (1991) who reported that women had heightened hypothalamic pituitary adrenal activity during stress due to hormonal disregulation. Lastly women had higher levels of perceived stress. This finding indicates that women perceive the events in their lives as more stressful than men (Cohen et al., 1983). They also have greater cardiovascular responses to these stressful events. Further investigation of these variables is warranted.

Table 1
Mean Gender Differences In Perceived Stress and Cardiovascular Reactivity

	Perceived Stress	Heart Rate Stim (white on black)	Heart Rate Stim (black on black)	Diastolic Stim (white on black)	Systolic Diff (scores for both scenes)	Systolic Diff (black on black)
Males	21.1	71.9 b/m	67.7 b/m	69.9 b/m	2.7 mm/Hg	51.2 mm/Hg
Females	26.9	83.8 b/m	84 b/m	77.2 b/m	10.05 mm/Hg	43.9 mm/Hg
T-values	*t*(37)=2.6 *p*=.014	*t*(38)=5.5 *p*=.000	*t*(38)=4.9 *p*=.000	*t*(35)=2.0 *p*=.053	*t*(35)=1.8 *p*=.070	*t*(36)=1.3 *p*=.068

Legend
Diff - Differences between pre-stimulus and stimulus period
Stim - Stimulus period
b/m - Beats per minute
mm/Hg - Millimeters of mercury

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REFERENCES

Anderson, N.B., Meyers, H.F., Pickering, T., & Jackson, J.S. (1989). Hypertension in Blacks: Psychosocial and biological perspectives. Journal of Hypertension,7, 161-172.

Cohen, S., Kamarck, T., Mermelstein, R. (1983). A global measure of Perceived Stress. Journal of Health and Social Behavior,24, 385-396.

Folkman, S., Lazarus, R.S., Pimely, S., & Novacek, J. (1987). Age differences in stress and coping processes. Psychology and Aging,2, 171-184.

Harrell, J.P. (1979). Analyzing black coping styles: A supplemental diagnostic system. Journal of Black Psychology,5, (2), 99-108.

Schneiderman, L., Gallucci, W., Baum, A. Gender differences to response and restraint stress. (Unpublished manuscript).

Smith, T.W., & Frohm, K. D. (1990). What's so unhealthy about hostility? Construct validity and psychosocial correlates of the Cook and Medley Hostility Scale. Journal of Health Psychology,4, 503-520.

An Extension of the "Two-Baskets' Theory of Self-Cognitions to Native Americans

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A theory that private and collective self-cognitions are stored in separate locations in memory (Trafimow, Triandis, & Goto, 1991, Trafimow, Silverman, Fun & Law, 1997) was tested with a sample of participants (Native Americans) that differed substantially from those used in previous research Nevertheless, the obtained findings were similar to previous ones, and supported the generality of the theory

INTRODUCTION

Several researchers (e g , Greenwald and Pratkanis, 1984, Triandis, 1989) have distinguished between private and collective aspects of the self, and have argued (Triandis, 1989, 1994) that people from individualistic cultures emphasize private aspects of the self, while those from collectivistic cultures emphasize collective aspects of the self Further, much evidence supports this distinction For example, when individualists and collectivists are asked to complete the Kuhn and McPartland self-attitudes instrument (a series of statements beginning with "I am"), individualists tend to write down more private self-cognitions (statements about traits, states, behaviors) and fewer collective self-cognitions (statements about group membership or common fate) than do collectivists (Bochner, 1994, Triandis, McCusker, & Hui, 1990) However, knowing that culture affects which aspects of the self are emphasized does not, by itself, explain how self-cognitions are organized

To answer this question, Trafimow, Triandis, and Goto (1991) suggested two possible ways of accounting for the findings described below First, self-cognitions could be stored in one location in memory (the "one-basket" theory), but with culture affecting the relative number of private versus collective self-cognitions stored there Invididualists have more private self-cognitions and fewer collective self-cognitions stored in memory than do collectivists, and consequently, this is reflected in the number of private and collective responses they make to the "I am" instrument

Second, private self-cognitions could be organized around a more general private self-concept and collective self-cognitions around a more general collective self-concept (the "two-baskets" theory) However, culture affects the relative accessibility of these self-concepts Thus, for individualists, the private self-concept, and hence, the private self-cognitions associated with that self-concept, are more accessible than for collectivists The reverse is true regarding the collective self-concept and the collective self-cognitions associated with it

Trafimow et al (1991) distinguished between these two theories in two ways First, they pointed out that according to the two-baskets theory, it should be possible to prime the private self, and facilitate the retrieval of private self-cognitions, or to prime the collective self, and facilitate the retrieval of collective self-cognitions According to the one-basket theory, there is only one "self", and so attempting to prime different "selves" should result in a failure Second, Trafimow et al suggested that according to the two-baskets theory, the order in which people write down self-cognitions should be a function of the self-structures from which they are retrieved If a private self-cognition is retrieved, then the private self-concept is presumably accessible, and the next item retrieved should be another private self-cognition Similarly, if a collective self-cognition is retrieved, then this indicates that the collective self is relatively accessible, and the next item retrieved should be another collective self-cognition According to the one-basket theory, there is

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no reason to make this prediction. Both of the predictions made by the two-baskets theory were confirmed, and these findings were later replicated by Trafimow, Silverman, Fan, and Law (1997).

Despite a variety of findings that have supported the theory (see Trafimow, 1997 for a review), one weakness of the theory is that the majority of the research was performed with student samples obtained from the United States (but see Trafimow et al., 1997 for a student sample obtained from Hong Kong). Given that Amir and Sharon (1987) found that most findings fail to generalize across cultures, this is a serious limitation for a supposedly "general" theory. Consequently, our goal was to test the generality of the theory by using a sample of participants from a population that is rarely studied in general, and has never (to our knowledge) been studied by researchers who have investigated the cognitive structure of self-cognitions.

EXPERIMENTAL METHODS

Participants

Twenty-eight male and 34 female Native Americans volunteered to participate in the experiment, and were randomly assigned to the conditions described below. Unlike previous samples, over 41% of this sample was over 30 years of age. Furthermore, 93% reported having spent a significant portion of their life on a reservation.

Procedure

The procedure was similar to that used by Trafimow et al. (1991, Experiment 2). Subjects read a story about an ancient Assyrian named Sostoras who had to send troops to help Sargon I in conquering Mesopotamia. Sostoras also had to assign someone to lead the troops. The priming manipulation was embedded in this story. Participants learned that Sostoras had assigned Tiglath who was a "member of his family" (collective self-prime) or a "talented general" (private self-prime). In addition, and in contrast to Trafimow et al. (1991), there were also control participants who were not primed. Later on, as part of an ostensibly separate experiment, they were given 5 minutes to complete the Kuhn and McPartland (1954) self-attitudes (20 "I am" items) instrument.

RESULTS

The results were analyzed as a 3 X 2 mixed factorial with Prime (private self-prime vs. collective self-prime vs. no prime) as the between-participants factor and Item type (private self-cognition or collective self-cognition) as the within-participants factor. A few of the items were also coded as "allocentric", but were not included in the subsequent analyses (see Triandis, 1989, Trafimow et al., 1991).

There was a significant within-subjects main effect for response type, *F*(1,58) = 80.33, *p*< .001. Consistent with other findings (e.g., Trafimow et al., 1991; 1997), there was a greater proportion of private self-cognitions than collective self-cognitions retrieved (*M*= .69 and *M*= .26, because a few items were allocentric, these do not sum to 1). Furthermore, the proportion of collective self-cognitions was greater than that obtained from the U.S. college student sample used by Trafimow et al. (1991, Experiments 1 and 2) (*M*= .26 versus *M*= .13 and *M*= .15, *p*< .05 in both cases), and similar to the student sample obtained by Trafimow et al. (1997) from Hong Kong (*M*= .26 versus *M*= .26), thereby suggesting, along with Bahr, Chadwick, and Day (1972), that Native Americans are more collectivistic than traditional U.S. students. More importantly, however, the Item type main effect was moderated by a Prime X Item type interaction, *F*(3,58) = 3.45, *p*< .05. Participants who received the collective self-prime or no prime retrieved more collective self-cognitions than did those who received the private-self prime (*M*= .29 and *M*= .32 versus *M*= .18), and participants who received the private self-prime retrieved more private self-cognitions than did participants who received the collective self-prime or no prime (*M*= .77 versus *M*= .64 and *M*= .65). Cell comparisons confirmed that the collective self-prime resulted in findings that were similar to the no prime condition with regard to both private and collective self-cognitions (*p*> .1 in all cases), and that the private self-prime resulted in findings that were different (*p*< .05 in all cases). Finally, to ensure that the no prime control group was not responsible for the Prime X Item type interaction, this group was dropped and a new analysis was conducted. Consistent with the two-baskets theory, this analysis also resulted in a significant interaction, *F*(1,39) = 5.26, *p*< .05.

Conditional probabilities were also analyzed. The probability of retrieving a collective self-cognition was greater following the retrieval of another collective self-cognition than following the retrieval of a private self-cognition (*M*= .35 versus *M*= .19),

$p < .05$, and the probability of retrieving a private self-cognition was greater following the retrieval of another private self-cognition than following the retrieval of a collective self-cognition ($M = .76$ versus $M = .60$), $p < .05$. Thus, like the previous analyses, the conditional probabilities are consistent with the two-baskets theory.

DISCUSSION

The data strongly supported the generality of the two-baskets theory to a Native American population. The data are particularly impressive given research by Amir and Sharon (1987) who found that most experimental manipulations fail to generalize across cultures. Further, the experiment was consistent with a viewpoint expressed by Pepitone and Triandis (1987) that "... the more exotic the cultural sample, the more general the original hypothesis that predicted the results" (p. 472). However, there was one unexpected aspect of the data. Trafimow et al. (1997) had included a "no prime" control group in their study using participants from Hong Kong, and found that the private self-prime resulted in findings similar to the no prime control group while the collective self-prime resulted in different ones. Here the reverse was true--it was the collective self-prime that resulted in findings similar to the no prime group and the private self-prime that differed. These results suggest that although the implications of the two-baskets theory generalize across diverse cultures, findings not specifically predicted by the theory (e.g., which prime should be most different from a no prime control group) may not. More generally, the present article demonstrates the importance of cross-cultural comparisons for testing theories.

REFERENCES

Amir, Y., & Sharon, I. (1987). Are social psychological laws cross-culturally valid? Journal of Cross-Cultural Psychology, 18, 383-470.

Bahr, H.M., Chadwick, B.A., & Day, R.C. (1972). Native americans today: Sociological perspectives. Harper & Row, Publishers: New York.

Bochner, S. (1994). Cross-cultural differences in the self-concept: A test of Hofstede's individualism/collectivism distinction. Journal of Cross-Cultural Psychology, 25, 237-257.

Greenwald, A.G., & Pratkanis, A.R. (1984). The self. In R.S. Wyer & T.K. Srull (Eds.), Handbook of social cognition (Vol 3, pp. 129-178). Hillsdale, NJ: Lawrence Erlbaum.

Kuhn, M.H., & McPartland, T. (1954). An empirical investigation of self-attitudes. American Sociological Review, 19, 58-76.

Pepitone, A., & Triandis, H.C. (1987). On the universality of social psychological theories. Journal of Cross-Cultural Psychology, 18, 471-498.

Trafimow, D. (1997). A theory of attitudes, subjective norms, and private versus collective self-concepts. In D. Terry and M. Hogg (Eds.), Attitudes, behavior, and social context: The role of norms and group membership. Lawrence Erlbaum Associates, Inc.

Trafimow, D., Triandis, H.C., & Goto, S.G. (1991). Some tests of the distinction between the private self and the collective self. Journal of Personality and Social Psychology, 60, 649-655.

Trafimow, D., Silverman, E.S., Fan, R.M., & Law, J.S.F. (1997). The effects of language and priming on the relative accessibility of the private and the collective self. Journal of Cross-Cultural Psychology, 28, 107-123.

Triandis, H.C. (1989). The self and social behavior in differing cultural contexts. Psychological Review, 96, 506-520.

Triandis, H.C., McCusker, C., & Hui, C.H. (1990). Multimethod probes of individualism and collectivism. Journal of Personality and Social Psychology, 59, 1006-1020.

The Relationship Between Self-Esteem and Extraversion

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Past research has indicated that self-esteem is positively correlated with extraversion when examined with other variables such as shyness, social participation, anxiety, loneliness, social participation, self-monitoring, coping, and baldness. The present study hypothesized that self-esteem and extraversion would uphold the finding of past research. Thirty-seven undergraduate students participated in the study by completing the Coopersmith's Self-Esteem Inventory and the Keirsey Temperament Sorter. A correlation coefficient was computed and failed to indicate a significant correlation between the variables. It might be that study had too few participants to demonstrate an effect.

BACKGROUND

In the last fifteen years much research has been conducted on the personality dimensions of self-esteem and extraversion, however most research has combined these two variables along with other aspects of personality (e.g. loneliness, shyness, coping, social participation, and baldness).

The relationship between self-esteem and extraversion has given researchers insight into social aspects. When self-esteem and extraversion were studied by Kameth and Kanekar (1993) with respect to men and women, it was found that women were more likely to have low self-esteem and to be less extraverted than men. However, research has not always consistently supported this finding (Kawash, 1982).

Current social concerns revolve around anxiety, shyness, loneliness because of the individualistic culture we have. Researcher have been recently studying the relationships among these concerns, self-esteem, and extraversion. With respect to anxiety, it was found that self-esteem consistently correlated with low anxiety and with high extraversion with both males and females (Kawash, 1982; DeMan and Efraim, 1987). Kawash also discovered that since low anxiety and high extraversion were source traits, overt behaviors, it might be that these source traits led to positive self-esteem which was identified as a surface trait. Shyness was found to correlate with low self-esteem and low extraversion. Bennett and Lawrence (1993) found three results when studying inherent and situational shyness. These results supported past research findings in three areas: 1) different types of shyness existed, 2) that there was a significant relationship between low levels of shyness and high levels of self-esteem, and 3) shy individuals tended to be more introverted (Lawrence and Bennett, 1992). Hojat (1983) studied loneliness with respect to self-esteem and extraversion and found that loneliness was negatively correlated to both self-esteem and extraversion.

Studying loneliness, anxiety and shyness offers us information about the people of our society. What is just as important is how these people deal with aspects of their lives. Ways that researchers have observed are social participation, self-monitoring, and seeking social support. DeMan and Efraim (1987) found that extraversion was the single best predictor of social participation. They also found that extraverts tended to report higher self-esteem, but that it was not significantly related to social participation. When people are involved in social participation, self-monitoring is an coping aspect that many people use without realizing it. It was found that high self-monitoring was positively correlated with extraversion and self-esteem. Therefore, the higher one's self-esteem and extraversion, the better the person is at attuning their self-presentation and adjusting it to adhere to the expected behavior of others (Briggs et al., 1980). Seeking social support, when studied by Amirkhan, Risinger, and Swickert (1995), was found to positively correlate with self-esteem and extraversion.

The previous studies mentioned have examined many personality traits and ways of coping. Wells, Willmoth, and Russell (1995) researched physical aspects that they hypothesized had an influence on self-esteem and extraversion. With respect to baldness they hypothesized that a person who had low self-esteem and felt unattractive compounded with baldness at an early age would lead to social withdraw. Results indicated that "hair loss in males was associated with depression, low self-esteem, neuroticism, introversion and feelings of unattractiveness, independently of age; and in the case of self-esteem , introversion, and feelings of unattractiveness, the effect was especially pronounced in younger males" (Well et al., 1995, p. 343).

While self-esteem and extraversion influence many other factors, do they influence each other? The present study aims to examine and discover a relationship between self-esteem and extraversion and support previous research that has indicated a consistent positive correlation between self-esteem and extraversion.

METHOD

Participants

Thirty-seven undergraduates from Xavier University in Cincinnati, Ohio, were recruited to participate in the study. The sample included 10 males and 27 females, most between the ages of 18 and 21 with one participant of the age of 60. A portion of the participants were recruited from a general psychology course in which they received credit for participating. Other participants were undergraduates gathered from various pars of campus. Ethical guidelines of the American Psychological Association were followed. Each of the participants were given a consent from which they filled out before completing the survey.

Materials

The Coopersmith Self-Esteem Inventory (SEI; 1987) was used to measure self-esteem. The second instrument used was the Keirsey Temperament Sorter (KTS) which measured extraversion. This survey consisted of 70 questions of which only 10 related to extraversion. Therefore, only questions relating to extraversion were used. The KTS has been used instead of the Meyers Briggs Indicator when money and time are a crucial factor. Due to my limited funding and time constraint, I chose to use the Keirsey Temperament Sorter because it was free and easy to score.

The first two groups that completed the survey wee gathered from a general psychology course. These students met in a room to take the surveys on two different days at the same time. Other undergraduates students were asked to complete the survey on a one to one basis with the experimenter. The other undergraduate students were recruited from personal acquaintances and other undergraduates students who were unknown to the experimenter. The unfamiliar students were asked to volunteer in the Down Under of the University Center of Xavier University.

All participants were given a manilla folder with two consent forms and the Coopersmith SEI and the KTS. The participants were asked to fill out both consent forms. Then one consent form was collected by the experimenter and the other consent form was kept by the participant for his or her records. After the consent forms were completed the participants filled out the surveys. The Coopersmith's SEI asked for the participant's name, institution, occupation, age, gender, and date. The name, institution, and occupation slots were whited out to keep responses confidential. Age and gender were assessed so the demographics could be properly reported. When the surveys were completed, they were placed in a single manilla folder. All responses were kept confidential, because participant identification numbers were used. The scales were later scored by the experimenter and keyed into the SPSS program.

RESULTS

Thirty-seven surveys were completed and the results were computed. The means and standard deviations for self-esteem and extraversion are presented in Table 1. Correlations between the variables are presented in Table 2. Inspection of Table 2 indicates that there were no significant correlations.

Table 1: Means and Standard Deviations for Self-Esteem and Extraversion

Variables	Mean	Standard Deviation
Self-Esteem	74.11	19.95
Extraversion	06.05	02.01

Table 2: Correlations Between Self-Esteem and Extraversion

Variables	Self-Esteem	Extraversion
Self-Esteem	1.00	.13
Extraversion		1.00

DISCUSSION

The results failed to indicate a significant correlation between self-esteem and extraversion despite past research that supported a positive correlation.

There are several possible reasons why significant results were not found. The lack of significance may have resulted because of the sample size. Only 37 participants were involved in this experiment compared to the hundreds used in previous studies. The small number of participants may not have been sufficient enough to show the actual correlation between self-esteem and extraversion. Another possible explanation may have been the haphazard way in which the participants were recruited. Part of the sample was recruited from a general psychology class which had a requirement to participate in experiments. Other participants were recruited from places on campus.

One last shortcoming of the experiment may have been the Keirsey Temperament Sorter. Reliability and validity were unavailable for this test, and, therefore, this test may have been an unreliable test for the population sample despite widespread usage of the test by school counselors.

Future research concerning self-esteem and extraversion should build upon the study conducted by Kawash (1982). Self-esteem was defined as a surface trait and extraversion was defined as a source trait. Since extraversion is a source trait of personality, does it affect surface traits such as self-esteem?

In conclusion, future research should continue to study the relationship between self-esteem and extraversion. Further studies should manipulate self-esteem as an independent variable and observe any effects it would have on extraversion. Findings from an experimental study may help clinicians when dealing with lonely, anxious, or depressed patients.

REFERENCES

Amirkhan, J., Risinger, R., and Swickert, R. (1995) Extraversion: A "hidden" personality factor in coping? Journal of Personality, 63(2), 189-212.

Briggs, S., Cheek, J., and Buss, A. (1980). An analysis of the self-monitoring scale. Journal of Personality an Social Psychology, 38(4), 679-686.

DeMan, Anton & Efraim, Danielle (1987). Selected personality correlates of social participation in university students. The Journal of Social Psychology, 128(2), 265-267.

Hojat, Mohammadreza (1983). Comparison of transitory and chronic loners on selected personality variables. Journal of Psychology, 74, 199-202.

Kamath, Malavika & Kanekar, Suresh (1993). Loneliness, shyness, self-esteem, and extraversion. The Journal of Social Psychology, 133(6), 855-857.

Kawash, George F. (1982). A structural analysis of self-esteem from pre-adolescence through young adulthood: Anxiety and extraversion as agents in the development of self-esteem. Journal of Clinical Psychology, 38(2), 301-311.

BEST COPY AVAILABLE

Lawrence, B. & Bennett, S. (1992). Shyness and education: The relationship between shyness, social class, and personality variables in adolescents. British Journal of Educational Psychology, 62, 257-263.

Well, P., Willmoth, T., & Russell, R. (1995). Does fortune favor the bald? Psychological correlates of hair loss in males. British Journal of Psychology, 86, 337-344.

862

Chicano Gangs in California: Analytical Analysis of the Structure and Dynamics of Chicano Gangs from Street Corner to Prison Cell

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Chicano gangs have been a social phenomenon in California since the early 1940's. Each gang has idiosyncratic characteristics such as history, size, amount of criminal activity, and structure. This paper examines the internal dynamics, command structure, and organizational principles of teenage and adult Chicano gangs. The focus is a case study of a specific population in a mid-size California county. The paper examines the rules which govern the hierarchy of officers and "foot soldiers". The working hypothesis is that gangs are a reflection of the marginalized status of the Chicano population in urban settings. Study is based on original work gathered by the author from personal interviews, observations, and questionnaire's.

BACKGROUND

For the purpose of this ethnographic study, the generic term "Chicano" will be used to describe the gangs studied. Other terms used by researchers and the population studied are: Mexican American, Hispanic, Latino, as well as Chicano. There are many definitions used to define gangs. In this research, gangs are defined as:

> A self-formed association of peers, bound together by the mutual interest, with identifiable leadership, well defined lines of authority, and other organizational features which act in concert to achieve a specific purpose which generally but not exclusively, conduct illegal activities and control over a particular territory, facility, or type of enterprise.

Gangs have been a constant part of United States history since the early 1840"s. Marginalized youth who immigrated Europe, formed brotherhoods for protection and survival. They were much like the gangs of today with minor differences. Turn of the century gangs used and sold morphine while gangs today market crack and cocaine. Earlier gangs used knives while guns are more prevalent in modern times. Historically, gangs were found in cities with large ghettos and minority populations such as Los Angeles, Chicago, and New York. In the 1990's, gangs can be found in all fifty states and in cities of any size. However, the factors which led to the formation of Irish gangs in the 1840's, are indeed similar to the situations which gave rise to the Chicano gang movement of the 1940's.

Chicano gangs share common features including a high sense of territorial ownership and pride. Loyalty and trust are at the core of the Chicano gangs. There is a strong sense of historical roots that both bind and divide the gangs. These roots have provided the strength and staying power over the years to gangs as well as the weakness. History accounts for the desire to revive the La Raza as well as the hesitation to join forces.

In several works, Joan Moore has stated that Chicano gangs did not exist prior to 1942. Before that time, Mexican American youth formed social clubs where they would drink and dance together. The Sleepy

Lagoon trial and the "Zoot Suit Riots" resulted in the formation of the first Chicano street gang, the White Fence. White Fence was formed as a means of protecting the barrios from outsiders as well as self defense and to restore lost pride and respect.According to Mirande (1987, 172):

> The beating and stripping of the zoot-suiters were, thus, attacks not only on their culture but also their manhood. The pachuco was left bleeding and naked stripped of his masculinity or machismo.

A historical overview is essential to the understanding of the formation of Chicano gangs in California. World War II was a catalyst that mobilized anglo citizens in southern California. There was a need to have a "common enemy" among the anglo population. With the Japanese in interment camps, the Mexican was the logical target. It was unimportant that the Mexican American soldiers were the most decorated fighters of all minority soldiers. In the battlefield, they had been first class citizens..on the streets, they were viewed as the enemy.

In 1942, there were several large military installations in the Los Angeles area which placed approximately 50,000 servicemen on the streets every weekend. The United States was at war, tension was high, and tempers flared. On August 1, 1942, a Mexican male was found dead in a mud ditch near the Sleepy Lagoon reservoir. The following day, twenty-two boys from the 38th. Street barrio were arrested for murder. The men were kept in jail and beaten over a period of three months. When brought to trial, they were denied haircuts and a change of clothing because, "the appearance of the defendants is distinctive, their style of haircut, the ducktail comb, the pachuco pants and things of that kind were important evidence." (Endore 1944, p. 31).

During the trial, the sheriff, a self proclaimed anthropologist testified as to the "biological killer instinct of the Mexican because of his Aztec roots" and urged that the whole gang be sent away to prison. The media played up the bloody thirsty nature of the Mexican population by issuing warnings to the public. The end result was the conviction of all twenty-two young men for murder and their incarceration at San Quintin Prison. The men spent eight months in prison before a federal misconduct investigation appeal set them free.

The barrio became a battlefield on weekends. Groups of servicemen would cruise the streets looking for zoot suitors. Young men were dragged out of bars and movie houses by anglo soldiers. Mothers and girlfriends watched in horror as the men were beaten, stripped of their clothing and left bleeding in the streets. To add insult to injury, the police would follow behind and arrest the victims rather than the perpetrators. Hundreds of Mexican American youth were arrested. Newspapers continued to warn that the Mexican was "not to be trusted because of their thirst for blood stemming from a heritage of cannibalism and human sacrifice.." The humiliation suffered by the young men in the barrio and their treatment by the authorities only intensified their distrust of the law. It also served to strengthen the common roots shared by the community as gangs and cliques flourished as a mode of protection and survival.

FINDINGS

According to the Gang Suppression Task Force in the California county studied, there are 31 Chicano street gangs with a membership of more than 3,500. This number does not include the "wanabe" members. These gangs or cliques pledge allegiance to either the Nortenos, Surenos, or Border Brothers.

Northern gang members claim the color red and the number 14, for "N". The letter also refers to Nuestra Familia, the prison gang with northern street ties. The average age of the northern street member is 13 to 25 with a few veterans as old as 45. In the prison system, the average age is 26. Black gang members and northern prison gangs are allies in time of need.

The NF structure is dictated by a very elaborate and strict written constitution. The gang takes priority over everything else in the members life, including family. The NF is selective in its recruiting. They usually only recruit Chicanos from northern California. Members with mixed blood find it hard to move up in rank if they are less than 50% Chicano. The NF attempts to shy away from elementary schools. One Lieutenant informed me that:

> We (NF) are very worried about the children. They have no idea what they are doing out on the streets. They don't know who they are. They wear the colors and flash the sign but know nothing of the history. They are willing to die for a color and they don't even know why..they are breakin all the rules with their gang banging.. they are suppose to protect the innocent..I don't blame them. There is nobody out there to teach them the ways. I had my uncle who schooled me and then gave me the power. Who do they have? They don't even have heroes. I had Chavez..who do they identify with? They need to get back to the business of education. We (NF) want them educated. We need doctors, lawyers, accountants, and teachers for the barrios helping the people, the brotherhood, themselves. They should forget about the gangs until they know what they are doing and why. Banging is a liability to the brotherhood, not a help. This is why a green light was given by the shot caller.

The NF is encouraging its young people to stay in school and get an education. Most NF members in prison are engaged in a GED program or a college education program.

The NF has 24 bonds that a man must take to climb the ladder. Officers are not allowed to use drugs and must keep both body and mind in top physical form. Most speak only English, a few are bilingual and many are third or fourth generation members by way of "passing the power." Northern gang members are often referred to as "Farmers" by their southern counterpart.

Southern gang members claim the color blue and the number 13 for the letter "M" which refers to its prison counterpart Mexican Mafia or EME. The Mexikanemi or "soldiers of Aztlan" is much like a military operation. The average age of southern street members is 11 to 23 with a few veterans in their late 20's or early thirties. In the prison system, the average age is 24. In times of trouble, the white prison population and the southern gangs form an alliance against the Northern gangs and the blacks.

In the southern structure of EME, the president is in charge of the system with the assistance of a vice president. Generals have regional authority while lieutenants control units and sergeants control the soldiers and associates. One EME officer informed me that, "The streets are the recruiting grounds. Schools, parks, it don't matter, we make them members. Got little babies packin.." This same spokesman admitted that if a young person is lucky, he never gets caught and does not enter the judicial system. If he does end up in a juvenile facility, soldiers are standing by begin his training which will continue on into the adult system. The EME has a saying, "respect the strong, use the weak." Southerners are referred to as "scraps" and "Wetbacks" by northern members.

Both groups have common factors despite the differences. Both use a matrix system of writing when they need to insure that the wrong people are not able to decode the message. The system is updated on a regular bases. Both groups use placas to mark their territory or boundaries. They are all highly territorial and this has lead to recent problems. In the past, boundaries were clearly marked by streets. With population growth, a mobile and migrating society, areas become questionable. Gang members now meet and party in cross areas where the potential for conflict and violence are greatest.

Most street gang members interviewed, north and south, indicated that the joining ritual was the same. New or potential members are "jumped in". They have to be beaten up by members of the gang and take the beating in order to join. The degree of violence used in the ritual depends on if you are barrio or non barrio. Getting the gangs tattoo is also a sign of toughness and commitment.

Prison is somewhat different. When an inmate arrives, someone has to sponsor him. The landlord will send someone to check out his papers and he has to prove himself. If something goes wrong, the member that sponsored him, has to take care of the problem. There is an imaginary line in prison gangs. If one is allowed to step over the line, he can never go back. It is a lifetime commitment of 24-7. The only way out is death. These groups pledge their lives to the family and put the cause above all else. Many are doing life sentences but still call the shots from behind the walls.

According to the California Department of Justice, in 1992, there were 1,272 validated gang members in the correction system. Validated members are automatically assigned to Pelican Bay SHU facility at a cost of $20,730 a year. That same year, there were 5,098 gang members in the youth authority at a cost of $31,370 per year.

Pelican Bay is an ultra modern facility located on the Oregon border. It has been called the Alcatraz of the 90's. A person serving a life sentence without possibility of parole may be placed in general population and be afforded human contact while a validated gang member in for petty theft is placed in the SHU or secure housing unit. The SHU unit is suppose to eliminate gang communication and operation. Inmates are kept in their cells 23 hours a day and are only out for a shower or a workout in the dog yard. There are no windows in the SHU cells and the doors are solid with pinpoint holes. Still, the inmates do find very effective modes of communication and always know what is going on.

The structure of the gangs are the same. The dynamics of membership is divided along the following lines:

Core Members are the leaders and regulars of the inner clique involved with the day to day operation of the gang. They set the standards, recruit, and set the tone of the groups behavior. The more hard core the core members, the more violent the group will be.

Associate and Peripheral Members have a lower status and may hold alliance to one particular core member. They do not see themselves as being an important part of the group.

Floaters have a very high status. They are articulate, resourceful, and know where to go and who to see to get things done. They are often used in peace talks and negotiations with rival gangs. For example, one floater was called upon by prison officials during this research to end fighting between the north and south which had resulted in a shooting and several stabbings. The problem was the number of days that each group had in the yard. The floater was able to work out a fair and equal number of days for each side to use the yard and future trouble was avoided.

Wanabes and Recruits are the younger, aspiring or potential members of the gang. This group can also be the most dangerous because their reasoning ability is not fully developed and they have a need to prove themselves.

O.G. or Veterans are usually in their mid 20's and have already devoted years of their life to the gang and survived. They are usually not as visual or as active. Those in jail are symbols and still have considerable influence.

Why join a gang? When ask. most street gang members and prison gang members gave the same or similar reasons. All those interviewed listed protection as a major factor. Identity was the second most common reason for joining a gang. Many felt alienated from the community that they lived in. They felt as if they were being discriminated against in school, by law enforcement, and society as a whole. One young man stated that the "teachers did not expect me to do much of anything but join a gang and drop out of school, so that's what I did." Many were searching for a sense of family or belonging. What they could not get at home from parents, they found on the streets in brotherhood. Not all, but a large number of those interviewed came from divorced or single parent homes. One common thread found in all interviews and in the questionnaires was the quest for love and acceptance.

Another factor in gang membership was economic survival. Many young people indicated that they had turned to gang life as a means of earning a living. Chicano youth from disenfranchised neighborhoods characterized by overcrowding, high unemployment, high drop out rates, and lack of social and recreational outlets, are more likely to turn to gangs. More than 75% of the gang members studied did not have a high school diploma. Lack of education makes finding a job paying more than minimum wage almost impossible.

Perhaps the saddest fact of all was the sense of hopelessness. Many of the young men did not have dreams beyond the streets. Many indicated that they did not expect to live past forty. For all the bravo and tough faces shown by the prison gang members, it was obvious that self-esteem was extremely low and fear of living, not dying, very high. They had never had the experience of being told that they were an important and productive part of society. Somewhere along the line, someone failed to give these young men the coping skills and the self esteem needed to compete in a discriminating society that has the need to dominate. Where society failed, the brotherhood of the gangs were successful.

CONCLUSION

Studies indicate that gangs exist for multicausual reasons. Economics, political, law enforcement policy, and attitudes, as well as group identity all play a major role in the staying power of gangs. Gangs are not all bad. They exist to meet needs that are not being met elsewhere. All gang members are not from poor families. In the case of Chicano gangs, discrimination and marginal acceptance as well as protection play a major role in gang formation.

The existence of Chicano gangs can best be explained using the Colonization Theory and the Radical Theory. Quinnery stated it best when he wrote:

> Society is characterized by diversity, conflict, coercion, and change..rather than by consensus and stability..Law incorporates the interest of specific persons and groups; it is seldom the product of the whole society. Law is made by men, representing special interest, who have the power to translate their interest into public policy. Unlike the pluralistic conception of politics, law does not represent the diverse interest in society, but supports some interest at the expense of others (35).

Crime, deviance, and gangs are common among immigrants because they are often forced into poverty. Chicanos however, were a colonized group who did not immigrate. Instead they were forced in mass to accept the

867

American ideal. American society is a diverse racial-ethnic mix of groups that have not been integrated into a cohesive "melting pot" but rather is a society characterized by the subordination of some groups by others who benefit from their subordinate status.

To put this into perspective, Europeans came to the United States freely and as individuals while Mexicans were forced involuntarily en mass. The same thing happened in Ireland when it was colonized by the British. The result was the formation of the Irish Republican Army which is still fighting to this day.

Even though the Mexican colonized group came from a superior civilization, they still end up at the bottom of the socio-economic and political ladder. Their subordinate status makes for a cheap labor force. All the while, the dominate group strives to eradicate the language, customs, and heritage of the sub group. Diego Vigil discussed the insensitive education practices that often promote drop outs among the Chicano youth in several of his gang studies. Children need to feel appreciated and accepted as a valuable part of the society that they exist in. If they do not have their needs met by society, they will have them met on the streets.

According to Arnold Goldstein, the Radical Theory "goes far beyond mere matters of labeling, differential opportunity, or like concerns. Its target is no less than the social and economic structure of society."(17) Quinney explained the specific propositions of the theory from a sociopolitical thrust which when condensed states that crime and gangs are created by the wealthy who control the capitalist economy and make the laws. Laws are used by the elite class to subjugate the poor, minorities, and the weak. Government agencies are regulated by the government who represent the primary interest of the wealthy. Coercion is used because a capitalist society cannot exist without a subordinate class.

As long as the state of California chooses to validate gang members for tattoos and conversations change cannot occur. After parole, gang members hit the street and usually end up flipping burgers or washing dishes at minimum wage until the humiliation and frustration sets in and they break parole. More than 85% of the members in this study have been in and out of juvenile facilities and prison. Most of the population indicated that they would like to make a change but do not see it happening.

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BIBLIOGRAPHY

Goldstein, Arnold P. Deliquent Gangs A Psychological Prespective. Champaign: Research Press, 1991.

Huff, C. Ronald ed. Gangs in America. Thousand Oaks: Sage Publications, 1996.

Mirande, Alfredo. Gringo Justice. Notre Dame: University of Notre Dame Press, 1987.

Moore, Joan and Vigil, Diego.(1983). "Residence and Territoriality in Chicano Gangs". Social Problems, 31, 182-194.

Quinney, R. Critique of Legal Order: Crime Control in Capitalist Society. Boston: Little, Brown, 1974.

The Relationship Between Parents' and Adolescents' Values

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The purpose of this study was to examine the relationship between adolescent and parent values. Survey research was conducted to gather information regarding demographics and personal values from 30 parent-child dyads. Based on prior research, we hypothesized that: 1) parent and adolescent values would differ, 2) female adolescents' moral reasoning would be more similar to their parents' than their male counterparts, and 3) female and male adolescents' values would differ significantly. Use of Pearson's r and Analysis of Variance ($p < .05$) yielded results that supported the hypotheses. This indicates that parents are not the sole source of guidance in the process of value formation.

Young adolescents' attitudes and behaviors are often a reflection of their parents' beliefs. They are influenced by the words and actions of those individuals who have been responsible for them since their birth. However, as adolescents approach young adulthood, the values and morals they have grown up with are questioned. It is a time for the adolescent to grow in personal identity, think for him/herself, and take responsibility for his/her own actions (Marcia, 1966). The process of rethinking values and determining one's own beliefs should not be looked at as a rebellion, but rather a maturing process during which beliefs that guide our actions are formed (Miller, 1993).

These beliefs, which may also be referred to as a value system, are a cluster of an individuals' values (Kalven, 1982). Value systems include issues such as morals, values, and ideology. By contrast, a value is a single stable belief that guides our actions in any given situation (Miller, 1993). Values are also different from attitudes which cause an individual to view a given behavior in a favorable or unfavorable way (Kalven, 1982). While attitudes may change, values are generally more stable.

Why should values be studied? Values are necessary to gain membership in a social group. Different patterns of values are accepted by distinct groups, but acceptance of a groups' values are vital to gaining a place in a group (Werkmeister, 1967). Second, values affect the choices that we make. In today's world choices are abundant. Understanding how values are formed and transmitted allows a greater understanding of the factors affecting how choices are made and what different cultures value. Finally, the study of values, belief systems, and moral reasoning has a long history and has been explored from a variety of perspectives, one of which is psychological.

Modern psychological value theories have arisen from a developmental psychology perspective. The works of Kohlberg, Erikson, and Marcia are particularly important. Kohlberg's theory of moral development is based on the concept of internalization (Kohlberg, 1976). Internalization is the process of moving from external control of one's actions to internal control of one's actions. Though Kohlberg's levels of moral development are not tied strictly to specific age levels, it is likely that adolescents would be in level two, conventional reasoning. Within this level are two stages: interpersonal norms and social system morality. Interpersonal norms, stage three, is characterized by placing value on trust, caring, and loyalty; children in this stage often accept the belief systems of their parents. During stage four, social system morality, values are based on understanding of the social

869

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order, law, justice, and duty (Kohlberg, 1976). These two stages of level two characterize the changes that begin in adolescence as individuals mature. During stage three, adolescents still accept the belief systems of their parents, but as they move into stage four, adolescents may begin to compare their parents' beliefs with the values and belief systems set up by those outside of their family group.

The work of Erikson is also important in understanding what happens during adolescence. In Erikson's theory of psychosocial development, each stage of our lives has a conflict particular to it. During adolescence, we face the identity versus identity confusion crisis (Erikson, 1968). While in this crisis adolescents begin to think about future plans and goals. This stage requires the adolescent to make many choices about his/her identity, including the development of a value system.

A third influential contributor to the understanding of development during adolescence, Marcia, who elaborated on Erikson's theory. Marcia (1966) determined four identity statuses -- diffusion, foreclosure, moratorium, and achievement -- that were the result of differing levels of exploration and commitment. These stages require varying levels of exploration and commitment, and though a better outcome can be fostered by supportive parenting that allows the adolescent the freedom to determine his/her own identity, in the end it is a responsibility that belongs to the adolescent.

These three theories concerning the developmental tasks of adolescence lend themselves to the typical script that is pervasive in our society concerning adolescent-parent relations. As children enter adolescence, they are compliant and tend to share their parents' values. As adolescents mature, however, conflict arises as their individual identities emerge. During this time, a process of self-exploration and value formation begins which eventually results in the crystallization of the adolescent's individual belief system.

Although a difference in beliefs between adolescents and their parents is often evident, under some circumstances parents do influence the beliefs and values of their adolescent children. Female children, younger children, and children who have non-authoritative parents are more likely to share their parents' values. This assertion is based on research, discussed below, which indicates that children growing up with authoritative parenting, older adolescents and male children in particular, have been shown to exhibit the most widely differing beliefs from their parents (Dalhouse & Frideres, 1996; Paulson & Sputa, 1996; Harbach & Jones, 1995).

Newman & Muzzonigro's (1993) findings suggest that adolescents from traditional families experience a period of turmoil while forming their own values. This does not necessarily indicate that they will develop different life-long values from their parents, but that they must explore the issues for themselves. Adolescents' ability to feel secure in exploring values that differ from those of their parents is connected to the parenting style practiced by their parents. Widely used parenting style categories include authoritative, authoritarian, permissive-indulgent, and permissive-negligent. Children of authoritative parents tend to have conflicting values with their parents (Dalhouse & Frideres, 1996). This makes intuitive sense because these youths are confident enough in their relationship with their parents to openly disagree about values.

Older adolescents are also more likely to have different values from their parents. As children mature they experience less cohesion with their parents and are more likely to develop their own views (Paulson & Sputa, 1996; Dalhouse & Frideres, 1996). When children move from elementary schools to secondary schools they are introduced to new and divergent values. Additionally, through contacts made in extracurricular activities and increasing work opportunities, adolescents are exposed to a wider range of belief systems. As adolescents age, their peer network expands and their need for parental approval diminishes.

Gender is yet another factor that influences adolescents' values. Speicher (1994) found that during adolescence, girls were more affected by parental moral reasoning than boys. Perhaps this is because parents are traditionally more overprotective of their young daughters; consequently, female children are not as likely to be exposed to situations that give them access to differing beliefs. In addition, they are socialized to be accepting and submissive in our society, which would result in their values being more similar to those of their parents.

It can also be inferred from Speicher's (1994) research that there are, in fact, sex differences. In addition, support for this premise exists in the research of Beutel and Marini (1995) who found that females are both more compassionate and more concerned with the meaning of life than their male counterparts. Again, social norms dictate that females take on these nurturing roles. This difference in socialization would necessarily result in differences in values and belief systems.

The purpose of this study was to determine the effectiveness of value transmission from parent to child. Based on existing research and theories of value formation, we formed several hypotheses. First, we predicted that parents' and adolescents' values would differ. Second, we hypothesized that adolescent females' moral reasoning would be closer to that of their parents' value systems than would their male counterparts. Finally, we proposed that adolescent males and females would differ significantly from one another on values.

METHOD

Participants. Participants for the study were obtained via two E-mail messages. The first of these was sent to the faculty and staff of a small, private college. The second was sent to the employees of a local business. The messages requested voluntary participation be any family with one or two children between the ages of 11-18.

From the advertisements we received approximately 70 responses. Eighteen replies came directly form college faculty and staff in the form of returned E-mails or phone calls and 7 more came in the same form from the employees of the business. In addition, one of the contacts made a at the college suggested seeking more participants from a local church youth group. This resulted in the remaining 45 respondents. Of those who responded, a total of 27 family dyads were actively involved in the study. Three of the families had two adolescents which made the total number of participating families 30 (parents were counted twice as if in two different families for this study).

Over half of the participants were affiliated with the local church and its youth group. The oldest adolescent was 18 and a student at another local college. The youngest participant was 12. The study had 16 male adolescents and 15 female adolescents. Neither race of participants nor age of parents were determined.

Design and Materials. Participants were asked to complete a survey based on Crisman's Moral Behavior Scale (1942). We chose this scale because rating scales have been shown to have a higher predictive validity than ranking methods (Kamakura & Mazzon, 1991). The scale was modified and updated to contain 25 questions relevant to today's society. A Likert scale was used to rate the 'rightness'--1, or 'wrongness'--5 of a given situation. The survey was scored by totaling the numbers associated with the Likert scale for each question. Possible scores ranged from 25 to 125, with a higher score indicating a greater level of conservatism.

Using these values, we attempted to find a correlation between parent values and adolescent values, parent values and female adolescent values, and male and female adolescents values. Predictor variables included gender of adolescent and parental value score. The criterion variable was the adolescent's value score.

Procedure. Packets containing a consent form, an instruction sheet, one parent survey, and one survey for each adolescent in the family were personally delivered to each faculty and a staff member at the college and to each employee a the local business. Fifty survey packets were also given to the director of the youth group at the local church so that he was able to distribute them at their weekly session. All packets were collected within a week of their distribution. A total of 30 surveys were returned.

The parents were instructed to read through the survey and approve it before allowing their child to participate. Once the parent had completed this task, both the parent and the child were asked to sign the consent form. Only the parent who had exhibited interest in the study was to complete the survey. Both the parent and the adolescent(s) were asked to complete the survey individually while at home. Only after both surveys were completed and returned to the envelope was discussion supposed to take place.

RESULTS

Pearson's *r* was used to correlate parent and child value scores. These scores were obtained by summing the numerical responses to each survey question. As predicted, there was no evidence of a significant correlation between these two variables (*r* = .185, N = 30, *p* ≤ .163).

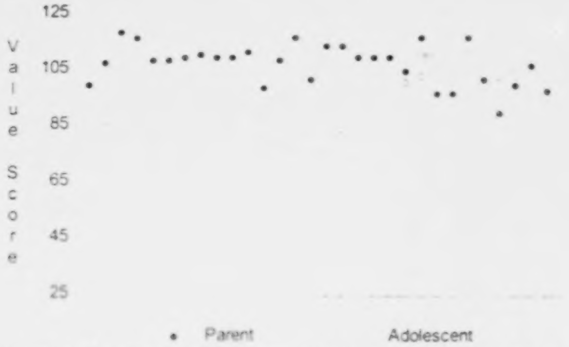

Figure 1. Parents' and adolescents' value scores are shown; each pair represents a parent-child dyad.

Pearson's *r* was also used to correlate the female adolescents' values to their parents' values. It was found that female adolescents tend to have values similar to those of their parents (*r* = .627, N = 14, *p* ≤ .008). There was no significant correlation between male adolescents' values and their parents' values (*r* = -.173, N = 16, *p* ≤ .260).

An Analysis of Variance was utilized to determine a significant difference between adolescent male and female values (*F*(1, 29) = 4.33, *p* ≤ .05). The independent variable was gender, and dependent variable was the adolescents' value scores. The mean value score for the male adolescents was 98.25, while the mean score for females was 105.93. This test indicates that males and females do have different values, and that females are more conservative than males.

DISCUSSION

Based on the results, the study indicated that parent and adolescent values are different. This indicates that the process of value transmission between parents and their adolescents is complex. One possible explanation for this difference in values is that the adolescents may be in the period of turmoil described by Newman & Muzzonigro (1993), during which the adolescent may be exploring many different values and belief systems. This does not necessarily indicate that these individuals will always have values different from those of their parents, but that they are trying out different beliefs to find the best fit. Newman & Muzzonigro's (1993) explanation of the lack of correlations between parents and adolescents values is also consistent with Marcia's (1966) theory of identity statuses and Erikson's (Erikson, 1968) theory of an identity crisis, since both of these theorists also describe a period of turmoil and exploration.

Another explanation for this finding is that adolescents are exposed to many potential sources for values, only one of which is their parents. Today's adolescents, unlike those of past centuries, come into contact with more than just family members. Unlike rural children of past centuries who grew into their parents' occupations as well as their values, modern adolescents are exposed to alternate value systems through their exposure to differing cultural, ethnic, and religious traditions at school, in the community, and even at home in blended families.

After examining the relationship between parents and children, the study also examined gender differences among the adolescents themselves. The research suggests that female adolescents' moral reasoning was more similar to their parents than the values of their male counterparts. This is consistent with Speicher's (1994) study. This may be due to the fact that society traditionally raises male children to be more individualistic and female children to be more submissive to their parents' wishes. As Mlboya (1995) found, parents often act differently towards their children depending upon each child's gender. These actions result in females being socialized to associate more closely with their parents than males.

Finally, the study showed that male and female adolescents' values differ from one another. This supports Beutel and Marini's (1995) research which suggested that there are differences in moral reasoning between males and females. Our results indicate that male adolescents tend to be more liberal than both their parents female peers. Again, this may be attributed to socialization. Based on research previously discussed, it can be assumed that male and female adolescents are treated differently by both their parents and society as a whole. This would offer a plausible explanation for why male and female adolescents' values are significantly different.

While this study has shown that adolescents' values are typically different from those of their parents, female adolescents' values are more likely to be influenced by those of their parents, and male and female adolescents' values differ significantly, it has also established that value transmission is a complex process. While parents play a crucial role in the development of their children, the influences of culture, technology, and adolescents' peers can not be discounted. There are several considerations which should be noted when interpreting this data. They include self-selection of participants, inability to insure identical conditions for all participants when completing the survey, and inability to insure complete privacy within participating families. Because the participants volunteered to take part in this study, generalizations should be made cautiously. Additionally, many of the participants were affiliated with a local church, which may have resulted in a sample bias that could have altered the outcome. It is also impossible to insure that all participants completed the survey in comparable conditions because the surveys were completed in their homes. Therefore, future studies should take these issues into account when planning further research.

ACKNOWLEDGMENTS

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REFERENCES

Beutel, A. & Marini, M. (1995). Gender and values. American Sociological Review, 60, 436- 448.

Crissman, P. (1942). Temporal changes and sexual difference in moral judgments. Journal of Social Psychology, 16, 29-38.

Dalhouse, M. & Frideres, J. S. (1996). Intergenerational congruency: The role of the family in political attitudes of youth. Journal of Family Issues, 25, 227-248.

Erikson, E. H. (1968). Identity: Youth and crisis. New York: W. W. Norton.

Harbach, R. L., & Jones, P. W. (1995). Family beliefs among adolescents at risk for substance abuse. Journal of Drug Education, 25, 1-9.

Kalven, J. (1982). Personal value clarification. In B. Hall, J. Kalven, L. Rosen, & B. Taylor (Eds.), Readings in value development (pp. 7-19). Ramsey, NJ: Paulist Press.

Kamakura, W. A., & Mazzon, J. A. (1991). Value segmentation: A model for the measurement of values and value systems. Journal of Consumer Research, 18, 208-218.

Klein, J. T. (1982). A brief history of value philosophies. In B. Hall, J. Kalven, L. Rosen, & B. Taylor (Eds.), Readings in value development (pp. 21-27). Ramsey, NJ: Paulist Press.

Kohlberg, L. (1976). Moral stages and Moralization: The cognitive-developmental approach. In t. Lickona (Ed.), Moral development and behavior. New York: Holt, Rhinehart & Winston.

Marcia, J. E. (1966). Development and validation of ego identity status. Journal of Personality and Social Psychology, 3, 551-558.

McDonald, G. (1982). Modern value philosophies. In B. Hall, J. Kalven, L.Rosen, & B Taylor (Eds.), Readings in value development (pp. 29-39). Ramsey, NJ: Paulist Press.

Miller, B. C. (1993). Families, science, and values: Alternative views of parenting effects and adolescent pregnancy. Journal of Marriage and the Family, 55, 7-21.

Mlboya, M. M. (1995). Variations in parenting practices: Gender- and age-related differences in African adolescents. Adolescence, 30(120), 955-961.

Newman, B. S., & Muzzonigro, P. G. (1993). The effects of traditional family values on the coming out process gay male adolescents. Adolescence, 28(109), 213-226.

Paulson, S. E. & Sputa, C. L. (1996). Patterns of parenting during adolescence: Perceptions of adolescents and parents. Adolescence, 31(122), 369-381.

Speicher, B. (1994). Family patterns of moral judgment during adolescence and early adulthood. Developmental Psychology, 30, 624-633.

Werkmeister, W. H. (1967). Man and his values. Lincoln, NE: University of Nebraska Press.

Attitudes of College Students Toward Using Animals In Research

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A recent study (Plous, 1996) reported that four out of five psychologists support animal research if it does not involve excessive pain or death for the subjects. However, the general public does not share the same level of support for animal research as the psychologists (Driscoll, 1992). The purpose of this survey was to determine the attitudes of African American college students who have and have not taken a live animal laboratory course. Fifty college students answered a survey dealing with their attitudes toward animal research. Results indicated that the responses of these students were similar to that of the general population. Students who had had research experience with animals responded more favorably than those who had not. These data are from the first year of a longitudinal study which will retest some of the participants after they have been exposed to a live animal research course.

INTRODUCTION

Research with animals has contributed to the control of many infectious diseases. However, there are several activist groups against using animals for research purposes because they feel it is unethical. The animal welfare movement initially focused on the humane care and use of animals: feeding, health care, housing, and alleviation of pain and discomfort. However, the more recent animal rights' movement, also referred to as the "animal liberation movement," has broadened its focus to the extent that animals are no longer viewed as appropriate resources to be used for any purpose by humans (Compton, Dietrich, Smith, & Johnson, 1995).

Animal research has raised many questions such as whether scientists should be allowed to do research that causes pain and injury to animals if it produces information about human health problems. Plous (1996) reported that eighty percent of psychologists support animal research if it does not involve excessive pain or death. That survey, entitled "Animals & Science: A Survey of Psychologists," was mailed to 5,000 randomly selected members of the American Psychological Association; 3,982 participants responded to the survey. Approximately 31.45% strongly supported the use of animals in psychological research, 46.6 % supported the use of animals, 9.1% opposed animal use, 5.0% strongly opposed animal use, and 5.8% responded "Not sure."

Gallup & Beckstead (1988) surveyed 263 college students who had varied majors. They were administered a questionnaire that contained 14 statements about animal research. Fifty-two percent of the participants were social science majors, 15 percent were business majors, 8 percent were humanities majors and 12 percent were undecided. Seventy-six percent expressed a concern about pain and suffering in animals. Approximately 73% percent of the students agreed that "many important biomedical breakthroughs are a consequence of animal research" (Gallup & Beckstead, 1988, p.475).

Pifer, Shimizu & Pifer (1996), reported that in the United States, 42% of the population are opposed to animal research. Past studies with students conducted in the United States have found that women are more likely to oppose animal research than men (Kellert & Berry, 1987). A recent comparison of attitudes in 15 countries found even greater support for animal rights in countries such as France, Belgium, and Great Britain. Because most radical animal activists are of European ancestry, one of the purposes of our research was to compare those students' attitudes with those of African American undergraduate college students. Because several undergraduate research training programs involve the use of animals, also the investigators wanted to determine whether participation in animal research or an animal behavior course might influence them with regard to a research career.

METHOD

Participants. Subjects included 22 male and 28 female college students at a predominately African American small liberal arts institution located in the southeastern region of the United States.

Procedures. The subjects were given a consent form and a brief demographic sheet and a questionnaire about their attitudes towards using animals in research. The questionnaire consisted of 19 questions about their attitudes about using animals in research. Once they completed the questionnaire the participants were instructed to place the questionnaire in an unmarked sealed envelope which was held in a separate box to insure confidentiality of the response. The entire process took approximately 10 minutes to complete.

RESULTS

In this paper we are focusing on questions concerning the need for animal research, personal support for animal research, the use of animal research in undergraduate courses, and the treatment of animals in studies designed to develop treatments for humans. As indicated in Table 1, responses to the questions addressing support of animal research suggested a positive attitude about the role of such research, especially among students who have had research experience with animals. Most of the students, regardless of their experience, believed animal research is necessary, although not all of these students said that they support such research. When asked if the use of animals is necessary for progress in psychological research, most respondents replied "Yes", but the support was greater among those who had experimented with animals. Approximately 74.1% of the participants who had experimented with animals responded "Yes", while 56.5% of those who had not experimented with animals said "Yes" (Figure 1). When asked about their personal support for such research, 59.3% of the students that had experimented with animals reported that they supported (or strongly supported) animal research, while 34.8% of the subjects who had no animal research experience supported it (Figure 2).

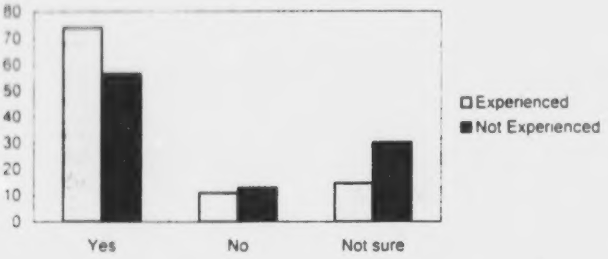

Figure 1. "Do you believe that the use of animals in psychological research is necessary for progress in psychology, or not?"

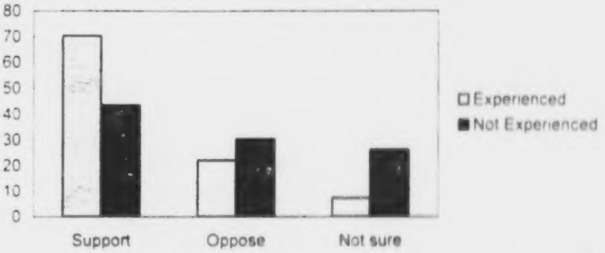

Figure 2. "In general, do you support or oppose the use of animals in psychological research?"

Having animal research experience appears to have a positive influence on some students who are undecided about the necessity of animal research in psychology and their support of such research. Of the subjects who had not experimented with animals, 30.4% answered "Not sure" when asked if animal research was necessary, whereas only 14.8% of the subjects that have experimented with animals said "Not sure". Approximately 7.4 percent of the participants that had experimented with animals said that the were not sure that they support the use of animals in psychological research, whereas 26.1% of the subjects that have not reported that they were "Not sure".

With regard to the use of animals in undergraduate psychology courses, 74.1% of the students who had experimented with animals reported that they supported the use of animals; 47.8 percent of the non-experienced students reported that they were in support of using animals in undergraduate psychology courses (Figure 3). However, support for making animal laboratory courses mandatory was not quite as strong. When asked "Do you feel that laboratory work with animals should be a required part of undergraduate psychology major?", 63.0 % of the subjects that had experimented with animals said "Yes" while only 30.4% of the students who had not experimented with animals replied "Yes" (Figure 4).

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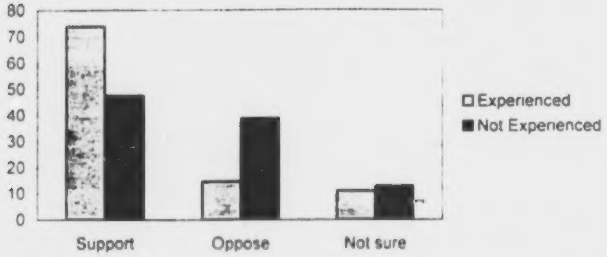

Figure 3. "In general, do you support or oppose the use of animals in undergraduate psychology courses?"

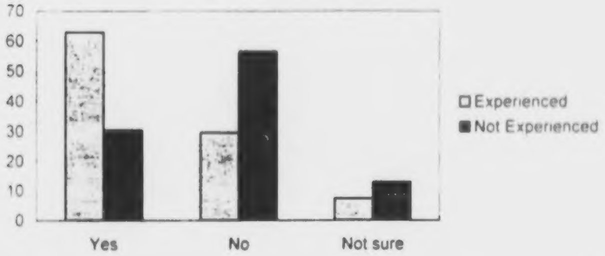

Figure 4. "Do you feel that laboratory work with animals should be a required part of the undergraduate psychology major?"

Experience with animals also appears to make students more sensitive to the well-being of the animal subjects. When asked, "Is it okay to inflict pain on animals to develop cures or treatment for pain or illnesses?," 44.4 percent of the students that had experimented with animals reported "Yes", whereas a majority, or 56.5 percent, of the subjects that had not experimented with animals reported "Yes".

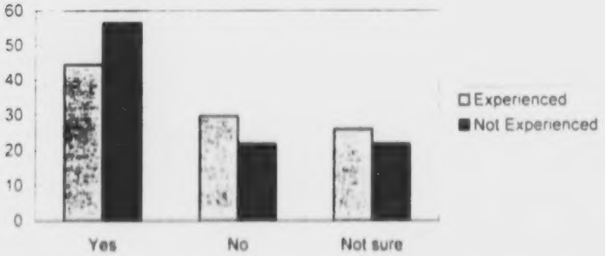

Figure 5. "Do you think it is okay for researchers to inflict pain on animals if it is going to develop cures or treatments for pain or illnesses?"

DISCUSSION

Students who have experimented with animals responded favorably toward using animals in research, while those who have had no animal research experience reported somewhat lower levels of support. One factor that may play a role in the non-experienced students' responses is their lack of familiarity with animal laboratory procedures. Thus, more of these students are "not sure" about their opinions regarding animal research. Having contact with animals in a laboratory situation appears to be a positive experience for many students; opinions tended to shift from "not sure" to support of animal research. It is interesting to note here that many psychology textbooks report data from animal experiments without making it clear that the subjects were animals (Domjan & Purdy, 1995), leaving students to assume that the information came from studies with humans (Cunningham, 1996). This may be an avenue by which to more effectively communicate the contributions of animal research to psychology.

We found that 58% of the African-American students that we surveyed supported animal research. This level is comparable to the level of support reported for college students (64%) reported by Compton, et. al (1995) and for adults in the United States (53%) reported by Pifer et al. (1996). Thus, it appears that these issues are of equal concern to everyone regardless of ethnic background.

REFERENCES

Compton, D.M., Dietrich, K.L., Smith, J.S., & Johnson, S.D. (1995). Animal rights activism and animal welfare concerns in the academic setting: Levels of activism and the perceived importance of research with animals. Psychologicl Reports, 76, 23-31.

Cunningham, P.F. (1996) Revealing animal experiments in general psychology texts: Opening Pandora's box. American Psychologist, 51, 734-738.

Domjan, M., & Purdy, J.E. (1995) Animal research in psychology: More than meets the eye of the general psychology student. American Psychologist, 50, 496-503.

Driscoll, J.W. (1992). Attitudes toward animal use. Anthrozoos, 5, 32-39.

Gallup, G.G. & Beckstead, W.J. (1988). Attitudes toward animal research. American Psychologist, 43, 474-476.

Kellert, S.R. & Berry, J.B. (1987). Attitudes, Knowledge, and Behaviors toward wildlife as affected by gender. Sociological Bulletin, 15, 363-371.

Pifer, L., Shimizu, K., & Pifer, R. (1996). Public attitudes toward animal research: Some international comparisons. Society and Animals, 2, 95-113.

Plous, S. (1996). Attitudes toward the use of animals in psychological research and education: Results from a national survey of psychologists. American Psychologist, 51, 1167-1180.

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Transitive Inference in Undergraduate College Students

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Transitive inference is a process that occurs when one is given specific information and from that information obtains additional ideas and concepts. The study of transitive inference has been performed using a number of animals, including rats and pigeons. Research shows that humans as young as age four are able to quickly infer information. Although most research with humans has used verbal procedures, this study presented information using nonverbal stimuli in undergraduate students. The results suggested that humans do successfully infer information.

INTRODUCTION

Transitive inference is a process that occurs when an individual is given specific information and from that information derives additional facts and concepts. An example is as follows:

1. If Mary is taller than Mike (A>B), and
2. If Mike is taller than Alan (A>C) then
3. Who is taller. Mary or Alan (A vs. C)?

This cognitive process occurs not only in humans, but also in a variety of animals including chimpanzees (Gillan, 1981), squirrel monkeys (McGonigle & Chalmers, 1977), pigeons (von Fersen, Wynne, Delius, & Staddon, 1991) and rats (Davis, 1992).

Transitive inference is more than successful performances on specific tasks, it covers a series of events that must demonstrate proper order and relationship. When these tasks are mastered, a subject's competence in managing transitive inference is made evident. When embarking on the challenge of transitive inference, he/she must rank objects on a ordinal scale and make judgments involving inferential logic. With transitive inference, items that have not been presented before must adopt a value relative to the other items on the scale (von Fersen, Wynne, Delius, & Staddon, 1991).

On tasks involving transitivity, humans are usually able to understand the required ideas if they are presented in a verbal format. All too often, when the information is presented nonverbally humans have difficulties while trying to determine the concept of transitive inference (Batsell, 1993). It is suggested that transitive inference is either the idea that one develops a hierarchy of a linear stimulus developed by Bryant and Trabasso (1971) where a five item series where is labeled as: A+B-B+C-D+E- (+ means correct and - means incorrect) or, transitive inference is the integration of a set of logical operations. Although transitive inference has been demonstrated in a number of species, the processes underlying this performance are not clearly understood (Steirn, Weaver, Zentall, 1995). The present experiment studied the transitive inference abilities of undergraduate students using a nonverbal task. It is felt that this experiment was needed in order to have more complete comparisons with transitive inference between animals and humans.

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METHOD

Participants

The participants were 15 undergraduate students from a small liberal arts college located in a large metropolitan city. The students were recruited by advertisements placed around the campus. When applicable, the students received extra credit in psychology classes for participating.

Apparatus

An IBM compatible personal computer was used. Turbo basic was the language used to create the computer program used during the entirety of the experiment.

Training Phase

The participants were asked to sign a consent form and fill out a demographic sheet and to sit at a computer while instructions were read. The instructions explained that each participant should "earn as many points as possible." After the instructions were read and all questions answered the participants saw simple directions on the computer screen asking them to type their initials and press enter. After this was complete the first two semicircles appeared on the screen.

Points were earned by choosing one of two semicircles presented simultaneously. The semicircles appeared on the screen until the participants chose one. The semicircles were one of five colors (red, blue, white, green, or purple). The pairs of colors were represented as: A+B-, B+C , C+D-, and D+E. Each color was randomly assigned to an A, B, C, D and E condition. All the colors were randomized in order to eliminate bias. Also, the stimuli pairs were presented randomly to the participants.

Each semicircle was one and three fourth inches wide and was presented three and one half inches apart. The semicircles were positioned on the middle of a black computer screen that was eleven by eight inches. Each semicircle had a different orientation and position when presented on the screen.

The participants chose the desired semicircle by pressing "F" for the semicircle on the left and "G" for the semicircle on the right. Once this occurred the two semicircles disappeared from the participants view and they saw one of the following screens: If the participants chose correctly, "Correct" appeared on the screen along with a dollar amount total, their accumulated points and a status bar which showed the participants how much time had passed. The reinforcement screen was displayed for two and one half seconds. Furthermore, the participants heard a brief beep each time the answer was correct. If the participants chose incorrectly, "Not correct...try again," a dollar amount total, the participants accumulated points, and a status bar appeared for two and one half seconds. The participants did not hear a beep if the chosen answer was incorrect. The words were presented in a gray color on a black screen. There were five trials given to each testing pair (there were four testing pairs). The Training phase lasted for a total 160 trials.

Testing Phase

During the Testing phase, another set of directions appeared on the computer screen. The directions explained that the participants had done well so far and that they needed to keep up the good work. The participants were told that during this segment of the experiment they would not know the total amount of money earned or how many points accumulated. The participants were reminded to earn as many points as possible although their earnings would remain unseen. In other words, the Testing phase was the same as the Training phase with these exceptions: No feedback was provided on correct/incorrect choices, and all combinations of the five stimuli pairs were tested. The status bar was all that the participants viewed after he/she chose the desired semicircle. The screen was presented for two and one half seconds.

During the Testing phase, the semicircles were presented as the following pairs: AB, AC, AD, AE, BC, BD, BE, CD, CE, and DE . The Testing pair being studied by the experimenter was the BD pair; (this pair was being tested because it had not been presented together previously). The same colors presented to the participants during the Training phase were also used during the Testing phase. All the colors and the stimuli pairs were randomized during the Testing phase.
This part of the experiment lasted through 100 trials. There were 10 blocks with 10 testing pair per block. After the final testing trial, the participants were debriefed, asked if they had any questions, and thanked for their time and effort. A credit sheet was given to the participants for extra credit in their psychology courses. The entire experiment lasted for approximately 20 minutes.

Dependent Variables

There were two dependent variables in this study: the choice made by each participant, using either the "F" key or the "G" key, and the reaction time of each participant during Training and Testing.

RESULTS

The results indicated that the number of correct responses improved over training trials. Initially, mean correct scores were not significantly different from chance (50%). The participants mean score was 69 percent. By the end of Training, the mean correct scores approached 90%. During the final two training trials participants' mean score was 74 percent. The analysis was, that participants learned the correct relations for the four training stimuli.

The most important data are the responses to the BD pair during Testing. B and D were equally reinforced (in BC and DE trials). Because this pair was not trained together previously, participants might not be expected to choose differentially. If, on the other hand, Training promotes a "mental ordering" of the five stimuli, then B should be preferred to D. In the absence of feedback about their choices during Testing, participants did choose the B stimulus significantly more often than predicted by chance. The mean correct response was .67 percent.(standard error equaled .06, 95% confidence interval = +/-13). Participants showed evidence of transitive inference.

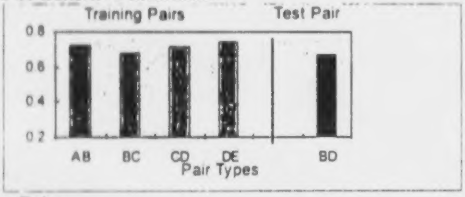

Figure 1 Training Pairs

DISCUSSION

The preference shown for the B stimulus in the BD test trials, demonstrated a logical ordering of the five stimuli. Some researchers argue that this "mental ordering" is established solely because of the reinforcement history. This is especially thought of in regards to the nonverbal approach of transitive inference. Still, others state that there is a more cognitive approach to transitive inference.

One goal of this study was to develop procedures with minimal spoken communication while studying transitive inference in undergraduate students. Because these procedures more closely approximate those used to study similar processes in animals, it is hoped that more thorough comparisons of inferential reasoning among species might now be possible. Proposed future studies will focus on the importance of distance between stimuli, and the effects of punishment during training in transitive inference.

REFERENCES

Batsell, W. R. (1993). A classroom simulation or transitivity problems in animals. Teaching of Psychology, 20, 228-230.

Bryant, P., B., & Trabasso, T. (1971). Transitive inferences and memory in young children. Nature, 232, 456-458.

Davis, H. (1992). Transitive inference in rats (Rattus nonvegicus). Journal of Comparative Psychology, 106, 342-349.

Gillan, D. J. (1981). Reasoning in the chimpanzee: II. Transitive inferences and memory in young children. Journal of Experimental Psychology: Animal Behavior Processes, 18, 311-312.

McGonigle, B. O., & Chalmers, M. (1977). Are monkeys logical? Nature, 267, 694-696.

von Fersen, L., Wynne, C. D. L., Delius, J. D , & Staddon, J. E. R. (1991). Transitive inference formation in pigeons. Journal of Experimental Psychology, 2, 334-341.

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Conflicts of Interest in the Early Stages of Intimate Relationships

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INTRODUCTION

Controversial issues in intimate relationships include annoying behaviors, arguments over relationship rules, and incompatible interests (Braiker & Kelley, 1979; Peterson, 1983; Witteman, 1992). Couples argue over how to spend money, how to have sex, how to distribute chores, and how to argue (Christensen & Heavey, 1990). Controversial issues usually differ in how important they are to each partner and how disruptive they are to the relationship. In addition, most partners tend to have some issues where they are willing to compromise, whereas other issues are not negotiable (Rubin, Pruitt & Kim, 1994). The latter ones are often issues where one's own position seems to be more justified and legitimate than the position of one's partner.

Whereas conflicts of interest merely indicate that partners hold different positions on an issue, judgments of legitimacy cast each position as "right" or "wrong" and imply that the legitimate position represents what "ought" to be done, while the illegitimate position "ought to change." Thus, a strong "self-legitimacy bias" may turn a conflict of interest into a battle for influence.

The present paper explores the issues couples are grappling with in more detail. First, which issues were raised by couples? Second, how important and disruptive were these issues for each partner? Third, how did partners perceive the legitimacy of their own position ("self-legitimacy") and the legitimacy of the other's position ("other-legitimacy")? How common were self-legitimacy biases and did they vary by gender or by conflict issue?

METHOD

Sample

Ninety-eight heterosexual couples at two state universities in the northeastern United States completed a questionnaire on conflict in close relationships. The sample was young in age and experience. Among the women, 48 were under the age of 21, 43 were between the ages of 21-25, and 7 were older than 25. Similar results were found among the men with 36 under the age of 21, 53 between the ages of 21-25, and 7 older than 25. Only one couple had been together for more than five years. For 21 women, this was their first relationship and 49 women had only had one or two prior relationships. Prior experiences for the men varied slightly, as only 13 were currently in their first relationship, and 42 had had only one or two prior relationships.

Procedure

The couple arrived at the research facility together; however, they completed all but one section of the questionnaire separately, under complete confidentiality. The participants were not interviewed, nor did they discuss the questionnaire with their partner. The questionnaire consisted of five sections, only one of which was completed jointly. In this, the first section of the questionnaire, each couple described a conflict they had experienced and indicated in a few words on the bottom of the first page what the conflict was about. After deciding on a conflict issue, the partners completed the remaining sections of the questionnaire separately.

Measurements

For this research, ratings on importance, disruptiveness, and legitimacy were analyzed. Each partner rated the importance of their conflict issue on a 5-point scale ranging from (1) very unimportant to (5) very important. A similar scale was used to rate disruptiveness ranging from (1) not at all disruptive to (5) extremely disruptive. Partners described their position and the other's position on the conflict issue and indicated whether they considered each position appropriate, legitimate, reasonable, and justified using four 5-point scales ranging from (1) strongly disagree to (5) strongly agree. Because scores on these four scales were highly correlated, they were averaged to form a single index for self-legitimacy and one for other-legitimacy.

The following example of Bob and Lisa (not their real names) illustrates how a conflict of interest can be intertwined with perceptions of "right" and "wrong". Bob and Lisa had a conflict of interest with regard to Bob's spending habits. Lisa's position was that Bob should take responsibility for his actions and be more careful with money. In contrast, Bob emphasized that he wanted to have fun and believed in living for today, not in worrying about tomorrow. Each partner found her or his own perspective extremely legitimate and discounted the legitimacy of the other's position.

This example shows how partners can evaluate their differences in terms of "I am right, and you are wrong" and thus implicitly place the burden of change on the other.

Content Coding

A coding system was developed to categorize the conflict issue raised by each couple (Sillars, Weisberg, Burggraf and Wilson , 1987; Weber, 1990). During the initial coding, conflict issues were categorized into broad content areas on the basis of the introductory statements listed by both partners. Examples included sex frequency, time together, money, relationship with friends, career choice, living arrangements, and relationships with ex-partners.

For the second coding, additional information from the questionnaire was used. Each partner's individual description of the controversial issue was analyzed to learn more about the conflict. These descriptions included her statements of her own position and her statement of his position as well as his statement of his own position and his statement of her position. The 98 issues were narrowed down to 13 categories. Next, the first and second coding were compared to obtain a final list of content issues. If a discrepancy existed between the first and second coding, the responses were once again reviewed and a category was decided on.

The categories were compared with those of another coder. The 13 categories were collapsed into a final category list of eight topics. A third, independent coder and myself coded all conflict issues again using the final list of eight categories. Our overall interrater agreement was Kappa=.778. Overall interrater agreement and agreement for individual categories was satisfactory.

RESULTS

Conflict Issues

Which issues were raised? Conflicts over relationship rules and third parties were most common. The relationship rules category includes arguments over reliability, dependability, being on time, and neatness, as well as arguments over how to use substances such as nicotine and alcohol, and how to have sex. These issues were raised by fifteen couples; the interrater agreement in this category was Kappa=.873. Third-party conflicts revolve around not getting along with each other's friends or family members and peers interfering with partners' attempts at being a "couple" (n=15; Kappa=.660). Also frequent were conflicts over the couple's future (e.g., to continue or end the relationship, to pursue similar or different careers; n=14, Kappa=.829) and over how much time to spend together as a couple (n=13, Kappa=.829). Twelve couples raised the issue of how to spend money (Kappa=1.000). Eleven couples were arguing over ex-boyfriends, ex-girlfriends, or potential sexual competitors (Kappa=.796). Issues concerning different values were raised by ten couples and included religious differences and different opinions about social issues (Kappa=.748). Finally, eight couples argued about assuming relationship responsibilities (e.g., distributing chores, whether to have children, how to show mutual respect; Kappa=.706).

Importance and Disruptiveness

The second question addressed gender and issue differences in importance and disruptiveness. The mean importance ratings were analyzed using an analysis of variance with issue as the between subjects factor and sex as the within subjects factor. Only the interaction between issue and sex was significant, that is men and women differed in the importance rating for certain issues only. In general, mean importance scores for women ranged from 4.7 for third parties to 3.6 for time; similarly, mean importance scores for men ranged from 4.3 for values to 3.1 for relationship rules.

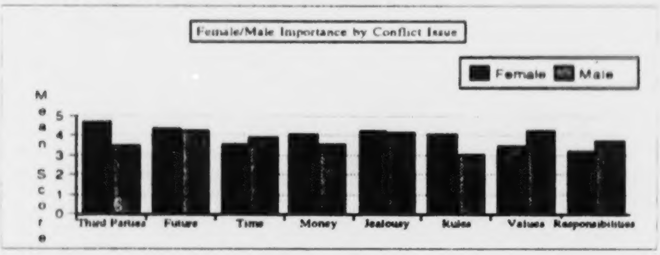

Figure 1: Female/Male Importance Rating by Conflict Issue

However, of the 15 couples who had raised a third party issue, the women's mean score on importance was 4.7, the men's mean score was 3.5. This difference was significant (t(14)=3.83, p=.002). The mean score for women's perceived importance of relationship rules was 4.0, the men's rating was 3.1. This difference was also significant (t(14)=4.18, p=.001). Results for importance ratings are shown in Figure 1.

Did women or men rate the level of disruptiveness of their conflict issue differently? Results of a multivariate analysis of variance with gender as a within subjects factor and conflict issue as a between subjects factor indicated that some issues were more disruptive than others, F(7, 89)=3.47, p=.002; neither the main effect of gender was significant, F(1, 89)=.79, p=.375, nor the interaction of issue and gender, F(7, 89)=1.17, p=.330. In general, both women and men rated jealousy as most disruptive (x=4.1 for women, x=3.9 for men), whereas values received a low disruptiveness rating by both the males (x=2.6) and females (x=2.5). The results of the disruptiveness ratings are shown in Figure 2.

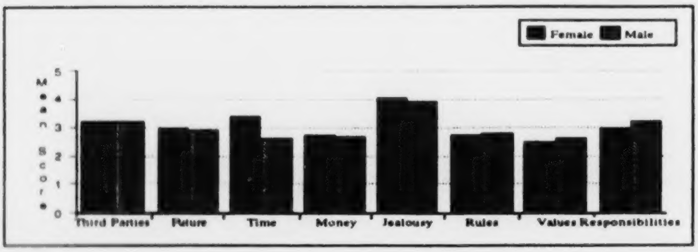

Figure 2: Female/Male Disruptiveness Rating by Conflict Issue

Self- and Other-Legitimacy

Next was the issue of legitimacy. The results of the legitimacy analyses are illustrated in Figure 3. Men and women's self-legitimacy ratings did not differ significantly and were combined in one score. Similarly, men and women's other-legitimacy ratings were not significantly different and therefore averaged.

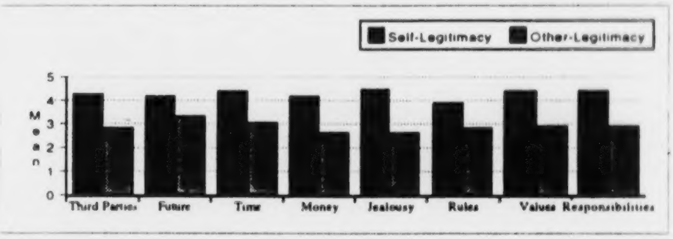

Figure 3: Legitimacy of Position

As illustrated in Figure 3, self-legitimacy was rated higher for all conflict issues while other-legitimacy was rated lower, F(1, 73)=134.06, p=.000. A few of the conflict issues were seen as slightly more legitimate than others, but for the most part the difference was very small, F(7, 73)=1.65, p=.136. For example, self-legitimacy ratings for all conflict issues except for relationship rules were in the range of 4.2-4.5. The rating for relationship rules was 4.0. The same was true for other-legitimacy, conflict issue did not make a difference in legitimacy ratings. All conflict issues ranged from 2.6-3.3. No other-legitimacy ratings were higher than 3.3.

Are self-legitimacy biases larger for some issues than for others? Figure 3 shows that women and men alike display a considerable amount of "self-legitimacy bias." However, closer inspection of the differences between self- and other-legitimacy suggested that women were particularly concerned about self-legitimacy when the conflict was over relationship rules; women's difference score (self-legitimacy minus other-legitimacy) was 2.00, men's was .64, t(13)=1.86, p=.086 (Figure 4). In contrast, men were particularly concerned about self-legitimacy when the conflict was over money ; women's difference score was .80, men's was 1.90, t(9)=2.54, p=.032 (Figure 5).

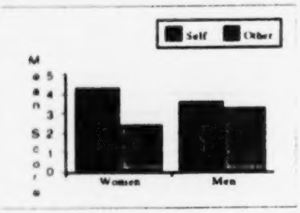

Figure 4:
Self- and Other-Legitimacy for Rules Issues

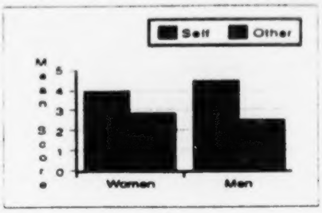

Figure 5:
Self- and Other Legitimacy for Money Issues

CONCLUSION

Controversial issues in this study fell into one of eight categories: relationship rules, third parties, the couple's future, spending time, money, jealousy, value differences, and relationship responsibilities. Problems involving friends or family members (third parties) as well as arguments over relationship rules were more important for women than for men. Both women and men described conflicts concerning jealousy as most disruptive and conflicts over value differences as least disruptive. Across issues, both partners thought of their own interests as the legitimate position while discounting the legitimacy of the other's point of view. Women were particularly clear about the legitimacy of their own position in conflict over relationship rules (e.g., sloppiness), whereas men emphasized the legitimacy of their own position in arguments over money.

This study can give only limited insight into the nature of conflict issues and the impact of issue identification on the conflict process. For example, the couples described only one controversial issue; it would be interesting to examine how the same couple responds to different issues. Also, this study used retrospective self-reports only; a promising research alternative would be to collect data on issue identification in the form of an ongoing conflict diary.

Nevertheless, the present findings highlight features of controversial issues that are central in issue identification. Particularly clear was the tendency to emphasize the legitimacy of one's own interest while discounting the legitimacy of the interests of the other side. This tendency can get in the way of problem-solving because it encourages partners to disregard the other's position, reduces their willingness to listen to the other side, and thus makes it more difficult to work on a problem together (Klein & Lamm, 1996). Partners may be less willing to compromise on conflicts of interest where they are particularly "biased" towards the merits of their own position as compared to issues where they can appreciate the legitimacy of the other's point of view. A "self-legitimacy bias" can fuel a partner's perception that the other is the "source" of the problem. While the merits of one's own position were obvious to most partners in the present study, only in one couple were partners able to appreciate the other's point of view. Although unable to reach consensus, this couple showed mutual respect and avoided the battle for influence.

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REFERENCES

Braiker, H.B. & Kelley, H.H. (1979). Conflict in the development of close relationships. In R.L. Burgess & T.L. Huston (eds), Social exchange in developing relationships (pp. 135-168). New York: Academic Press.

Christensen, A. & Heavey, C.L. (1990). Gender and social structure in the demand/withdraw pattern of marital interaction. Journal of Personality and Social Psychology, 59, 73-81.

Klein, R.C.A. & Lamm, H. (1996). Legitimate interest in couple conflict. Journal of Social and Personal Relationships, 13, 619-626.

Peterson, D.R. (1983). Conflict. In H.H. Kelley et al., Close relationships. New York: Freeman.

Rubin, J.Z., Pruitt, D.G. & Kim, S.H. (1994). Social conflict (2nd ed.). New York: McGraw-Hill.

Sillars, A., Weisberg, J., Burggraf, C.S. & Wilson, E.A. (1987). Content themes in marital conversations. Human Communication Research, 13, 495-528.

Weber, R.P. (1990). Basic content analysis. Newbury Park, CA: Sage.

Witteman, H. (1992). Analyzing interpersonal conflict: Nature of awareness, type of initiating event, situational perceptions, and management styles. Western Journal of Communication, 56, 248-280.

Social Adjustment of Children and Adolescents with Juvenile Rheumatoid Arthritis: Parent Report

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Parent report of social adjustment was examined for children and adolescents with juvenile rheumatoid arthritis (JRA) and non-chronically ill comparison peers. The parents of 35 children and adolescents with JRA and the parents of 35 non-chronically ill comparison peers completed the Child Behavior Checklist (CBCL). The Total Social Competence Scores on the CBCL were examined. It was expected that the children and adolescents with JRA would have lower Total Social Competence Scores than the non-chronically ill comparison children and adolescents. It was also expected that the adolescents with JRA would have lower Total Social Competence Scores than the children with JRA. Contrary to these hypotheses, neither illness status (JRA or control) nor age significantly affected the Total Social Competence Scores. The implications of these findings are positive in terms of psychosocial adjustment for children and adolescents diagnosed with JRA.

BACKGROUND

Juvenile rheumatoid arthritis (JRA) is a chronic illness that affects about 250,000 children in the United States today (Schaller, 1980). It is a disorder involving the inflammation and overgrowth of the synovium, the thin membrane lining the space around joints which secretes a fluid that allows the cartilage to move without friction and facilitates joint movement. JRA ranges in severity from pauciarticular (affecting four or fewer joints) to polyarticular (affecting five or more joints) and systemic (affecting internal organs as well as joints) (Cassidy & Petty, 1995). Children with this disease experience periods of stiffness, swelling, and pain in their joints. In addition to pain, fatigue is a common symptom of JRA, and growth retardation and abnormalities are frequent complications of the disease (Cassidy & Petty, 1995). JRA is treated with a strict routine of exercise, medication, nutritional support, and surgery. Although many children and adolescents with JRA outgrow their disease, about five percent of children with JRA have recurrent arthritis as adults, and about 10 percent enter adulthood with severe disabilities (Cassidy & Petty, 1995).

In addition to the above physical challenges, children and adolescents affected by JRA may be faced with social stressors related to the disease, including social development (McAnarney, Pless, Satter, & Friedman, 1974). For example, daily pain and debilitation may make it difficult for children and adolescents with JRA to lead "normal" social lives. Aside from social activities being restricted by physical limitations, children with JRA may be limited further by strict treatment regimens and frequent hospitalizations resulting in an increase in absenteeism from school. It is developmentally important for children and adolescents to feel accepted by their parents and siblings and to find social acceptance beyond their home life.

Several studies have focused on the social impact of JRA, and findings have been equivocal. Some studies have found that children and adolescents with JRA score lower on measures of social competency than either comparison groups (Timko, Stovel, Moos, & Miller, 1992; Zeltzer, Kellerman, Ellenberg, Dash, & Rigler,

1980) or population norms (Ennett et al., 1991). Zeltzer et al. (1980) utilized child report and found that adolescents with JRA experience more illness and treatment-related disruption of body image than non-chronically ill adolescents and other chronically ill adolescents. This study also found that adolescents with JRA experience more problems with parents than non-chronically ill adolescents. Examining a combination of parent and child reports, Timko et al. (1992) found that children and adolescents with JRA participate in fewer extracurricular school activities and fewer activities with friends than non-chronically ill children and adolescents. In relation to population norms, Ennett et al. (1991) concluded that children with JRA have significantly poorer social competence and emotional functioning.

In contrast to the above results, other researchers have found that children and adolescents with JRA do not differ significantly from either comparison groups (Harris, Newcomb, & Gewanter, 1991) or population norms (Thompson, Varni, & Hanson, 1987; Wallander, Varni, Babini, Banis, Wilcox, 1988). Harris et al. concluded from a combination of child, parent, and school reports that having JRA was not associated with detrimental outcomes. Through classroom observations, they found that children with JRA have peer relations that were quite similar to those of children without chronic illness. Through parent report, Thompson et al. (1987) found no significant differences between children with JRA and population norms in social competence scores.

Ungerer, Horgan, Chaitow, & Champion (1988) examined social variables, such as self-perception and social contacts, and their effect on adjustment in children and adolescents with JRA. They found that these variables differed between the age groups. Social adjustment in children was found to be more strongly associated with positive perceptions of the self and others, whereas social adjustment in adolescents was found to be more strongly associated with positive self-perceptions and social contacts outside of the family context. This suggests that social adjustment may be different for children than adolescents. Adolescents have an increased understanding of bodily processes and underlying pathology (Dolgin et al., 1989), but they have yet to acquire adult coping mechanisms (Goldberg & Tull, 1983). Important developmental tasks during adolescence include achieving independence and autonomy from one's parents, establishing a comfortable body image, forming goals for future career development, and finding social acceptance beyond the home environment (Gavaghan & Roach, 1987; Goldberg et al., 1983; Zeltzer et al., 1980). Hospitalizations and being bound to the home due to stiffness and pain generally detract from the amount of freedom adolescents with JRA are able to enjoy away from their home.

A few studies have examined this issue of age and social adjustment in children and adolescents with JRA. In one study, it was found that diminished social competence was weakly associated with older age (Daltroy et al., 1992). However, in another study, it was concluded that age did not significantly affect social competence (Wallander et al., 1988).

Inconsistencies in the current literature may be due to multiple methodological limitations. First, some of the current studies utilize nonstandardized measures (Ennett et al., 1991; Ungerer et al., 1988; Zeltzer et al., 1980). Using such instrumentation results in questionable validity of the results of the study. Second, nonrepresentative samples due to ascertainment bias can produce in skewed results. Finally, some of these studies either do not have a well-matched comparison group (Zeltzer et al., 1980) or have no comparison group at all (Daltroy et al., 1992; Ennett et al., 1991; Thompson et al., 1987; Wallander et al.,1988). A well-matched comparison group is essential in determining whether or not children and adolescents with JRA have poorer social competence than their non-chronically ill peers. Simply comparing the social competence scores of children and adolescents with JRA to test norms may not provide valid results due to cohort effects or regional variations in scores.

It is especially important to utilize a well-matched control group in research involving standardized measures such as the CBCL. Achenbach & Howell (1993) conducted a 13-year comparison study utilizing the CBCL to determine whether the original norms are representative of current populations. It was found that more untreated children in the 1989 sample (18%) than in the 1976 sample (10%) would be considered to need clinical assistance and social competence scores were lower in the 1989 sample than in previous samples. This finding suggests that there has been an overall shift in parent perceived behavior problems, and social competence for children. This evidence of a cohort effect is clear support for the necessity of a well-matched control group when using a measure such as this in research. A similar study was conducted by Sandberg, Meyer-Bahlburg, & Yager (1991). These researchers also found that, of the nonclinical sample of boys, for example, tested in 1987-88, 17% (versus 10% in the CBCL nonclinical sample) fell within the clinical range on the Total Social Competency, and 20% (versus 9%) exceeded the clinical cut-off for Total Behavior Problems. Sandberg et al. also found significant race/ethnicity effects, which also account for regional effects. In the current study a well-matched control group is utilized, a standardized measure of social competence which has been shown to be valid and reliable is used, and ascertainment bias is minimal.

The current study utilizes parental report of social competence on the CBCL to assess social adjustment of children with JRA in comparison to a matched control group of non-chronically ill peers. The Total Social Competence Scores are based on the compilation of the Activities, Social, and School scores on the CBCL. It is expected that the Total Social Competence Scores from the CBCL will be lower for children and adolescents with JRA than for non-chronically ill comparison children. It is also expected that adolescents with JRA will have lower Total Social Competence Scores than children with JRA.

METHOD

participants

Participants were selected from the files of children with JRA who were receiving treatment at the Children's Hospital Medical Center (CHMC). Nearly every child with JRA living within a 50-mile radius of the medical center receives treatment at CHMC because it is the only treatment center in the area staffed with board-certified pediatric rheumatologists. Potential participants were included if they met the following criteria: 1) diagnosed with JRA according to American College of Rheumatology classification standards (Cassidy & Petty, 1995); 2) receiving no full-time special education; 3) between 8 and 14 years of age; and 4) living within 20 miles of CHMC. These criteria generated a potential sample of 40 children with JRA. Four of the families of children with JRA declined to participate, and one family of a child with JRA could not be located.

The comparison participants were selected from the classrooms of the children with JRA. They will be referred to as the matched classroom comparison peers (MCCP). A list of all the children in the classroom of a child with JRA who were the same race and gender as the target child was compiled. The child on the list with the closest birthdate to the target child was then selected. The families of the potential MCCP were contacted, informed about the general nature of the study, and asked to participate. If a family did not agree to participate, the family of the child with the next closest birth date to the target child was then selected, and so on until a family agreed to participate. Only three of the MCCP were not first choices.

This study is part of a larger ongoing project which includes longitudinal data collected from parents, teachers, peers, and children with a variety of chronic illnesses.

measure

Child Behavior Checklist (Achenbach, 1991) The CBCL is a parent report of a child's current social competence. It is composed of 20 social competence items. The focus of the current study is on the 20 items measuring a child's activities, peer relations, and school performance, which compose the Total Social Competence Score. This checklist has been standardized on 1,300 community nonclinic-referred and 2,300 mental health clinic-referred children between the ages 4 and 16, and it has been used extensively in clinical research. Scores on all scales were computed as normalized T scores. Daltroy et al. (1992) found a test-retest reliability of .82 to .90 for this measure, depending on the age/gender of the subgroup tested and found established validity.

procedure

The families of the children with JRA and the MCCP were contacted by phone and informed of the general nature of the study. The parents were told that the data collection would be scheduled at the family's convenience and that they would receive $50 for their participation. The research staff members who collected data were blind to the family's status (JRA or MCCP). Before the actual data collection, each family read a letter explaining the study and the parents and child signed an informed consent. Each parent was given a battery of questionnaires including the CBCL to be completed.

RESULTS

To test the hypotheses, a 2 (Total Social Competence Scores for children with JRA versus those of MCCP) x 2 (age less than or equal to 11.8 years versus greater than 11.8 years) analysis of variance (ANOVA) was used. This test revealed non-significant results (see Table 1), suggesting that social competence for children with JRA does not significantly differ from the social competence of MCCP regardless of age. Follow-up t-tests were also performed for the type of participant (JRA versus MCCP). These results were also statistically non-significant.

Table 1: Total Social Competence Scores of Younger and Older Children with JRA and Comparison Peers

	Younger (n=35)		Older (n=35)	
	Mean	SD	Mean	SD
JRA (n=35)	46.41	12.20	48.71	10.28
MCCP (n=35)	48.47	9.75	47.33	8.60

DISCUSSION

This study compared the social competence of children with JRA to MCCP based on parent report on the CBCL. Two hypotheses were considered in this study. First, it was expected that children with JRA would have lower Total Social Competence Scores than the MCCP. Analysis of the CBCL data revealed that there were no significant differences between the social adjustment of the children with JRA and the MCCPs. Secondly, it was hypothesized that older children with JRA would have lower Total Social Competence Scores than younger children with JRA. Analysis of the CBCL data also revealed no significant difference in social functioning between older and younger children with JRA. The implications of the results are positive ones for children diagnosed with JRA. The results suggest that the social adjustment of children with JRA and healthy comparison peers does not differ significantly. This outcome suggests that parents believe children with JRA have adequate coping strategies in dealing with their chronic illness and that they are socially accepted and well-adjusted.

Several factors may have led to insignificant results in this study. First, due to the relatively small sample size, power was limited. A larger sample may detect more significant differences. It is also possible that parent report may not be the most accurate report of a child's social adjustment. Perhaps self-report of the children or information from teachers or peers would have revealed significant differences in terms of social adjustment. Lastly, parents may have reported higher levels of social adjustment than actually was the case because they did not want their children to seem "abnormal."

Future research in this area should include child, teacher, and peer reports of social adjustment as well as parent report. Analysis of longitudinal data would be useful in determining changes in social adjustment throughout children's lives (e.g., possible change at the beginning of adolescence, change when the disease goes into remission). Also, it would be intriguing to administer a measure determining coping styles to children with JRA as well as to the healthy comparison children to determine if coping style is related to social adjustment.

REFERENCES

Achenbach, T. M. (1991). Manual for the child behavior checklist/4-18 and 1991 profile. Burlington, VT: University of Vermont Department of Psychiatry.

Achenbach, T. M., & Howell, M. S. (1993). Are American children's problems getting worse? A 13-year comparison. Journal of the American Academy of Child and Adolescent Psychiatry, 32, 1145-1154.

Cassidy, J. T., & Petty, R. E. (1995). Textbook of pediatric rheumatology (3rd ed.). Philadelphia, PA: Saunders.

Daltroy, L. H., Larson, M. G., Eaton, H. M., Partridge, A. J., Pless, I. B., Rogers, M. P., & Liang, M. H. (1992). Psychosocial adjustment in juvenile arthritis.

Journal of Pediatric Psychology, 17 , 277-289.

Dolgin, M. J., Katz, E. R., Zeltzer, L. K., & Landsverk, J. (1989). Behavioral distress in pediatric patients with cancer receiving chemotherapy. Pediatrics, 84, 103-110.

Dreher, N. (1995). Understanding juvenile rheumatoid arthritis. Current Health 2, 21, 13-15.

Ennett, S. T., DeVellis, B. M., Earp, J. A., Kredich. D., Warren, R. W., & Wilhelm, C. L. (1991). Disease experience and psychosocial adjustment in children with juvenile rheumatoid arthritis: children's versus mothers' reports. Journal of Pediatric Psychology, 16, 557-568.

Gavaghan, M. P., & Roach, J. E. (1987). Ego identity development of adolescents with cancer. Journal of Pediatric Psychology, 12, 203-215.

Goldberg, R. J., & Tull, R. M. (1983). The adolescent. In R. J. Goldberg & R. M. Tull (Eds.), The psychosocial dimensions of cancer (pp. 20-39). NY Free Press.

Harris, J. A. Newcomb, A. F., & Gewater, H. L. (1991). Psychosocial effects of juvenile rheumatic disease. Arthritis Care and Research, 4, 123-130.

McAnarney, E. R., Pless, I. B., Satterwhite, B., & Friedman, S. B. (1974). Psychological problems of children with chronic juvenile arthritis. Pediatrics, 53, 523-528.

Sandberg, D. E., Meyer-Bahlburg, H. F. L., & Yager, T. J. (1991). The child behavior checklist nonclinical standardized samples: Should they be utilized as norms? Journal of the Academy of Child and Adolescent Psychiatry, 30, 124-134.

Schaller, J. G. (1980). Juvenile rheumatoid arthritis. Pediatrics in Review, 2, 163-173.

Thompson, K. L., Varni, J. W., & Hanson, V. (1987). Comprehensive assessment of pain in juvenile rheumatoid arthritis: An empirical model. Journal of Pediatric Psychology, 12, 241-255.

Timko, C., Stovel, K. W., Moos, R. H., & Miller, J. J. (1992). Adaptation to juvenile rheumatic disease: A controlled evaluation of functional disability with a one-year follow-up. Health Psychology, 11, 67-76.

Ungerer, J. A., Horgan, B., Chaitow, J., & Champion, G. D. (1988). Psychosocial functioning in children and young adults with juvenile arthritis. Pediatrics 81, 195-202.

Wallander, J. L., Varni, J. W., Babini, L., Banis, H. T., & Wilcox, K. T. (1988). Children with chronic physical disorders: Maternal reports of their psychological adjustment. Journal of Pediatric Psychology, 13, 197-212.

Zeltzer, L., Kellerman, J., Ellenberg, L., Dash, J., & Rigler, D. (1980). Psychological effects of illness in adolescence. II. Impact of illness in adolescence - crucial issues and coping styles. The Journal of Pediatrics, 97, 132-13.

The Relationship Between Nicotine and Alcohol Dependence: Treatment Implications

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Several studies have demonstrated an extreme correlation between today's most common addictive behaviors - smoking and alcohol consumption. This link may be biological in nature. Indeed, the endogenous opioid system supports each addiction to some degree, permitting the symptom-substitution hypothesis, in which increased smoking would be considered a replacement for alcohol consumption. Some alcoholism treatment centers even encourage smoking in the belief that this may facilitate alcohol abstinence. In order to investigate the validity of such therapeutic strategies, 19 participants in a 12 week outpatient alcoholism treatment program were evaluated for changes in smoking and drinking patterns. Though data indicated a significant decrease in alcohol consumption and a significant increase in smoking, these changes were not significantly related. Thus, the lack of support for the proposed symptom substitution hypothesis, as well as the strong positive correlation between smoking and drinking levels during pretreatment, advocates a need for introducing smoking cessation approaches to recovering alcoholics.

BACKGROUND

Research has established smoking and alcohol consumption as the two most prevalent addictive behaviors in the world today. Several studies have also indicates an unusually high positive correlation between both behaviors (Bobo 1983, Walton 1972, Bobo 1993, Burling 1988). Indeed, rates of smoking are two to three times greater amongst alcoholics than amongst the general population (Burring 1988, Kozlowski 1986), and smokers are ten times as likely as non-smokers to be alcoholic (DiFranza 1990). The profound implications of these associations on health and treatment methodology have galvanized research on substance abuse disorders and addictive behaviors - the dynamic interplay of alcohol consumption and smoking is now a fundamental motif in scientific inquiry.

Both addictions are partially maintained by the endogenous opioid system. This relation permits the symptom-substitution hypothesis, in which smoking may be viewed as a substitute in an endogenous opioid system withdrawing from alcohol. Thus, many alcohol treatment centers maintain that smoking cessation attempts antagonize alcohol addiction therapies and increase risk of relapse (Bobo 1983, Miller 1983, Hurt 1994). Therapists may even encourage smoking in the belief that this may facilitate alcohol abstinence.

METHOD

In order to investigate the validity of such therapeutic strategies, we investigated smoking and drinking patterns in 19 alcoholics participating in a 12 week outpatient alcoholism treatment study. Patient demographic assessments reflected the sample's mean age, as well as gender and ethnic distribution.

We determined the correlation between smoking and alcohol consumption in alcoholics prior to alcoholism treatment, as well as the relationship between changes in smoking and drinking patterns during the twelve week treatment period. Study assessments included

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pretreatment measurements of smoking and drinking levels, weekly self-reports of number cigarettes per day, daily drinking diaries, weekly breathalyzers, monthly verification of drinking by friend or relative, monthly Liver Function Tests, and Alcohol Use Histories. Each patient reported to the treatment center once every week for a period of twelve weeks in order to complete designated surveys and tests. Patients also maintained individual logs of smoking and alcohol consumption throughout the twelve week study period.

Data analyses involved student 2-tailed t-tests, correlation tests, as well as mean and standard deviation measurements for demographic characteristics.

RESULTS

Results indicated that pretreatment smoking and drinking levels were highly correlated ($r = .58$, $p < .01$). Data analyses also revealed a significant increase in smoking ($t = 2.46$, 2-tailed significance = .02), and a significant reduction in alcohol consumption ($t = 5.05$, 2-tailed significance = .00) across treatment conditions. These changes, however, were not significantly correlated ($r = .03$, $p = .90$).

Demographic characteristics indicated a mean age of 42.83 years (reflecting an 18 patient sample size) with a standard deviation of 9.5 years. The majority of the 19 patient sample was male (68.4% male; 31.6% female). Caucasians represented the vast majority of the 19 patient sample (84.2% Caucasian, 10.5% Hispanic, 5.3% Unspecified).

CONCLUSION

The strong correlation between smoking and alcohol consumption during pretreatment, as well as the lack of support for a hypothesized substitution of smoking for drinking, emphatically pronounces the need for an effective smoking cessation approach amongst recovering alcoholics. Treatment centers, therefore, should work towards constructing and executing detailed smoking cessation procedures with their alcoholic clients (Bobo 1983). Indeed, treatment programs should focus on controlling or eliminating both dependencies simultaneously; as smoking and drinking levels seem to be highly correlated prior to treatment, such a singular approach to these dependencies may even yield synergistic effects (Miller 1983).

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REFERENCES

Bobo, JK, et al. "Cigarette smoking cessation and alcohol treatment." Addiction (1993) 88, pp. 405 - 412.

Bobo, JK, et al. "Urging the alcoholic client to quit smoking cigarettes." Addictive Behaviors (1983) 8, pp. 297 - 305.

Burling, TA & Ziff, DC. "Tobacco smoking: a comparison between alcohol and drug abuse in patients." Addictive Behaviors (1988) 13, pp. 185 - 190.

DiFranza, Jr., et al. "Alcoholism and smoking." Journal of Studies on Alcohol (1990) 51, n2.

Hurt, RD, et al. "Nicotine dependence treatment during inpatient treatment for other addictions: a prospective intervention trial." Alcoholism: Clinical and Experimental Research (1994) 18, n4.

Kozlowski, LT, Jelinek, LC, & Pope, MA. "Cigarette smoking among alcoholic abusers: a continuing and neglected problem." Canadian Journal of Public Health (1986) 77, pp. 205 - 207.

Miller, WR, et al. "Addictive behaviors and life problems before and after behavioral treatment of problem drinkers." Addictive Behaviors (1983) 8, pp. 403 - 412.

Walton, RG. "Smoking and alcoholism: a brief report." American Journal of Psychiatry (1972) 128, pp. 1455 - 1459.

Social Isolation of Nursing Home Residents and Their Perceived Health

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The study examined eleven indicators of social isolation and assessed relationships to the perceived health of three care levels in a nursing home. Social isolation was operationalized by the question focused on social interaction. The quantitative measures used to assess the level of social isolation included frequency of visitation with children, family living within fifty miles, family living outside of fifty miles, friends in the home, and friends outside of the home. In addition the number of moves within the home, distance from last residence, and the existence of a person to whom they feel close with inside and outside of the home, were used to assess social isolation. There was no significant relationship found between social isolation and perceived health. However, other significant relationships between frequency of visitation and level of care were discovered. The examination of the variables was hampered by a small sample from one of the care levels.

INTRODUCTION

Social isolation has been extensively researched in the general area of the elderly. Of those studied the largest proportion live at home. In contrast, little research has specifically focused on social isolation of nursing home residents. In literature social isolation is commonly operationalized as little or no personal relations in areas of family, friendship, care-giving, community, and peer groups (Rubinstein et. al. 1994; Chappell and Badger, 1989; Lumpkin, 1990; Townsend 1957).

It is necessary to understand social isolation because the denial of meaningful social contacts has negative effects on individuals. A considerable amount of evidence supports the importance of social networks and social support to health and well-being among the elderly (Rubinstein et. al. 1994, p. 58). Research has shown that the more socially isolated individuals are, the less healthy they are (House et. al. 1988, p. 241). It is apparent that social isolation has detrimental effects on individuals. Due to the expected increase in the utilization of nursing homes from the proportion of elderly growing at a phenomenal rate, it is necessary that social isolation assessments are developed to evaluate the living conditions of residents.

LITERATURE REVIEW

While there no assessment designed specifically for nursing home residents, one researcher has had a profound effect on the way social isolation is measured. Lubben (1988) researched to assess actual and potential social isolation among the elderly. The Lubben Social Network Scale consists of a ranking of family networks, friend networks, confident relationships, and living arrangements, collapsing distinct levels of interaction into two categories; family and friends (Lubben, 1988, p.48).

Other factors must be incorporated into an assessment that evaluates institutionalized elderly. Individuals in an institution have different governing structures over their lives. Of the many influences, one significant influence over the life of an institutionalized individual is relocation within the institution (Wells and Macdonald, 1982, p.181). Another, important influence is the distinction between friends within the home and friends outside of the home. A lack of distinction may lead one incorrectly assess an individual (Biztan and Kruzich, 1990, p.385). Lastly, a crucial factor in determining the amount of social isolation is distance from where the residents moved (Hook et al, 1982, p. 427).

METHODOLOGY

The purpose of this study was to explore the relationship of social isolation and perceived health of nursing home residents. The data for this study came from interviews conducted on a sample of fifty-six residents from a home, in Clark County, Ohio. In order to accurately examine the relationship between the two variables, the residents interviewed were divided into subgroups, according to the level of care received. The three levels of care examined were independent living, assisted living, and nursing home care.

Each randomly selected nursing home resident was asked if they perceive their health to be; 1. excellent for your age (never prevents activities), 2. fair for your age (occasionally prevents some activities), 3. poor for your age (very often prevents some activities), or 4. bad for your age (health troubles or infirmity all the time - prevents most activities or requires confinement to bed). Residents were then asked questions about their social life; 1. frequency of visits with children, 2. frequency of visits with siblings, 3. frequency of visits with other family members, 4. frequency of talking on the phone, 5. frequency of visiting with friends inside the nursing home (meaning the entire campus, residents were informed of this), 6. frequency of visiting with friends outside of the nursing home, 7. frequency of leaving the home (for what activities), and whether these are daily events, weekly events, monthly events, events that occur two to four times a year, yearly, less than yearly, or events that due not occur at all.

In addition to these questions, three questions about the social circle of the residents and persons to whom residents felt close, were asked. One question asked the residents to describe the people in their social circle. A second question asked residents if they have a person to whom he or she feels close in the home and to describe the nature of the relationship. A third question asked residents if they have a person to whom he or she feels close outside of the home and to describe the nature of the relationship. Seven final questions were asked, how long the residents have lived in the facility, how old the residents are, how the residents are feeling on that particular day, how many children the resident has, how the resident describes his or her living situation, how many moves the resident has made in the home, and where the residents lived before placement into Ohio Masonic Home.

To determine if social isolation existed, residents' social interaction was examined using the previous questions. Relying heavily upon the Lubben Social Network Scale, the answers to the questions were coded to evaluate the level of social isolation. This assessment reproduces the numerical assignment. The more frequent the interaction, the larger the numerical value assigned. The largest value assigned is five and the smallest value assigned is zero. There is an exception for the number of moves in the home. The number of moves in the home was subtracted from the total score. The numerical values are totaled to arrive at the score. The total possible score, assuming that there are not moves, is fifty. This social isolation assessment acknowledges and equally accounts for individuals with varying types of social interaction.

RESULTS

A brief look at some of the characteristics of the participants provides a general overview of the home. First, in examining age, there are a large number of individuals in both the 70 to 79 and 80 to 89 age bracket. Overall each of these two categories account for 39% (or 78% total) of the participants. Second, males accounted for 55% of the participants and females accounted for 45%. Third, 11% of the participants came from Springfield, 29% from within 50 miles, 32% outside of fifty miles, and 29% came from out of state. Fourth, 82% of the nursing home residents live by themselves, as compared to 16% of independent living and 60% of the assisted living residents. It should be noted here that individuals live with their spouse or by themselves, not with an unrelated other. Fifth, 96% of the residents from independent living have never moved, compared to 40% for assisted living, and 18% for nursing care. A significant fact is that 55% of the nursing home residents have been moved three or more times.

When examining relationships inside the nursing home, approximately 84% of the residents reported having a person who they felt close to, living inside of the home, whereas 16% of the residents said there was no one who fit this description. There were

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great variances associated with feelings of closeness and the level of care. Of the nursing home residents less than 65% reported feeling close to someone, and 36% felt close to no one. The levels were quite different for assisted living. Of this group, 95% of the residents said there is a person in the home they feel close to. Similar findings were found for the independent living residents, nearly 90% of these residents; reported having a close friend in the home.

Residents reported various types of individuals as close friends within the home. Overall 68% of the residents reported a resident as the person to whom they feel close. While 7% reported a spouse, 2% reported a nurse, and 7% reported other staff. Particularly interesting is the differences in nursing home and assisted living care. Of the individuals in assisted living 95% reported being close to another resident, as compared to only18% of nursing home residents who reported being close to another resident.

When examining relationships outside the nursing home, over 90% of the residents interviewed reported having a person they feel close to outside of the nursing home. The person that the resident feels close to outside of the home varies greatly by level of care. Of the nursing home residents, 45% reported the person they feel close to as their child. This compares with 12% of independent living and 15% of assisted living. The great majority of the residents reported that the person they are close to, outside of the home, was a friend. Of the independent living residents, 72% reported this, and 75% of the assisted living residents reported the same. However, only 35% of the nursing home residents reported that a person they feel close to outside of the home is a friend.

Visitation by family includes three variables: visitation by children, visitation by family less than fifty miles away, and visitation by family more than fifty miles away. In contrast, visitation by friends includes two variables, friends who live in the home and friends who live outside of the home. Overall, 34% of the visitation by friends occurred daily. The overall visitation by friends on a daily basis has little variation in the various levels of care. Of the independent living residents, 20% reported visitation on a daily basis, as compared to 48% of the assisted living residents, and 41% of the nursing home residents. The only noticeable difference lies in the visitation of nursing home residents. Of the nursing home residents, 27% of the visitation by friends occurs two to four times a year. This is compared with 13% of assisted living residents and 4% of independent living residents.

Overall, the frequency of visitation by family occurred the greatest in the period categorized as less than yearly. Approximately 36% of the visitation of residents by family occurred less than yearly. This is illustrated in independent living with 35% of the residents reporting visitation by family less than annually, 40% in assisted living, and 33% for the nursing home residents. However, nursing home residents received the greatest amount of visitation by family, on the most frequent basis.

As for the perceived health of the residents, approximately 36% of the residents stated they perceive their health to be excellent for their age. This is compared with 63% of the residents who perceived their health to be fair for their age. There are large differences with perceived health and level of care. While 63% of the total sample perceived their health to be fair, 82% of the nursing home residents perceived their health to be fair. However, there are strong similarities between independent living and assisted living. Of the independent living residents, 44% perceived their health to be excellent, compared with 40% of the assisted living residents.

Table 1. Social Isolation and Perceived Health of Residents

Social Isolation	Perceived Health			
	Excellent	Fair	Poor	Total
Isolated	0	3	1	4
Possible Isolation	2	6	0	8
Not Isolation	18	26	0	44
Total	20	35	1	56

As for social isolation, approximately 79% of the residents were not found to be socially isolated or possibly socially isolated. Again there was some variance according to care level, however, very few were found to be isolated. Of the individuals in nursing home care, 18% were found to be socially isolated, and 18% were found to possibly be socially isolated. Of the individuals in assisted living 5% (one individual) was found to be socially isolated, and 20% were found to be possibly isolated. Of the individuals in independent living only one individual was determined to be socially isolated, and two (or 4%) were determined to be socially isolated.

No significant observation was discovered between social isolation and perceived health. The individuals who were socially isolated perceived their health to be fair or poor. Additionally, the possible isolates perceived their health to be in the excellent and fair categories.

THEORIES AND HYPOTHESES

In general there appeared to be no significant correlation between social isolation and perceive health. Overall, individuals reported perceiving their health as quite well. This is somewhat surprising with past research in mind. Studies have shown a correlation between levels of isolation and health. However, there are no studies to compare the levels of social isolation of the residents of the home were this research was conducted . It may be that most of the people in the home are genuinely satisfied.

The low levels of isolation that have been discovered do not seem to be explained by the frequency of visitation by family. Residents, generally speaking, receive infrequent visitation by family. Across all levels of care, the greatest frequency of visitation occurred less than yearly. There was little difference when comparing independent and assisted living. However, nursing home residents reported the greatest amount of visitation by family to occur on a monthly basis. This is not difficult to explain, considering the frequency of visitation by friends. Subsequently, nursing home residents received less visitation.

The higher levels found in the frequency of visitation do explain the low levels of social isolation, as over 50% of the visitation with friends occurred on a daily or weekly basis. It should be restated that the statistics include friends outside the home and inside the home. However, it is not surprising that the group with the highest amount of visitation was assisted living, because these individuals eat lunch and dinner with each other on a daily basis. They have incentives to meet others. Life for these residents is very similar to life in a college dormitory. However, life for independent living and nursing home residents is very different. Independent living residents, do just that, live independently. There is little interaction amongst this group of individuals. Nursing home residents eat in their rooms and many are not allowed to venture freely throughout the complex. For these residents there is less of an incentive, or possibly not even the ability, to venture out and socialize.

Generally, people were very satisfied with the institution and what it has done for them, although this varied somewhat by level of care. In independent living and assisted care comments were only positive. One resident said "they do every thing to make life pleasant." Another stated that "we do as we please, we have anything we want." A common comment was that there were "no restrictions." This satisfaction appears to come from the quality of care, the highly integrated group cohesion, and the great number of activities. Residents reported a highly qualified medical staff. Residents also spoke of a bond that exists within the home. A resident stated that there is "a bond you do not find anywhere else." Another resident said, "other homes don't have the ritual bond ... people here are all brothers and sisters (Masons and Eastern Stars)." Other residents said, "we all have so much more in common than other nursing homes ... we all have something we can talk about." Residents also spoke about the number of activities in the home. One resident said "everyone who comes in is amazed ... at the activities." However, this overall sense was not the same for the nursing unit. A great number of residents spoke about being lonely.

This positive feeling about the home is reflected in the number of residents who reported a resident being the person to whom they felt close within the home. Assisted living and independent living residents spoke of high interaction. Of the assisted living residents, 95% reported another resident as the person they feel close to in the home, this compares to 68% of the independent living residents. Opposed to this, more of the nursing home residents spoke of loneliness. Of the individuals in nursing home care, 36% reported not feeling close to anyone.

Although there was little correlation found between social isolation and perceived health, other significant correlations presented themselves. Interesting findings were ones that compared various levels of care. In the areas studied, the residents from independent and assisted living generally responded similarly, and differed greatly from the residents in nursing home care. Each of the variables analyzed indicated a significant difference. The perceived health, number of moves within the home, and the numbers of residents having a person in the home they were close with, all varied greatly from the individuals in other levels of care. These differences help to explain the differences in social isolation. Residents with higher levels of care (nursing) have a far more regimented and controlled life. Nursing home residents lead a life that is enclosed, supervised, and carefully administered. Although, assisted living residents live in the same institution, they have a greater amount of freedom and control over their life. This control over lives of the nursing home residents greatly influences the way in which they interact and how they perceive themselves.

CONCLUSION

More accurate assessments of social isolation are necessary. Previous research has shown a direct correlation between social isolation and physical, psychological, and emotional problems. However, no solid social isolation assessment has been developed to accurately include and measure the housing situations of the elderly, including institutions. Only through future research can assessments be developed and tested.

It is imperative that accurate means of assessing isolation are established. There is a large bulge in the population, the Baby Boomers are about to confront us as elders, and we do not have the means necessary to evaluate their problems. Only through an accurate identification of the problems can we enstate policies to deal with and prevent unnecessary suffering on the part of the elderly and the rest of society.

REFERENCES

Bitzan and Kruzich, Janet E. and Jean M. Kruzich. 1990. "Interpersonal Relationships of Nursing Home Residents." *The Gerontologist* 30:385-390.

Chappell, Neena L. and Mark Badger. 1989. "Social Isolation and Well-Being." *Journal of Gerontology* 44:S169-176.

Hook et al. Wade F., Jeff Sobal, and Jeffery C. Oak. 1982. "Frequency of Visitation in Nursing Homes: Patterns of Contact across the Boundaries of Total Institutions." *The Gerontologist* 22:424-428.

House, James S., Karl R. Landis, and Debra Umberson. 1988. "Social Relationships and Health." *Science* 241:540-544.

Lubben, J. E. 1988. "Assessing Social Networks Among Elderly Populations." *Family and Community Health* 11:42-52.

Lumpkin, James R. 1990. "Stability Of The Isolation/Disengagement Relationship Across Age Groups." *Psychological Reports* 66:176-178.

Rubinstein, Robert L., James E. Lubben, and Jacobo E. Mintzer. 1994. "Social Isolation and Social Support: An Applied Perspective." *The Journal of Applied Gerontology* 13:58-72.

Townsend, P. 1957. *The Family Life of Old People.* London: Routlegde and Kegan Paul.

Wells, Lilian and Grant Macdondald. 1981. "Interpersonal Networks and Post-Relocation Adjustment of the Institutionalized Elderly." *The Gerontologist* 21:177-183.

The Effects of Minority Influence on Group Polarization

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Trends in the work force today include an increase in women and minorities and greater use of teams. This study examined gender and the effects numeric minorities have in the decision making process and group polarization. It also examined type of influence used in discussion, specifically normative or informational influence statements. Subjects selected from a midwestern University (N=144) were divided into groups of three, with four separate conditions based on gender composition and presented six scenarios involving risk. Decisions before and after the group discussion were obtained. Analysis revealed that participants polarized on some of the scenarios. Women tended to make more normative statements, whereas men tended towards informational statements. However, when a minority, males did not have a greater amount of influence over the majority than did female minorities, as was hypothesized.

BACKGROUND

Companies across America are experiencing an increase in workforce diversity. With this changing tide comes a difference in the way people may interact in the business world. In addition to the increase in work force diversity, a major trend in the work force is the use of teams to make decisions and complete projects. As a result of company down-sizing and re-engineering, production teams often make decisions that were once reserved for upper-level managers (Bennet, 1994; "I.B.M..", 1994). When individuals form a group, various forces come into play, including polarization and influencability, based on the makeup of the group. This study examined the effects that the interactions between men and women have in the decision making process, specifically in relation to group polarization. Group polarization is the phenomenon that group members will become more extreme in their opinions and advocate a more risky or more conservative position when they make a decision with others than they would if they thought about their position without discussion (Stoner, 1961; Kogan & Wallach, 1964; Kogan & Wallach, 1967). In addition to group polarization, the study also examined the type of influence, specifically informational and normative statements as a function of gender, during the course of the discussion.

Groups are swayed by two types of influential pressures, normative and informational influence. Normative statements involve primarily opinions or personal statements used to influence another person. Deutch and Girard (1955) define normative influence as what results when one conforms, complies, or obeys in order to gain rewards or avoid punishment from another person or the group. Normative influence is used to enhance one's position in the group, to maximize social rewards such as acceptance and status (Pruitt, 1971; Sanders & Baron, 1977). The members may feel that to be seen as a good group member they must adopt to a position that is at least equal to or more extreme than the other members', causing group polarization (Isenberg, 1986).

In contrast, informational influence occurs when one tries to persuade others through novel, valid arguments with the use of logic or verifiable facts (Bishop & Myers, 1974). Group members seek information about reality from other group members when they don't know the degree of risk or correct attitude that they should have on a situation. The desire is to arrive at the correct solution to a problem and to have accurate views (Deutch & Girard, 1955). Thus, under this type of influence others' reasons or facts about an issue are more likely to shift opinions to the extreme, because a majority's opinions are often seen as more correct than individual's, even one's own.

Hypothesis 1: Participants would become more influenced, and thus polarized if they were members of a homogeneous group (that is, all three members of the same gender) than if they were members of a mixed gender group of two males and one female, or two females and one male. This would likely happen because homogeneous groups would be more cohesive (Byrne, 1971), leading to more interpersonal influence and polarization.

Hypotheses 2 and 3: Males will make use of more informational influence statements, and females will make use of more normative influence statements (Tannen, 1990). Eagly (1987) proposes these gender differences in influence are due to social relations styles associated with gender roles. Stereotypically, a woman is more likely to use a communal style, and exhibit a concern for others' welfare and feelings, and interpersonal relations within the group. This involves the use of more normative statements. Conversely, males tend to use agentic orientation in conversation, which focuses on task demands, adequacy and correctedness. This orientation incorporates more use of informational statements. (Bakan, 1966; Eagly, 1987). These differences were also supported in research by Dose (1995) who found that women had a lower proportion of giving informational influence, thus reflecting the more communal and less dominant types of interaction in which women engage.

Hypothesis 4: Due to the power differentials between men and women, the male minority would influence the two females to a greater extent than the female minority would influence the two males. Research by Eagly and Wood (1985) suggest that differences in conformity are the result of different social roles occupied by men and women. If females are more likely to feel that they are in a position of low status, they will be more influenceable than males. Research has also shown that both male and female groups are more prone to influence of a male than a female, even though both are equally competent at the task (Ridgeway & Jacobson, 1977). In addition to these social role differences, others have found that informational influence is a more effective form of influence when both forms are introduced (Burnstein & Sentis, 1981; & Kapan & Miller, 1983). Thus, if women tend to use more normative statements, instead of the more persuasive informational statements, they may not be as effective at influencing others

SUBJECTS

The participants were 144 college students, primarily of traditional college age. Students received extra credit for their participation. They were randomly placed in groups of 3 based on gender, for a total of 48 groups. There were four conditions with 12 groups in each, based on gender and group homogeneity: (1) three males, (2) three females, (3) two females and one male, (4) two males and one female.

MATERIALS

Six scenarios adopted from Kogan and Wallach's Choice Dilemma Questionnaire (1964) were used. Only two scenarios were exactly as stated in their questionnaire. The others were similar to the originals but were adapted to illustrate non-traditional gender role dilemmas. Each of the scenarios required the participant to mark the odds of success they would desire before advising the individual in the scenario to undertake this risky yet, more desirable alternative. For example, a family must decide whether the father should take time off work in order to care for the child, something he wants to do, while the mother resumes her job as an account executive. If he leaves his job, he can't return, and the family worries they will not be able to survive financially on her income alone. The participant would mark the odds on a continuum from 1 in 10 to 10 in 10. If they marked a 1 in 10, there is only a 10% chance that they could survive financially on her income, but if the participant thinks the benefits of him staying home with the child is worth taking the 90% chance that they will not be financially secure, they would mark that line. Conversely, if they would only advise the father to stay home if it is certain they won't run into financial trouble, they would mark the 10 in 10 line, or they could mark any one line in between the two extremes, depending on how they felt about the situation. Participants also answered 15 questions taken from the Attitudes about Women Questionnaire (Spence &

Helmreich, 1978) to measure their thoughts on the roles of women in society. Another questionnaire elicited thoughts on the group decision making process.

PROCEDURE

The experimenter briefly described the task to the participants. Group members were then each given a packet that contained six scenarios from the Choice Dilemma Questionnaire. After they individually advocated the odds on each scenario, these packets were collected and they were given the same packet of scenarios again, this time to discuss with the other two group members. This portion was audio-taped, to allow coding of the decision making and influencing processes at a later time. The participants discussed each scenario and gave reasons for why they marked certain probabilities. They had to reach a unanimous decision on each. After the discussion phase, they were given another scenario packet for a third time, in which they again answered the questions individually.

RESULTS

The following table lists the differences in the mean odds advocated by all individuals from Time 1 (Individual), and Time 2 (Group discussion). Overall, across gender and conditions, polarization occurred in three of the six scenarios. ANOVA's showed a movement toward greater riskiness in scenarios 4 and 6 and greater caution in scenario 5 ($F_4(1,138)=7.91$, $F_5(1,139)=6.69$, $F_6(1,139)=4.45$, all p's<.05, see Table 1).

Table 1:

MEAN LEVEL OF ODDS ADVOCATED BY SCENARIO

	Time 1	Time 2
Scenario 1	6.50	6.81
Scenario 2	5.24	4.96
Scenario 3	5.48	5.56
Scenario 4	5.80 •	5.37 •
Scenario 5	8.03 •	8.47 •
Scenario 6	6.88 •	6.27 •

• significant at p<.05

Effects of group homogeneity on polarization were tested using repeated measures ANOVA's. Homogeneity effects on group polarization as predicted in the first hypothesis were only found for scenario 6 (F(1,138)=14.80, p<.001). Here, homogeneous groups experienced more polarization (mean shift=1.02) and thus advocated a greater shift from their individual responses than did the mixed groups (mean shift=.15).

Gender differences in polarization were found only for scenario four. Males became more risky during Time 2 than did females (F(1,139)=15.54, p<.001). The table below illustrates the differences between male and female risk advocated. Additionally, in this scenario, the three-way interaction between gender by condition by polarization was significant, (F(1,139)=9.37, p<.01).

Table 3: Differences between odds advocated in Time 1 & Time 2 for Scenario 4

	Time 1	Time 2
Males	5.32_{ab}	4.69_{ac}
Females	6.28_{b}	6.01_{c}

(Smaller numbers indicate greater risk, like-subscripts reflect significant differences, p<.05).

The second hypothesis that males would make use of more informational statements was supported in this study. A simple factorial ANOVA compared the total informational statements by gender and by group condition. Males used a significantly greater amount of informational statements (mean = 26.18) than females (21.86) (F(1,139)=4.764, p<.05). Homogeneous groups used more informational statements (mean = 27.85) than the mixed gender groups (mean = 20.19, F(1,139) = 9.859, p<.001). In addition, there was a two-way interaction between gender and homogeneity of the group (F(1,139)=11.682, p<.001). The Tukey-Kramer test was used to examine the comparison of the means among the different conditions. This confirmed that males in homogeneous groups shared more total informational statements than did any of the other groups (p<.01).

Homogeneous male groups made a significantly larger amount of total statements ($M_{homog.}$ = 74.86, M_{mixed} =52.64) than the males in mixed groups F(1,139)=8.718, p<.01). Thus, I felt it necessary to look at the percentage of statements that were informational in nature, as a way to control for total statements made. Again, the interaction between gender and homogeneity was significant (F(1,140)=6.493, p<.05) and the Tukey comparison again confirmed a greater percentage of informational statements by males in homogeneous groups compared to any other group (p<.01). It was found that 44% of the total statements that men in homogeneous groups voiced were informational in nature.

The third hypothesis as stated was not supported in the study. Women did make a significantly larger amount of normative statements (mean =21.97), regardless of homogeneity of the group, compared to the males average of 18.97 statements (F(1,140)=4.19, p<.05). However, in examining the percentage of total statements that were normative in nature, the interaction between gender and homogeneity was significant (F(1,140)=20.646, p<.001). The Tukey comparison test confirmed that the males in homogeneous groups made a significantly lower percentage of normative statements than any of the other groups (p<.01). Thus, it can be seen that although the all female groups and the mixed groups tended to make about the same percentage of normative statements, it was the male homogeneous groups that seemed to avoid these statements, and only used them in 24% of their total statements.

Hypothesis four was not supported in the present study. In examining if the gender of the minority had an effect on the amount of influence over the majority, no significant differences were found. However, they are in the direction as hypothesized in that males were seen as having slightly more influence over the women in the group and women in the minority were seen as having the least amount of influence.

CONCLUSION

It has become necessary to look at how genders influence one another in the working arena. In addition, it is important to examine how various combinations of group composition based on gender may affect the outcomes of these group-made decisions. In the present study, group polarization occurred in the last half of the scenarios, possibly from increased cohesion among the group, which motivated them to polarize to a greater extent. Depending on the scenario, groups became either more risky or more cautious when they discussed the scenarios.

When groups come together to make decisions, group members may differ in the style of influence they employ to persuade others. The present study found that males used more informational statements and, contrary to predictions, females did not use more normative statements. Instead, males in a homogeneous groups used fewer statements of this type. This difference in the type of influence used in conversation may affect how influential one may be to others. These stylistic differences support past research that females will have a more difficult time influencing the majority, yet there was only a slight, non-significant, tendency for males in the majority or the minority to be perceived as influencing the group's decisions to a greater extent.

The earlier reported gender differences in influence could be due to the fact that this research was conducted a number of years ago when there was greater gender inequality in the business world and in society in general. Thus, the participants may have been more likely to gender stereotype than today's college students, who are exposed to a greater diversity of gender roles (Lottes & Kuriloff, 1994). Additional studies should examine if significant gender differences do exist in the 1990's. A study could be conducted in the workplace in which an older cohert of business personnel as participants to examine if differentials in influence exist among those actually in the business world.

The greater tendency for polarization in the last three scenarios reveals a potential problem with the methodology in the present (and other) studies. Although only lasting 20 minutes, the pattern of results is consistent with increased group cohesion over time. Yet this is markedly less than the interaction time spent in actual settings. Thus, differences in influencability between the genders and degree of polarization may not be as pronounced as what might occur in the real world of decision making, when the groups often interact for a longer period of time. It may become necessary to have the groups discuss a greater number of scenarios so they may influence one another over a greater length of time. .

Styles of influence clearly differed between males and females. Thus, there is a need for understanding its direct or indirect effect on male and female roles in decision making. With more women entering the upper-level management positions today, and with the use of diverse work teams making decisions and undertaking group projects, gender differences in influence and conformity must continue to be examined.

REFERENCES

Bakan, D. (1966). The duality of human existence. Chicago: Rand McNally.

Bennet, J. (1994, January 4). At G.M. parts plants, painful change. *The New York Times*. pp. C1, C5.

Burnstein, E., & Sentis, K. (1981). Attitude polarization in groups. In R.E. Petty, T.M. Ostrom, & T.C. Brock (Eds.), Cognitive responses in persuasion (pp. 197-216). Hillsdale, NJ: Lawrence Erlbaum.

Byrne, D. (1971). The Attraction Paradigm. New York: Academic Press.

Clark, R.D., III, & Haberkorn, G. (1982). The effects of differential ascribed category membership and norms on minority influence. *European Journal of Social Psychology, 12*, 89-104.

Dose, Jennifer J. (1995). *The Role of Diversity in Group Processes and Outcomes: Values and Sex Composition.* Unpublished Doctoral Dissertation, The Ohio State University.

Eagly, A.H. (1987). *Sex differences in social behavior. A social role interpretation.* Hillsdale, NJ: Lawrence Erlbaum.

Eagly, A.H., & Wood, W. (1985). Gender & Influenceability: Stereotype versus behavior. In V.E. O'Leary, R.K. Unger, & B.S. Wallston (Eds.) *Women, Gender, and Social Psychology*. Hillsdale, NH: Erlbaum.

I.B.M. may give up its headquarters on a hilltop. (1994, January 13) *New York Times*. pp. A1, C16.

Isenberg, D.J. (1986). Group Polarization: A critical review and meta-analysis. *Journal of Personality & Social Psychology, 50*, 1141-1151.

Kaplan, M.F. & Miller, C.E. (1983). Group discussion and judgment. In P. Paulus (Ed.), Basic group processes (pp. 65-94). New York: Springer-Verlag.

Kogan, N. & Wallach, M.A. (1964). Risk taking: *A study in cognition and personality*. New York: Holt, Rinehart, & Winston.

Kogan, N. & Wallach, M.A. (1967). Risky shift phenomenon in small decision making groups: A test of the information-exchange hypothesis. *Journal of Experimental Social Psychology, 3*, 75-84.

Lottes, I.L. & Kuriloff, P.J. (1994). The impact of college experience on political and social attitudes. *Sex Roles*, 31, 31-54.

Maass, A., & Newcombe, N., & Arnkoff, D.B. (1979). Effect of speech style and sex of speaker on person perception. *Journal of Personality and Social Psychology, 37*, 1293-1303.

Pruitt, D.G. (1971). Conclusions: Toward an understanding of choice shifts in group discussion. *Journal of Personality and Social Psychology, 20*, 495-510.

Ridgeway, C.L., & Jacobson, C.K. (1977). Sources of status and influence in all-female and mixed-sex groups. *Sociological Quarterly, 18*, 413-425.

Sanders, G.S., & Baron, R.S. (1977). Is social comparison irrelevant for producing choice shift? *Journal of Experimental Social Psychology, 13*, 303-314.

Spence, Janet T., & Helmreich, Robert L. (1978). *Masculinity & Femininity: Their Psychological Dimensions, Correlates, & Antecedents.* Austin: University of Texas Press.

Stoner, J. (1961). A comparison of individual and group decisions involving risk. Unpublished master's thesis, Massachusetts Institute of Technology.

Tannen, D. (1990). *You just don't understand: Women and men in conversation.* New York: Morrow.

Wallach, M., & Wing, C. (1968). Is risk a value? *Journal of Personality and Social Psychology, 9*, 101-106.

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Scottish Soccer Violence and Religion

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The rivalry between regional soccer teams in Scotland can lead to violence, both around the field and across the nation. The two most prominent soccer clubs in Scotland are Celtic and Rangers, and these teams have religious affiliations which have led to a passionate rivalry between the fans. This presentation analyzes recent studies of soccer violence in Scotland and Ireland, incorporates a survey of Scottish University students and their attitudes towards this rivalry, and enhances the findings through interviews with Celtic and Rangers fans. The research indicates that the basis for this rivalry is not just in passionate team support nor is it solely due to sectarianism. The theory being proposed is that the soccer violence in Scotland between Celtic and Rangers is really a personification of deeply rooted hostilities of native Scots towards Irish (Catholic) immigrants over politics, economics, housing, education, nationality, and religion. It concerns one group's quest to establish an identity in Scotland and the majority's quest to keep them out.

BACKGROUND

For many Scots, The Old Firm rivalry means two things: soccer and religion. "The Old Firm" is the name given to the long standing association and rivalry between the Catholic-founded Celtic Football Club and the Protestant-founded Rangers Football Club and their respective fans. In the theory presented here, the sectarian argument that is used to explain this antagonism covers up many other integral components. It involves the old tale of Protestant vs. Catholic, but also majority vs. minority, native vs. immigrant, Unionist vs. Nationalist, and Northern Ireland vs. Republic of Ireland.

Celtic was founded in 1887 as a charitable organization to provide relief for the poor of Glasgow's East End. Brother Walfrid and Brother Dorotheus were the originators of the idea for a Catholic Irish soccer club. The official proposal was made on November 6, 1887, and in January 1888, a call was made for support for the new club. By May, the ground at Parkhead (an area of Glasgow) was ready after months of labor by volunteers and the first match was played on the 8th. The first game Celtic played and won was against Rangers later that month. They enjoyed continued success and within their first ten years had become one of the finest teams in Britain (Murray 1984:17-21).

Celtic has never had a Catholic-only signing policy and many of its players have been non-Catholic. Ireland is recognized as the spiritual homeland of Celtic, and in the early days the club had formal associations with the struggle for Irish Home Rule. All formal ties to Irish politics are gone now, but Celtic has "retained its religious character and its Irish sympathies, and remained inseparably linked with both" (Murray 1984:24-27, 60, 66).

Rangers was founded in early 1872 and played their first game in May. The club was started "by a group of lads from the Gareloch...attracted by the new craze on the Glasgow Green, they set out to found a football team." The team's stadium, Ibrox, was opened on its present site in 1899 in Govan, Glasgow (Murray 1984:12-17). The team did not knowingly sign any Catholic players until 1989, and this plus other actions of its administrators and players labeled it as a very Protestant-oriented club. A strong Unionist member, John Ure Primrose, first became identified with Rangers in 1887, and was elected a patron of the club in 1888. He had a very strong influence on the club and owned one of the two largest share holdings in 1899. "Primrose not only links Rangers to Unionism and anti-Irish politics, he was also a very keen, active and prominent freemason: an order which in Scotland has a strong anti-Catholic tradition... Leading members of Rangers had strong links with Unionism, freemasonry and Protestantism." (Finn 1991, pt.1:86-87).

Bill Murray states that just because of the religious affiliations the teams possessed, they were bound to experience hostility eventually. This is not the only theory as to when the sectarian troubles of The Old Firm began, however. Another theory mentioned by Murray is that the shipyard that was established by Harland and Wolff from Belfast in 1912 brought with it many Protestant workers to Glasgow. The area of the shipyard was near Govan, the home of Rangers, for whom many of the new workers began to show their support (Murray 1984:31, 59). It was also around this time that Rangers became associated with Ulster Unionist feeling. Celtic have always been proud of their Irish connection and since this was a particularly volatile time in the struggle for Home Rule, Rangers became a rallying point for Protestant Ulster and still are today (Moorhouse 1984:299). Irish political groups like the Orange Order and the IRA were starting to have followings in Glasgow, and the latter "aroused justifiable alarm among Protestants, particularly the working class of Glasgow; hostility to Catholicism and Irish nationalism, and what might have been seen as a defensive reaction to IRA militancy, found expression in a popular cultural sense through football" (Walker 1990:141, 143). Ireland was now showing its influence on both teams.

These ties to Irish politics and religious feeling are reflected very strongly in the teams' colors, emblems, and songs. Celtic has adopted the flag of the Republic of Ireland as its team flag and Rangers fly and wave the Union Jack of the UK. Celtics' colors are green, white and orange (gold) while Rangers' colors are blue, white, and red. These are also the colors of the flags of Ireland and the UK. Celtic fans wear scarves and other clothing with images of the Pope and shamrocks while Rangers use the Queen of England (the head of the Protestant Church of England) as their symbol. At games, Celtic fans sing about freedom from the crown, rebellion from religious oppression, there being "no Protestants at all," and blessing the Pope. Rangers fans sing about being up to their knees in Fenian blood, "f*****g" the Pope and the Vatican, and they call themselves Billy Boys after William of Orange (historical Protestant leader who beat the Catholics at the battle of the Boyne) (Murray 1984). The political connotations are abundant.

It was not by choice that the Irish community established its own clubs in order to participate in Scottish soccer. Scotland in the nineteenth century held strong religious and racial prejudices against the Irish, which limited their options in society. Social class divisions provided another barrier to the Irish. They tended to live among the lower classes and their work was largely unskilled. This low working class was excluded, sometimes deliberately, from many Glaswegian sporting clubs. Starting their own clubs was the only way the immigrant Irish could participate in Scottish sport (Finn 1991, pt.1:82-83).

Irish came to Scotland for many reasons, but especially for the new factories that were opening. Industrial growth in the western and central lowlands created many jobs as well as vacating the resident Scots from their agricultural positions which resulted in more labor demand. However, Scotland was largely a Presbyterian country and the majority of Catholics there were Irish immigrants. "In the co-existence of two populations competing for scarce resources and radically divided by religion, one has the basis for enduring conflict" (Bruce 1990: 232). Thus the friction between Catholics and Protestants in Scotland was not due to just religious and nationality differences, but also economic competition for employment.

The Irish also faced difficulties in housing and education. When the Education (Scotland) Act, 1918, was passed, Catholic Schools were given state support for the first time. In response to this, the Church of Scotland set up a committee to investigate this Act and the continuing immigration of Irish to Scotland. The committee reported on May 29, 1923 that the Irish were "a distinct 'race' whose presence was having a deleterious effect on the Scottish 'race' and Scottish culture" (Miles & Muirhead 1986: 120). Among the list of grievances against the Irish was that they were converting residential areas into Irish communities. First it was stated that the Scots desired to leave because "whenever the Irish population reach a certain proportion in any community, whether village, small town, or area of a great city, the tendency of the Scottish population is to leave as quickly as they can..." Then later the same report claimed that the Irish desired segregation. "The Irish have separate schools for their children; they have their own clubs for recreation and for social intercourse; they tend to segregate in communities, and even to monopolise certain departments of labour to the exclusion of the Scots" (Miles & Muirhead 1986: 121).

Whether the Irish desired separate housing or not, the fact remains that they were living in segregated communities and were being attacked for receiving the same financial support for their Catholic schools as the (Protestant) state schools. Many Scots did not like governmental aid for Catholic schooling and this added to the hostility between the two communities. It was seen as the next step by the Catholic Church to start its "destruction of the unity and homogeneity of the Scottish people" (Miles & Muirhead 1986:123). The segregation and paranoia that the Irish experienced in Scotland shows that they were the victims of racism. This racism was used to make a political issue out of Irish settlement in the late nineteenth and early twentieth century in Scotland. It is argued here that this treatment of the original immigrants is still shaping the experiences of their descendants and is finding expression today in The Old Firm rivalry.

The formation of Celtic brought with it a hope that the racism and discrimination that the Irish in Scotland had experienced could be ended when they were seen on an equal plain with the Protestant majority. The Irish clubs and their success, though well intended, were not welcomed, however. They were still seen as alien clubs and resentment against them became more pronounced as the conflicts in Ireland gained a greater place in Scottish and British politics (Finn 1994:47). Though the Irish in Scotland were doing all they could to establish a dual identity with Scots, the majority could not separate them from their homeland and would not accept them as fellow countrymen in any social arena. "True Scots would not support clubs of Irish-Scottish origins: truly Scottish clubs would not honour associations with another country" (Finn 1994:48). The Irish in Scotland, no matter how long they had lived there, were denied any claim on a Scottish identity.

Is there any clear definition of a Scottish identity then? As has been described earlier, religion plays a large role in Scottish life, but one that is very divided and turbulent. Though Catholicism is a minority religion, it has a strong following that makes its presence known in various ways, one of the most obvious being its soccer teams (e.g. Celtic). Another aspect of Scottishness is its history, but that too is not clear cut. Many inhabitants of Scotland are of Irish descent and claim to be Scottish as well. These are a minority but express their presence through football and other institutions (e.g. the IRA). A final defining aspect of a Scottish identity is a strong claim to *not* being English and this too, finds a declaration in sport. When the Scottish National soccer team travels to play abroad, the fans that go with them have become well known for their friendly and open attitude. A large part of why they do this is to differentiate themselves form the English fans who are portrayed as violent "hooligans." Thus, they are expressing not so much what they are, as what they are NOT (Finn & Giulianotti 1996:18-19).

Any claims to Catholicism or Ireland disqualify a person from an identification with Scotland. So, a Scot is not Catholic, not Irish, and not English. Unfortunately, it is difficult to find a clear definition of what a Scot *is*. Scotland has developed for itself a narrow, unyielding, sectarian identity that has come to be expressed in sport. Under the guise of religion and sport, soccer teams like Celtic and Rangers and their supporters fight and compete over many more deeper issues like nationality, politics, housing segregation, education, and employment. This narrow definition of what it means to be Scottish has created severe hostilities between people in its society that cannot be effectively released in any other way than soccer violence. A survey was developed to investigate this theory.

METHODS

The survey, written by this author, was administered to Scottish university students with the help of Dr. Christopher Wright at the University of Aberdeen. It had one section for personal data and then 14 statements about soccer, The Old Firm, religion in Scotland, their connections to Ireland, and the importance of these topics to the respondent. The choices provided were "strongly disagree," "disagree," "agree," and "strongly agree." Respondents were either allowed a week to complete the survey and return it, or were given a few minutes at the end of a lecture to fill it out.

RESULTS

The survey itself is too lengthy to be included here, but the findings will be described. The answers to the first four statements were in agreement with the theory proposed. The most frequent responses indicate that Catholics and Protestants do have problems with each other in Scotland, religion is a part of The Old Firm rivalry, and this rivalry is not a harmless thing. The answers to statements five through nine, however, were not in agreement with my theory since the respondents denied any ties to Ireland or Irish politics in The Old Firm. Responses to the last four items show that while the respondents themselves are not very interested in football, the country as a whole is. Religion also did not seem to apply very much to their lives or the team they support.

The responses to the items were cross-tabulated with the respondents' sex, religion, favorite team, and subject of study. These results can be seen in Table 1. Age, year in university, and nationality were not relevant to my investigation and therefore not considered.

Table 1: Significant results from Chi-square cross-tabulation

Statement Number	Variable in Tabulation	Result	Significance
13: "Football is a large part of your life."	Sex of Respondent	males: agree females: strongly disagree	.00012 (Pearson)
5: "Celtic is not a true Scottish team - it is more Irish."	Respondent's subject of study	Sociology: disagree Divinity: agree	.01956 (Pearson)
3: "There is nothing wrong with the rivalry between Celtic and Rangers."	Favorite team of respondent (Celtic or Rangers only)	Celtic fans: disagree Rangers Fans: agree	.08028 (Pearson) .04596 (Likelihood Ratio)

Even though there were 14 statements and four bases of comparison, only three Chi-square analyses were found to be significant at the .05 level.

The statistical analysis reveals that females do not have much interest in football, Divinity students see Celtic as being more Irish than Sociology students do, and Celtic fans feel The Old Firm rivalry is more problematic than do Rangers fans. However, the last two results are questionable. There were so few Divinity students (11.7% of sample population) that the second significant finding might be different if the numbers had been more balanced, and the last finding was only obtained by leaving out 82.2% of the respondents and considering only the 17.8% that listed Celtic or Rangers as their favorite team. This makes for very small numbers and an even more inaccurate sampling of the population. Females composed 61.9% of the sampled population, and if they do not care much about soccer, one wonders how much they know of the subject. Because the majority of the respondents showed this apathy, the rest of the findings are now questionable.

CONCLUSION

If the sample population had been more evenly distributed and larger, more accurate results would have been found. Although the survey did not entirely support the theory being investigated, the theory should not be discarded because the results may be a product of methodological problems. Soccer does play a large role in defining an identity for the people of Scotland, but more on divided, sectarian, and club-specific lines rather than on a national one. The Old Firm reflects these divisions and the quest for a Scottish identity of the immigrant Irish and their descendants, but The Old Firm is not the problem itself. A Scottish identity is still too narrow to allow all its people to feel welcome in claiming it. If the sectarian divisions in Scotland are ever to end and The Old Firm rivalry to cool its bitterness, the majority in Scotland needs to see immigrants and non-Protestants as equals and fellow Scots. The issue here is not about stopping the classic Protestant/Catholic fighting, but about making a minority group feel welcome to claim a Scottish identity.

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REFERENCES

Bruce, Steve. "The Ulster Connection." Sermons and Battle Hymns: Protestant Popular Culture in Modern Scotland. Eds. Graham Walker and Tom Gallagher. Edinburgh: Edinburgh University Press, 1990: 231-255.

Finn, G.P.T. "Racism, Religion and Social Prejudice: Irish Catholic Clubs, Soccer and Scottish Society -- I. The Historical Roots of Prejudice." *The International Journal of the History of Sport* 8.1 (1991): 72-95.

Finn, Gerry P.T. "Sporting Symbols, Sporting Identities: Soccer and Intergroup Conflict in Scotland and Northern Ireland." Scotland & Ulster. Ed. Ian S. Wood. Edinburgh: Mercat Press, 1994: 33-55.

Finn, Gerry P.T. and Giulianotti, Richard. "Scottish Fans, Not English Hooligans! Scots, Scottishness, and Scottish Football." Il Mito Del Tifo Inglese. Ed. Rocco De Biasi. Milano: Sheke 1996: 1-21 (personal translation sent by R.Giulianotti).

Miles, Robert and Muirhead, Lesley. "Racism in Scotland: A matter for further investigation?" Scottish Government Yearbook (1986): 108-133.

Moorhouse, H.F. "Professional football and working class culture: English Theories and Scottish evidence." *Sociological Review* 32 (1984): 285-315.

Murray, Bill. The Old Firm: Sectarianism, Sport and Society in Scotland. Edinburgh: John Donald Publishers Ltd., 1984.

Walker, Graham. "'There's not a team like the Glasgow Rangers': football and religious identity in Scotland." Sermons and Battle Hymns: Protestant Popular Culture in Modern Scotland. Eds. Graham Walker and Tom Gallagher. Edinburgh: Edinburgh University Press, 1990: 137-159.

A Content Analysis of Children's Television Commercials

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Television commercials have been the subject of much research over the past few decades. This study attempted to analyze children's television commercials and the continued perpetuation of male dominance through commercials and narration. It was found that males still dominated as voice-overs, especially in mixed-sex advertisements, as compared to the research from ten and twenty years ago. In addition, there was a significant abundance of food-centered advertisements and repeated commercials in the sample as well.

BACKGROUND

Television commercials are extremely interesting to examine when looked at from a gender perspective. It is engaging to investigate gender roles and stereotypes perpetuated in commercials. Furthermore, it is apparent that the stereotypes and images portrayed on the screen have impact on the viewer; this impact is what most often stands out as important to analyze.

There has been a multitude of research conducted over the past few decades concerning television advertisements. More specifically, there has also been research which asserts that sex-role stereotyping and male dominance is perpetuated through advertisements aimed at children.

Male dominance in commercials was investigated in a study by McArthur and Resko (1975). Males were found to be the central figure in the commercials more often than females. Males were portrayed in more authoritative roles over females, and were also found to be more credible. In a study by Feldstein and Feldstein (1982), children's televised commercials were examined, from 1977 to 1978. There were significantly more males shown in commercials, but not more females shown. As expected, males and females were portrayed in commercials pairing them with sex-stereotyped toys. Accordingly, a content analysis of children's commercials was conducted, questioning sex-role stereotyping (Macklin & Kolbe, 1984). It was found that while most of the commercials were coded as mixed-sex (at least one male and one female in the commercial), males dominated as central figures and in voice-overs overall.

There has also been research regarding commercials for food and their effects on children. In one study (Galst & White, 1976), the effects of commercials and purchasing attempts in the supermarket were investigated. Results showed that children averaged about 2 purchase attempts (where the child attempted to persuade the parent to buy an item) for every minute in the store. There was a significant positive relationship between the overall television-reinforcement value and the total number of purchase attempts. Often times, children's attempts were for sugared foods, 68% for sugared cereal, for example. In a related study by Galst (1980), the effects of television food commercials and pro-nutritional service announcements as determinants of children's snack choices were examined. Results indicated that children in the control group chose sugared foods as snacks significantly more often than other control group chose sugared foods as snacks significantly more often than other intervention groups. After the intervention, it was found that having children in the no added sugar, pro-nutrition condition with positive adult comment was the most effective way to reduce the children's overriding selection of sugared snacks.

The present study attempted to analyze the content of children's television commercials, focusing more closely on male dominance and food-centered advertisements. The study also set out to investigate to what extent the commercials aired on television were repeated commercials. The reason for this content analysis was to see to what extent times have changed the way that gender images and dominance are portrayed through commercials, especially ones geared at children.

METHOD

Materials

A total of 248 children's television commercials were watched, taped from the three major networks and two cable channels. Commercials were taped in both the mornings and in the afternoons, on both weekdays, and on weekends. Service announcements were omitted from the sample, as were advertisements in which it was impossible to identify the gender of the narrator and/or the characters in the commercial itself. Service announcements were examined independently. The final sample was comprised of 203 commercials.

Procedure

The sample of advertisements was coded for the following variables: gender of the narrator in the voice-over, type of commercial (as a function of gender of actors), type of commercial (as a function of the product in the advertisement), and status as a novel or repeated commercial. For type of commercial (as a function of gender of actors), the advertisements were coded as either male (all males in the commercial), female (all females in the commercial), or mixed-sex (at least one male and one female in the commercial). All actors in the commercials were children. A repeated commercial was one that was coded at least once. The product was the targeted item being advertised in the commercial.

RESULTS

Chi-square analyses were conducted for all of the variables. The alpha level for all analyses was set at .05.

Narration

Of the 203 commercials coded, males dominated as the narrator 80.29% of the time, as compared to only 19.70% for the females. In the male commercials, males were the narrator 90.47% of the time. In the female commercials, females were the narrators 88.0% of the time, a slightly lower percentage when compared to males as narrators in the male commercials. Finally in the mixed-sex advertisements, males dominated as narrators 89.56% overall as compared to only 10.43% for females as narrators (See Table 1). After a two-way Chi-square analysis was performed, it was found that a significant difference for narrator as a function of gender did exist, $(2, N = 203) = 83.38, p < .01)$. Post-hoc analysis were performed, with two significant results found. Using Ryan's procedure, it was found that there were significantly more males as narrators when mixed-sex commercials were compared to female commercials, and when male commercials were compared to female commercials, $\chi^2 (1, N = 140) = 63.00, p < .05$; $\chi^2 (1, N = 88) = 47.25, p, < .05$.

Gender of actors

Of the 203 commercials watched, all were coded as being either male, female, or mixed-sex commercials. The male advertisements comprised 31.0% of the total sample, the female commercials encompassed 12.31% of the sample, and the mixed-sex advertisements subsumed the remaining 56.65% of the sample. The proportions for each expected frequency was based on the Macklin and Kolbe (1984) research. A Chi-square analysis was performed and a significant difference was found to exist, χ^2 (2, N = 203) = 17.74, p. < .01.

Table 1: Frequency (and Percentage) of Males and Females as Narrators (by type of commercial)

	Narrator	
Type	Male	Female
male	57(90.47%)	6(9.53%)
female	3(12.0%)	22(88.0%)
mixed-sex	103(89.56%)	12(10.44%)

Product type

Of the 203 advertisements viewed, 164 (80.78%) were for food, as compared to only 13 (6.40%) for toys. The remaining 26 advertisements (12.80%) were coded as other. A Chi-square analysis revealed that a significant difference was found to exist, χ^2 (2, N = 203) = 207.99, p < .01.

Novelty of the commercial

Of the total sample watched, 150 advertisements were repeated at least more than once. This comprised 73.9% of the entire sample.

DISCUSSION

The present study concluded that male dominance has continued to be perpetuated in children's television commercials, as compared to research from ten and twenty years ago. First of all, it was shown that males significantly dominated as narrators over females overall, especially in mixed-sex commercials. The present study's results were in concordance with previous research (Macklin & Kolbe, 1984), which showed a dominance of males as narrators during mixed-sex advertisements. Perhaps males dominated as narrators because they have often been portrayed as authoritative figures (McArthur & Resko, 1975). Based on these results, it can be posited that even in commercials geared at children, the idea of the male as the authority figure was perpetuated even twenty years later, in the present study. In the present study, males dominated as narrators significantly more when mixed-sex commercials were compared to female commercials, and when male commercials were compared to female commercials. Subsequently, it was shown that the results in this study paralleled those in the Macklin and Kolbe study (1984). Mixed-sex advertisements significantly dominated the total sample of all commercials watched; however, as compared to male-centered commercials, female commercials were extremely underrepresented. The abundance of male commercials over female ones did show a trend of under-representation of female commercials and an overrepresentation of male commercials.

In addition, the present study also found that there were significantly more food-centered commercials shown over the other advertisements in the sample. These results mirrored the results from the previous research (Macklin & Kolbe, 1984), but there was a larger percentage of food commercials in the present sample (80.78%). Along the same vein, the Galst and White study (1975) found that 68% of the purchasing attempts made were for sugared cereal alone, and a large portion of these attempts were successful. One might conclude that with more exposure to sugared food and junk foods, the more likely a child will be to attempt to consume that food. Considering that evidence points to the fact that pro-nutrition service announcements can help reduce sugar consumption in children (Galst, 1980), it was surprising to see so few service announcements for nutrition, but so many commercials promoting sugar consumption. Of the 164 food-centered commercials coded, 114 (70.0%) were for sugared foods or drinks, as compared to only 50 (30.50%) commercials for non-sugared food items. Finally, the abundance of repeated commercials should be considered. Of the entire sample, 74% were previously seen advertisements, and many of these were seen more than three times. It is also interesting to note that many of the repeated commercials were also for food items, and more often than not, food items with a high sugar content.

The present study attempted to analyze the content of children's television commercials. The present study provided some interesting and convincing data that demonstrate that there is still a strong presence of males dominating the authoritative role in commercials, especially in mixed-sex commercials. It is unfortunate that there seems to be little change regarding male dominance from 1975 and 1984 compared to the present time. Also, it seems as if children are being exposed to an extremely high number of food-centered commercials, many of which are for foods with a high sugar content and low in nutritional value.

REFERENCES

Feldstein, J.H., & Feldstein, S. Sex Roles. Sex differences on televised food commercials; Vol 8, 1982. pg. 581-587.

Galst, J.P. Child Development. Television food commercials and pro-nutritional public service announcements as determinants of young children's healthy snack choices; Vol 51, 1980. pg. 935-938.

Galst, J.P., & White, M.A. Child Development. The unhealthy persuader: The reinforcing value of television and children's purchase-influencing attempts in the supermarket; Vol 47, 1976. pg. 1089-1096.

Macklin, L.Z., & Kolbe, R.H. Journal of Advertising. Sex role stereotyping in children's advertising: Current and past trends; Vol. 13, 1984. pg. 34-42.

McArthur, L.Z., & Resko, B.G. Journal of Social Psychology. The portrayal of men and women in American television commercials; Vol 97, 1975. pg. 209-220.

A Critical Analysis of Current State Responses to the Problem of Child Maltreatment

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Child maltreatment is a devastating social problem that lacks an adequate social response. Recent research statistics indicate that the number of abuse cases reported to Child Protective Services (CPS) is rising. Child abuse can result in many long-term impacts that can traumatize the abused child and generate negative influences within families, communities, and society at large. This research explores why attempts made by the child welfare system to alleviate child maltreatment have failed. Data was collected through an in-depth review of current literature. Findings suggest that the problems are multi-faceted and include: (1) unclear and inconsistent definitions used by "front-line" staff, administrators, and legislators, (2) structural problems within CPS, and (3) inadequate coordination between inter-governmental and private agencies. Based on these findings, recommendations concerning the elements of a more responsive system that can better guarantee the safety and protection of our children are provided.

THE SCOPE OF THE PROBLEM

Recent research data suggests that rates of child maltreatment in the U.S. are staggering and continuing to rise. According to the National Committee to Prevent Child Abuse (1995), in 1994, over three million children were reported as victims of maltreatment to state child protective service (CPS) agencies. This figure represents a 4.5% increase over the number of children reported in 1993 and a 330% increase from 1976 (Tower, 1996). Substantiation rates of child maltreatment cases are also rising. According to the U.S. Department of Health and Human Services and the National Center on Child Abuse & Neglect (1996), 1,012,000 children in 48 states were victims of substantiated abuse and neglect in 1994, an increase of 27% since 1990.

In 1994, an estimated 1,271 child abuse and neglect related fatalities were confirmed by CPS agencies. Approximately 45% of these deaths occurred to children who were known to CPS agencies as current or prior clients. Since 1985, the rate of child abuse fatalities has increased by 48% (National Committee to Prevent Child Abuse, 1995). Currently, more than three children die each day as a result of child maltreatment.

The physical and psychological consequences of child maltreatment are devastating. Research consistently shows that the impacts associated with abuse can be severe and long-lasting (Bensley & Meengs, 1996, Briere, 1992, Iverson & Segal, 1990, Tower, 1996, Wolfe, 1991). While children are affected by abuse in different ways, research findings suggest that maltreatment can impact all areas of functioning including the cognitive, socioemotional, affective, behavioral, and physical domains (Bensley & Meengs, 1996, Briere, 1992, Iverson & Segal, 1990, Tower, 1996, Wolfe, 1991). As a consequence, maltreated children are at risk for violence and delinquency, depression, self-destructive behavior, and suicide (Bensley & Meengs, 1996, Briere, 1992, Iverson & Segal, 1990, Wolfe, 1991). These devastating outcomes not only traumatize children but also generate negative influences within families, communities, and society at large.

OVERVIEW OF CURRENT RESPONSES

The Federal Child Abuse Prevention Act of 1974 (PL 93-247) established a general definition of child maltreatment and set requirements for states, including laws consistent with federal definitions, mandated reporting, and a CPS agency to respond to all reports of child abuse and neglect. In accordance with the Act of 1974, definitions used by federal and state legislatures have a tendency to be non-specific, describing only the phenomenon of child maltreatment. On the other hand, "front-line" staff use operational definitions, or specific sets of conditions, that outline possible indicators and consequences of child maltreatment (Iverson & Segal, 1990). The requirement of mandated reporting is responsible for the majority of reports now received by CPS agencies (Besharov & Laumann, 1996). Most states mandate professionals including teachers, school counselors, principals, law enforcement officers, mental health workers, hospital staff, private medical staff, and in some cases adults working with children to report suspected abuse (Pecora et al., 1992).

Every state CPS agency is designed to facilitate aid to children in abusive situations through casework intervention and treatment services. CPS agencies are only responsible for abuse or neglect occurring within the home due to parent or guardian actions. Any cases of abuse by strangers is conducted as a criminal investigation. Intake personnel in CPS agencies are responsible for the following duties: initial assessment and investigation, notifying law enforcement, risk assessment, and referral to caseworkers. Caseworkers complete the investigation, conduct a comprehensive family assessment, develop a case plan with the family, and follow-up with case management. The caseworker's main objective is to establish a service plan and to provide the family with assistance in following the plan. If the family does not voluntarily cooperate with the caseworker they can be court ordered to do so. Failure to comply with court orders results in the removal of the child. If the parents do not comply within an allotted time period, their parental rights may be terminated and the caseworker arranges permanency planning for the child's future (DePanfilis & Salus, 1992, Pecora et al., 1992).

Child maltreatment services fall into three categories: (1) CPS-provided, (2) community-based, and (3) family-based. CPS-provided services are managed by state agencies and include casework, foster care, parent aide, homemakers, adoption, and group homes. Community-based services, which may or may not be under contract with CPS, include guardian ad litems, public health nurses, child protection teams, parenting classes, drug and alcohol treatment, private counselors, and mental health centers. Family-based or home-based services are those which aim to keep the family unit together, avoiding unnecessary placement of children in substitute care. They also attempt to improve family functioning while eliminating the destructive behavior that led to the initial crisis. Examples of family-based services include therapy and concrete services such as providing toys, transportation, child care, clothing or food assistance, helping clients obtain employment, and arranging for financial assistance (DePanfilis & Salus, 1992, Pecora et al., 1992).

EVALUATION OF CURRENT RESPONSES

Due to inconsistencies observed between federal, state, and local agencies, there lacks a consensus as to precisely what constitutes child maltreatment (Bensley & Meengs, 1996, Iverson & Segal, 1990). While federal and state agencies use general definitions, "front-line" staff and social workers are guided largely by operational definitions. When federal and state laws and definitions conflict, social workers are put in a 'double bind' as to which goals take precedence in preventing and treating child maltreatment. Similarly, conflicting definitions impact mandated reporting rates in that many professionals either underreport or over report. Several factors may influence the decision to report including a concern for parental reaction and consequences for the child, confusion regarding what constitutes child abuse and neglect, worries about identity disclosure, and reluctance to attend court proceedings (Bensley & Meengs, 1996, Besharov & Laumann, 1996, Iverson & Segal, 1990, Reiniger et al., 1995). According to Reiniger et al. (1995), underreporting occurs because many mandated reporters lack knowledge of their legal obligations and the process of reporting suspected child maltreatment. However, Iverson & Segal (1990) state that there is a bias toward over reporting because mandated reporters may face criminal sanctions for failing to report suspected child maltreatment.

There are serious structural problems within the governmental CPS agencies mandated to handle cases of child abuse and neglect. Most state CPS agencies are large and bureaucratic, fostering ineffectiveness and a considerable lack of accountability. CPS agencies are protected by privacy laws, thus eliminating an internal system of checks and balances. As a result, they are not directly held accountable for the injuries and deaths that occur due to their ineffective efforts (Iverson & Segal, 1990, Pecora et al., 1992, Reiniger et al., 1995).

CPS agencies are governed by conflicting goals. The Federal Child Abuse Prevention Act (PL 94-237) requires that states prioritize family preservation. However, state laws require CPS agencies to protect the child. Paul Traus (personal communication, May 8, 1996), a former Deputy Secretary to the Washington Department of Health and Human services, believes that the primary policy dilemma of CPS agencies involves a balancing of family preservation and child protection Ultimately, CPS caseworkers must decide which goal takes precedence

Most CPS caseworkers are not trained in the social work roles, specific education and experience are crucial Likewise, to better address the needs of abused child and their families, caseworkers must engage in continuing education Presently, in-house training by state CPS agencies is insufficient to stay abreast of current issues Furthermore, CPS caseworkers are not afforded time to reeducate themselves (Roxanne Lowe, personal communication, May 17, 1996)

The predominant problem facing CPS caseworkers is extremely high caseloads Caseworkers average between 30 and 60 cases a week (Kaaren Jackson, personal communication, May 7, 1996) According to Pecora et al (1992), caseloads exceeding 45 per caseworker prevent any form of professional casework to be executed Given that CPS is mandated to respond to all reports, setting standards for caseloads is difficult Currently, there is not sufficient funding or enough caseworkers to meet the level of need According to Rick Winters, a Washington State CPS expert (personal communication, May 17, 1996), high caseloads force caseworkers to pick priorities and cut corners, taking away their ability to devote the necessary attention to each individual case High caseloads contribute to other complex problems for "front-line" staff including excessive time spent on documentation, an inability to investigate and assess all suspected cases, inadequate response times, high stress levels, excessive turnover rates, and a lack of communication with other agencies

Similar to CPS, prevention and treatment service agencies designed to facilitate aid to maltreated children and their families are plagued with a variety of problems First, there is a severe lack of communication and coordination between inter-governmental and private agencies Consequently, victims and perpetrators of maltreatment do not always receive proper care Additionally, the majority of existing services focus on residual rather than preventative care As a result, incidents that may be avoided through early intervention continue to occur Overall, these problems hinder the effective and productive delivery of services

ELEMENTS OF A MORE EFFECTIVE RESPONSE

In order to define and clarify the goals of the child protection system, it is necessary to determine a universally accepted operational definition of child maltreatment According to Iverson & Segal (1990), operational definitions based on knowledgeable factors and causes affecting the child result in the effective protection of children, which in essence should be the primary goal of all CPS agencies Using clear and precise definitions, laws, and goals also leads to educated reporting of suspected child abuse, therefore reducing the problems of over reporting and underreporting (Besharov & Laumann, 1996, Reiniger et al , 1995)

Structural problems within state CPS agencies must be addressed First, because caseworkers make critical decisions with limited information and time, it is extremely important that they be closely monitored and supervised This would lead to greater accountability (Pecora et al , 1992) Second, it should be mandatory for caseworkers and CPS staff to fulfill minimal educational and training requirements upon entry into state CPS agencies Similarly, caseworkers and other CPS employees need regular additional training in special areas and current issues These areas include cultural differences within the community, the relationship between child abuse and other prevalent social problems, and social work roles (e g intervention, interviewing, advocacy, mediator, and decision-making skills, etc) State CPS agencies should provide this training and also grant compensated time for their employees to pursue further education Finally, even with proper education and training, it is difficult for caseworkers to make effective decisions, assessments, and case plans when they are constantly beset by an unmanageable number of caseloads Reducing the number of caseloads may be achieved by hiring more caseworkers and increasing clerical support According to Kaaren Jackson (personal communication, May 7, 1996), a caseworker in Seattle, more caseworkers and increased clerical support within CPS would allow caseworkers to spend more time in the field, enhancing their ability to evaluate each situation separately, thoroughly, and more efficiently

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In addition to remedying the problems within state CPS agencies, it is necessary to address the problems facing existing services geared toward abused children and their families. In order to ensure the effective service delivery, CPS-contracted, community-based, and family-based services should be coordinated at the state and local levels. According to Renee Toolson Doran (personal communication, April 26, 1996) of the Washington Council for the Prevention of Child Abuse and Neglect, services should be viewed as a web and improving the linkages between them will result in "catching more people." One method for creating more effective service coordination is to co-locate services. Co-location involves the housing of two or more entirely separate services under the same roof. Each service remains accountable to their respective agencies. Although co-location is not essential for effective service coordination, placing services in the same location would facilitate cooperation and accessibility to clients (Mark Ezell, personal communication, April 26, 1996).

Currently, most services are developed and implemented within the system only after a problem is identified. While there is a need to confront residual problems, efforts toward a solution must also focus on prevention. According to researchers, prevention services fall into two categories: primary and secondary. Primary prevention efforts include activities, services and programs directed toward the general population. On the other hand, secondary prevention includes activities, services and programs targeted to at-risk populations. Effective prevention utilizes both of these strategies (Pecora, et al., 1992). Overall, redirecting the focus toward prevention would produce many positive and long-term impacts, including a reduction in costly treatment services, and most importantly, the elimination of potential child maltreatment cases.

The majority of legislators in charge of allocating funds to programs do not believe that prevention is effective. In fact, there is little concrete evidence that many of the prevention and treatment services that currently exist are effective in alleviating the problems related to child abuse. Convincing legislators to fund programs without first demonstrating their outcome/effectiveness with empirical data is extremely difficult. In order to solve this problem, more outcome research on existing programs must be conducted. Government funding should be made available to agencies for this purpose.

In conclusion, these recommendations concerning the elements of a more responsive child protection system would better guarantee the safety and protection of our children.

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REFERENCES

Bensley, L. & Meengs, M. (1996). Prevention of Child Abuse and Neglect: A Review of the Literature. Olympia: Washington State Department of Health.

Besharov, D.J. & Laumann, L.A. (1996). Child Abuse Reporting. Society, 33 (4), 40-46.

Briere, J.N. (1992). Child Abuse Trauma: Theory and Treatment of Lasting Effects. Newbury Park: Sage Publications, Inc.

DePanfilis, D. & Salus, M.K. (1992). Child Protective Services: A Guide for Caseworkers. McLean: The Circle, Inc.

Iverson, P.J. & Segal, M. (1990). Child Abuse and Neglect: An Information and Reference Guide. New York: Garland Publishing, Inc.

National Committee to Prevent Child Abuse (1995). [Information Received from Rene Toolson Doran, personal communication, April 26, 1996]. Unpublished raw data.

Pecora, P J , Whitaker, J K & Maluccio, A N (1992) The Child Welfare Challenge New York Aldine de Gruyter

Reiniger, A , Robison, E & McHugh, M (1995) Mandated Training of Professionals A Means for Improving Reporting of Suspected Child Abuse Child Abuse & Neglect, 19, 63-69

Tower, C C (1996) Understanding Child Abuse and Neglect (3rd ed) Boston Allyn & Bacon

U S Department of Health and Human Services & National Center on Child Abuse and Neglect (1996) Child Maltreatment 1994 Reports from the States to the National Center on Child Abuse and Neglect Washington, DC U S Government Printing Office

Wolfe, D A (1991) Preventing Physical and Emotional Abuse of Children New York The Guilford Press

The Assessment of College Students' Perceptions and Attitudes Towards Academic Dishonesty

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ABSTRACT

Academic dishonesty in college has increased to epidemic proportions over the past three decades. Perhaps competition for jobs and graduate school entry are partly responsible for the growing rates of academic dishonesty, but a consensus on the causes has not been reached by researchers. In addition, students are uncertain as to what behaviors constitute cheating inside and outside of the college classroom. While professors assume that students know and understand cheating policies, the students' views may differ from what instructors espouse. The current research assessed students' definitions and attitudes concerning academic dishonesty.

This study explored students' opinions of cheating behaviors using an experimenter-created Likert-formatted 25-item scale. The questionnaire asked students to rate the degree to which a behavior constitutes cheating by listing descriptions of behaviors related to plagiarism, outside classroom assignments, and giving/copying answers on tests. The students responded to the items using a 5-point scale where 1=strongly agree and 5=strongly disagree.

The sample of students participating in this study was drawn from a variety of courses at the University of Montevallo. Demographic data such as gender, age, and classification were collected to describe the sample and to use in the analysis of data. Data were analyzed with a factor analysis of the experimenter-created scale, frequency tables, and correlational analyses to facilitate future scale refinement.

Preliminary results indicated that while traditional "cheating behaviors," such as copying from someone else's paper during a test yielded an overwhelming majority of students(75%) rating the behavior as a clear example of cheating, but behaviors such as calling a friend about a take-home test were much less likely to be rated as clearly "cheating" (49%). These results will be used in a follow-up study to determine whether faculty and students' perceptions of cheating differ. Future research plans will focus on a comparison of faculty and students' views of behaviors constituting academic dishonesty. Such assessment will be useful in educational settings to enable professors to clearly define what they should stress to students concerning cheating policies, especially when assigning take-home assignments. Implications for future research are discussed, as well as additional applications of study findings.

INTRODUCTION

There is an increasing number of college students in the United States who are participating in an unfavorable and potentially career threatening activity, academic dishonesty. Whether it is referred to as academic dishonesty, academic misconduct, or cheating, the number of students who participate in this activity seems to be rising. One article reports that the occurrence of college academic dishonesty has increased from 23 percent to 75 percent from 1941 to the 1980's (API general info., 1996). While the percent of participators can be estimated, the exact activity or activities they participate in and with what frequency are unclear. To understand why academic dishonesty is increasing, a clear definition must be reached.

The majority of colleges have their own policy on academic dishonesty. However, the variations in the policies make it difficult to decide on a standard for defining academic

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dishonesty The University of Montevallo, where our study takes place, states, "cheating is the giving or receiving of aid, whether written, oral, or otherwise, in order for a student to receive undeserved credit on work that is his or her own responsibility" (Fledgling, 1994-1995) The University of Alabama in Tuscaloosa stated specifics on what would be considered academic misconduct and direct penalties (Code of Academic Conduct, 1996) However, Lewis and Clark College states in its catalog that, "Academic dishonesty or cheating involves the use of any method or technique enabling a student to misrepresent the quality or integrity of his or her academic work (Academic Dishonesty 1995-1996)" It is hard to reduce the occurrences of academic dishonesty when policies, such as the one stated above, are so vague

A general lack of definitional clarity may be the cause of increasing numbers who cheat (Cheating, Hacking, and , 1996) The word "cheating" denotes a purposeful, unethical action, however there are people who "cheat" without realizing it This mostly occurs in out of class assignments where ideas of dishonesty vary the most There is confusion as to whether or not a group study session of brainstorming ideas for a paper, or exchanging interpretations of directions, oversteps "some ambiguous or undocumented" line of academic dishonesty (Cheating, Hacking, and ..., 1996) What may be seen as dishonest to faculty may be seen as much needed help and social interaction by students One recent study (Becker, Davis, Grover, McGregor, 1995) discussed academic dishonesty in terms of students internalizing ethical standards and stated that before students can apply standards, the schools and faculties should support these standards How can a faculty member support a standard when none is stated? How can students know they violate a policy when the definition is unclear or simply not there?

To help solve this definitional problem, we conducted a study to see how students define academic dishonesty Using an earlier study which analyzed students' perceptions of academic dishonesty (Doherty, Staik, Westcott, 1992), we created an instrument to be given to students now, and perhaps to faculty in a later study The instrument was based on a qualitative research analysis of students' responses to the question, "What constitutes cheating inside and outside of the classroom?" We identified categories which emerged from these responses and created a quantitative instrument representing these categories This instrument will allow us to assess the current views on academic misconduct and the differences between the ideas of upperclassmen and underclassmen It also will show us that upperclassmen will be more lenient than underclassmen on outside classroom misconduct

METHODS

Subjects

The subjects within the study are University of Montevallo students of Fall 1996 The gender ratio among subjects is as follows 26 males and 55 females In addition, there were 34 upperclassmen(Sophomore, Junior, and Senior) and 47 underclassmen(Freshmen)

Materials

In order to assess subjects' opinions of what is and what is not considered to be academic dishonesty, we have developed the Academic Dishonesty Scale, a questionnaire consisting of 25 questions The variation in questions consists of both in-class and out-of-class assignments in order to determine if students view them differently The method used to answer these questions is a 5-point Likert scale with 1= strongly agree, 2=agree, 3=neutral, 4=disagree, 5=strongly disagree Questions ranged from plagiarism to using crib notes during a test Other materials used include a general consent form, giving us the right to use the students' surveys in our study and a demographics page asking for information on the student's age, sex, race, religion, marital status, college major and minor, participation in a social Greek organization, and campus resident status

Procedure

We stressed the importance of the confidentiality of the students' answers to our survey and the special procedures we would be taking to ensure them of this confidentiality We informed them that the results would be available in the Psychology Office in May of 1997 if they want to know the outcome of our study

RESULTS

A principle component analysis was conducted on the Academic Dishonesty Scale as part of scale refinement procedures An orthogonal rotation of the items into two factors yielded factor loadings at the .4 level or above which could be used to define the factor structure. A factor loading represents the simple correlation (r) of the scale item with the hypothetical underlying factor.

Fifteen items loaded at the .4 level or above on Factor I. The content of these items identifies the most commonly accepted instances of academic dishonesty held by college students. The content of the top eight items with factor loadings of .92 to .82 involve cheating practices in which the student actively initiates the dishonest act. The items also include high profile actions that have severe punishment, such as plagiarism and looking at another person's test.

The remaining scale items with factor loadings of .76 to .50 have no commonalties that could be distinguished. The items dealt with a mix of overt, covert, classroom and outside classroom activities related to academic dishonesty, but by the strength of their relationship with Factor I indicated that the item content was valid.

Seven scale items loaded at .4 or above on factor 2. The items that loaded high on this factor were items that most students did not feel were representative of academic dishonesty. Four of the items deal with outside classroom activities which involve comparing/receiving test or homework answers through other persons or sources. The remaining three items focus on dishonest actions that do not involve a person's score on tests, homework, or projects. These final three items consisted of lying to a teacher, complimenting a teacher in order to try to influence a grade, and not reporting an incident of cheating that the student saw. The students do not see these activities in the same light as they see more active cheating behaviors. See Table 1 for specific item descriptions and loading on Factor I and Factor II.

Three of the scale items loaded at approximately the same level in both Factor I and Factor II. The content of these items involve: copying someone's homework, taking money for doing someone's work, and glancing at another paper and seeing something to jar your memory. See Table II for item description and loadings.

This research sample consisted of 47 (58%) underclassmen and 34 (42%) upperclassmen. The study indicates that on outside classroom assignments, upper and lower classmen generally have similar views. There are only three items where a larger percent of underclassmen were more lenient on activities outside of the classroom. These include: not carrying your weight in a group, discovering someone else's idea and using it as your own, and using answer keys when doing homework. See Table III for frequency data.

TABLE I - Items Loading on Factor I or Factor 2 at .4 Level or Above

Item #	Description	F1	F2
02	Cheat sheet	92	
09	Putting your name on someone's work	92	
01	Looking at a classmate's paper	91	
19	Selling copy of test	89	
07	Leaving test to get answers	88	
04	Paying someone to do your work	86	
14	Plagiarism	83	
17	Unequal work in group project	82	
13	Asking for answers with sign language	76	
18	Using teacher restricted sources	71	
12	Using someone else's idea	71	
21	Give answers with sign language	69	
03	Getting a copy of test	62	
08	Answering *here* for someone else	58	
15	Someone's research = Your benefit	50	
10	Brownnosing teacher		78
25	Getting help for take-home tests		72
20	Swapping answers among group		68
22	Lying to teacher		68
06	Using answer book to get answers		60
16	Not reporting seeing someone cheat		59
11	Sorority/fraternity test files		48

TABLE II - Items Loading on Both Factors at 4 Level or Above

Item #	Item Description	E1	E2
5	Copying someone's homework	50	43
23	Doing someone else's work for money	53	52
24	Glancing at a paper to jar memory	45	72

TABLE III - items differentiating upperclassmen from freshmen in frequency of response

Item #	Item Description	Freshmen%	Upperclassmen%
06	Using answer book/keys	51 06	29 41
12	Using another's idea	27 60	11 80
17	Unequal work in group project	29 70	14 70

DISCUSSION

The goal of our study was to assess University of Montevallo students' perceptions of academic dishonesty and to begin to form a working definition of the term "academic dishonesty" for our campus and student population From our factor analysis, we can determine the most commonly thought of instances of academic dishonesty in our sample It appears that the items in the survey dealing with widely known and severely punishable infractions such as looking at another's paper, having a cheat sheet, having/paying someone do homework for you, and leaving the test to get answers are those items that rank high on Factor I If an item scored low on Factor I and conversely high on Factor II, it was generally not considered as important to the students as representing academic dishonesty The items that scored low on Factor I were those dealing with outside classroom activities where people were working together (as opposed to paying or receiving money for work done) or dishonesty by omission, e g , not reporting someone else cheating It appears that it is more acceptable to share answers in group form with people who are taking the same class, than to pay someone to do work for you or put your name on someone's paper Also, lying to a teacher about why you were not prepared was more acceptable than using a resource that the professor told you not to use

In opposition to our original hypothesis, the results of our survey indicate that, in general, upper and lower classmen hold similar views toward outside-classroom cheating activities There are only three items that show a significant difference between the views of upper and lower classmen in relation to outside-classroom behaviors These items had a larger percentage of freshmen indicating on the survey that they did not think these items constituted academic dishonesty These results show that underclassmen are more lenient on such actions as using answer keys for homework, discovering another's ideas and using them as your own, and not carrying one's weight on a group assignment

We are proposing that definitions of academic dishonesty within colleges and universities be more clearly stated with specific examples of undesirable behaviors and their consequences given We feel that this will help erase the confusion of undergraduates as to which behaviors are or are not examples of academic dishonesty Once schools bring attention to these behaviors and students realize the repercussions they must face if they are participants, perhaps students will be less likely to rely on someone other than themselves in completing their academic work

Further research done on this subject assessing the attitudes of faculty in comparison to those of students will bring attention to the differences of students' and faculties' perceptions of academic misconduct This research would allow universities as well as faculty members to develop specific academic dishonesty policies in hopes of reducing the rate of academic dishonesty

It would be optimistic to think that simply clearly defining academic dishonesty would considerably lower its occurrence However, if a specific definition was combined with an emphasis on the benefits of being academically sound and the importance of learning for a lifetime, then students might decide not to participate in such a degenerating activity Although a university whose lax conduct policies might facilitate cheating, it is the students who make the choice whether to commit the crime or not A significant change will come about only if faculty and students together work toward the goals of honor and integrity

REFERENCES

Academic Dishonesty (1995-1996) Available [on-line]http //www lclark edu/COLLEGE/CATAL/POPR/propracdi html

API General Information On Test Cheating (1996) Available [on-line] http //www wp com/API/cheat html

Becker, A H , Davis, S F, Grover, C A , McGregor, L N (February, 1992) Academic dishonesty Prevalence, determinants, techniques, and punishments Teaching of Psychology, 19(1), p 16-20

Cheating, Hacking, and other Nasty Stuff (1996) Available [on-line] http //www cs wahington edu/people acm/guide/Cheating html/Code of Academic Conduct (1996) Available [on-line] http //www sa ua edu /SA/HANDBOOK/acacon htm

Doherty, M , Staik, I , Westcott, D (April, 1992) Assessing differences in students' perceptions of academic dishonesty between a church-supported college and a state-supported university Paper presented at the Seventh Southeastern Undergraduate Psychology Research Conference, Birmingham, Alabama

Fledgling University of Montevallo Student Handbook (1994-1995) [Brochure] Montevallo, AL

Academic Dishonesty Scale

For each item below, choose the number from the following scale which best represents your opinion

5 - Strongly disagree
4 - Somewhat disagree
3 - No opinion
2 - Somewhat agree
1 - Strongly agree

ACADEMIC DISHONESTY IS

1 ______ looking directly at another person's paper to copy an answer during a test
2 ______ using "crib notes" or a "cheat sheet" during a test or class assignment
3 ______ getting a copy of the test prior to taking it
4 ______ having/ paying someone do homework or at-home projects for you
5 ______ copying someone's homework
6 ______ using answer book or keys to get homework anwers
7 ______ leaving the test to go to the restroom/or another place to get answers
8 ______ answering "here" or signing someone's name when he/she is absent
9 ______ copying someone's paper or work and putting your name on it
10 _____ trying to influence a teacher to give you a better grade
11 _____ using sorority /fraternity test files
12 _____ discovering someone's idea and using it as your own
13 _____ asking for answers with gestures or sign language during an in-class assignment
14 ____ plagiarism of resource materials or documented work
15 _____ using someone else's research for your own benefit
16 _____ watching someone cheat without reporting it
17 _____ not carrying your weight in a group project for which everyone gets the same grade
18 _____ using sources on homework which the professor told you not to use
19 _____ getting a teacher's copy of a test to sell
20 _____ conducting group sessions to swap or check the accuracy of answers
21 _____ giving answers with gestures or sign language during an in-class assignment
22 _____ lying to a teacher about why you are not prepared in class
23 _____ taking money for doing someone else's work
24 _____ glancing at another paper and seeing something to jar your memory
25 _____ working with someone else on a take-home exam

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Changing Pedagogy: Using a Computer Simulator to Teach Ethnographic Methods

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ABSTRACT

Advances in multimedia computer technology have lead to changes in instructional pedagogy. Emerging from these advances is an Ethnographic Field Research Simulator (EFRS). The guiding principles behind EFRS has been to design a delivery system encompassing, ethnographic data, languages, culture, scientific and ethnographic methods, and the field into the classroom.

This study will focus on how students learn using EFRS, and the advantages of using a simulator versus learning ethnography from strictly reading books and attending lectures. My presentation will discuss how students learn ethnographic research methods, and the management of electronic data to write an ethnography.

INTRODUCTION

Within cultural anthropology, there is a wide abyss between acquiring an understanding of the nature of ethnographic field data, the pedagogy used to teach ethnographic field methods, and the execution of actual fieldwork. Although the discipline of cultural anthropology in the US and Europe has undergone several distinct periods, the process and manner in which ethnographic field methods are taught has changed very little (Johnson, 1990). Indeed it appears that the systematic teaching of fieldwork methodology has been conspicuously absent from graduate and undergraduate training programs. According to Alfred Kroeber, one of the founding fathers of anthropology, when asked some years ago by a then beginning professor of cultural anthropology, Charles Wagley, for advice on teaching field methods, Kroeber replied "Some can and some can't." (Wagley, 1983) This sink or swim approach to fieldwork, although a serious flaw in the programs teaching anthropology today, leaves room for changes and innovations in the planning, delivery of teaching ethnographic field methods, and cultural navigation. Fortunately, there appear to be some changes taking place that attempt to remedy this condition (Carlos, et. al, 1996).

Given the paucity of information regarding innovations in anthropological pedagogy (Russell, 1995) , and the disciplines' mystique about fieldwork; it is assuring to know that there are recent attempts to give large numbers of learners knowledge about the conduct of anthropological field methods and experience in carrying out ethnographic research. The purpose of this report is to describe the features and value from the point of view as a student participant of one such innovation. This innovation involves the use of ethnographically authentic and computer lab based simulations of field work.

METHODOLOGY

What would it be like to practice ethnographic field methods in Mexico's peasant villages without actually traveling there? Well, this past year approximately 45 students at two universities have had such an opportunity They are using, what Dr. Manuel L. Carlos, professor of anthropology in the Social and Behavioral Sciences Center at CSUMB and Professor Emeritus at UCSB calls, an Ethnographic Field Research Simulator (EFRS). I have been among those students using this learning package.

It is the first of its kind anywhere, which integrates scholarly content and multimedia into the curriculum. EFRS is on the forefront of changing educational pedagogy in American higher education. The virgin territory EFRS crosses will have long lasting implications in terms of the way ethnographic method and theory are taught, the mobility of higher education, and intellectual property rights issues.

EFRS is the result of over nine year's field research in Queretaro, Mexico. The Queretaro Research Project (QRP) is where the computer simulation idea began and was carried to fruition. QRP is a binational research project housed at the University of California, Santa Barbara (UCSB). Besides being at UCSB, this project works in collaboration with the University of Queretaro (UAQ), and is now being taught at California State University Monterey Bay (CSUMB). The project is supported by UCSB and the National Science Foundation (NSF Grant No. 9455699), Division of Undergraduate Education. Dr. Carlos began the project over nine years ago and it is ongoing.

EFRS is being beta tested at two campuses, UCSB and CSUMB. CSUMB, the newest campus in the California State University system is also seeking to make a mark in

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higher education, with emphasis on technology, second language acquisition, commitment to multi-culturalism, and a global awareness; is well suited as a beta testing site. Instructors at CSUMB are given more latitude to be pedagogically innovative as compared to a more established institution (UCSB). Compare UCSB's Anthropology 111A: Ethnographic Data Analysis to CSUMB's SBSC 313 Learning Ethnographic Methods in a Multimedia Electronic Environment, the difference in course titles begins to describe the atmospheres at each institution. The culture of technology and experimental nature of the university make it an excellent choice to try something that has not been done before.

After several years of data collection by Dr. Carlos and his students, attempts were made to archive the data. The data was first digitized and then catalogued. Initially, an electronic searchable database was to be constructed. Working in a similar manner as current search engines do on the Internet, the database rapidly compile and produce "links" to the requested information. Although the projected began as a database, the notion of the simulator derived from how airplane pilots use flight simulators to teach prospective pilots how to fly an airplane. Basically, the same principle of introducing the concepts of flying an airplane are then applied to the teaching of ethnographic methods and fieldwork. Not only are the concepts introduced, but also so are building the requisite skills that are then necessary to fly an actual plane are then gained through practice.

Although, a simulation does not provide exactly the same sensation as actually flying a plane it does have validity for flight training. Similarly, EFRS provides students with conditions to practice ethnographic methods in a computer laboratory environment. Although, one could argue that the missing human factor nullifies the usefulness of EFRS, I will provide evidence derived from my experiences and those of other student's to the contrary.

A simulator such as EFRS is a device that enables the operator to represent under test conditions phenomena likely to occur in actual performance. This definition, according to Webster's Dictionary, implies the presence of a replication so well constructed that the product can pass for the real thing. When applied to the study of flight simulation or ethnographic methods, simulations can serve as suitable substitutes for the real thing. In a similar fashion, EFRS allows students a unique opportunity to practice ethnography without leaving the classroom and more properly the computer lab.

EFRS has several immediate contributions concerning teaching ethnographic methodology. First, EFRS introduces students to fieldwork, in an international setting, without the cost of travel to the field. On a related notion, students are taught that time and budgetary constraints are a part of the field experience. With shrinking budgets and the highly competitive nature of obtaining funds to conduct field research, it is not too early to have undergraduates thinking about the relationship between time and money.

Further, EFRS allows students to make mistakes without embarrassment or harm to the study population, while gaining research experience. Additionally, students can practice language skills while learning field methods and other patterns for living. Finally, students practicing fieldwork-using EFRS will not face the same situation as Kroeber's student did mentioned earlier in this paper.

Concepts of doing ethnography are introduced through lecture and augmented with supplementary information posted via the World Wide Web (http://www.monterey.edu/academic/centers/sbsc/sbsc313/index.html.) The content of these web pages provides background information and hypertext links to other sites of relevance. Not only do students receive additional information from a variety of sources, but also they are encouraged and have actively engaged other students in on-line asynchronous electronic discussions. The forum for this type of discussion is through newsgroups. Newsgroups are electronic "bulletin" boards where participants send and read messages, using currently available web browsers. A medium such as newsgroups differs substantively from email, because email arrives in your email account, whereas you have to seek the newsgroup.

METHODOLOGIES STUDIED USING EFRS

The developers of the simulator state that the purpose of EFRS it to introduce students to many of the dilemmas of ethnographic field research in a non-English speaking environment as well as in a non-US historical and cultural setting. (Carlos 1995) It is not intended as a substitute of a field experience or to be used instead of classroom instruction. It is an educational tool used to teach ethnographic methods.

The type of practice and assessment that EFRS provides is at the level that is most often introduced to first or second year graduate students. Though using the simulator is not the same as practicing ethnography in the field, it does offer many opportunities that will enrich an actual field experience. For example, students are not limited to using the simulator in class. In addition, students can repeat the exercises as often as their schedules will allow and add to their existing fieldnotes, field diaries and ethnographic reports. The concept of time and budgetary constraints are woven throughout the exercises, thus underscoring the importance of being prepared and understanding what types of data are sought. Students quickly learn that time and money is a fundamental issue when in the field.

Specific skills obtained though the use of the simulator are: (1) to collect observation and interview data, (2) conduct interviews, (3) record participant data, (4) take field notes, (5) analyze census data, (6) keep a field diary and write field reports. Additional secondary skills acquired are the ability to navigate in the regional culture of Queretaro, Mexico and surrounding communities, and to practice using the Spanish language. Exercises are available in Spanish and English, with many of the interviews are audible in Spanish and text translations are available in English.

Students can complete each of the seven simulated exercises and/or experiences at their own pace. Accompanying each exercise are a series of assignments and evaluation of the simulator and its contents. EFRS is designed to provide an introduction, but advanced undergraduates and graduate students can easily benefit from its use. The level of detail and analysis of the data is at the instructors' discretion.

ASSESSMENT

EFRS has built in evaluations that examine the content of the data and the effectiveness of the simulator. Students provide QRP with troubleshooting problems, suggestions and data on the effectiveness of the simulator. Qualitative responses are elicited from students rather than numerical because the simulator is being beta tested. The following skills can be practiced and evaluated using EFRS:

- the ability to take field notes;
- the ability to conduct simulated interviews;
- the ability to observe, and record what is being observed;
- the ability to keep a field diary;
- computer and Internet skills

The evaluation of the uses of electronic technologies in the enhancement of research methods teaching is assessed by:

- learning by doing
- presenting oral and written reports
- interacting with a research group
- distance learning
- analyzing ethnographic data
- communication with peers
- writing an ethnographic report
- categorization of collected data

FINDINGS

The initial findings suggest that EFRS has cost saving potential. Content analysis from student reports and feedback from state wide budget analysts indicate that EFRS is portable, can be easily used and introduces students to fieldwork in an international setting without travel. This is particularly valuable to student pursuing advanced degrees in the social sciences. Furthermore, it introduces students to the relationship of time management and budget. EFRS provides a baseline to track student progress. Each student can access identical data sets, and has the same resources to complete exercises and write ethnographic reports. Perhaps the greatest potential of EFRS is to provide opportunities for students to practice ethnography in the classroom, before they take ethnography to the field.

CONCLUSION

EFRS brings students into contact with an ethnographically accurate environment in which to conduct research and experience field work as ethnographers would. It also provides a readily accessible method and curriculum for teaching undergraduates how to do ethnography. The content of the simulator seems form a longitudinal study being conducted in Queretaro, Mexico. With subsequent models or versions of the simulator change over time can be analyzed, such as in the case of Robert Redfield's Tepoztlan and Oscar Lewis' Life in a Mexican Village: Tepoztlan Restudied.

EFRS allows students to learn the fundamental skills needed to carry out field work. Although one could argue, that instruction in ethnographic methods must include real informants, not videotape. Certainly, the human factor is critical in the field, but so is a low cost alternative for the purpose of practice. The technical skills students acquire based on systematic data collection methods, and discipline should prove useful in the field. In June 1997, approximately four students from CSUMB will travel to Mexico to find out exactly how well the simulator has prepared them for fieldwork in a Mexican peasant village. I will be among them. We will be gathering data the will augment data for Simulator 2, which focuses on Mapping, and Simulator 3, which focuses on Genealogy and Kinship.

Again, EFRS offers a low cost alternative going to the field, while providing a replication of life in a peasant village. It introduces the relationship that time and funding play in a research project. EFRS provides a baseline for students and instructors to use when assessing progress. In addition, no special computer training is needed to us EFRS, besides the ability to use a mouse. With rapidly changing computer technology and increasing global interdependence, tools such as EFRS will be on the forefront of changing pedagogy.

REFERENCES

Agar, M.H.
1980 The Professional Stranger: An Informal Introduction to Ethnography New York: Academic Press

American Anthropological Association Program.
95th Annual Meeting San Francisco, California. Anthropology: A Critical Retrospective November 20-24, 1996. Arlington, Virginia: American Anthropological Association Press.

Bernard, Russell H
1995 Research Methods in Anthropology: Qualitative and Quantitative Approaches. Walnut Creek, California: Altamira Press

Boone, Margaret S. and John J. Wood, editors
1992 Computer Applications for Anthropologists. Belmont, California: Wadsworth Publishing Company

Carlos, Manuel L., Philip C. McCarty, Melody Knutson, and Juan Jose Gutierrez.
1994 Undergraduates as Ethnographic Field Researchers of Mexican Peasant Communities: The Application of Classroom Skills to Field Settings. Paper prepared for presentation at the 93rd Annual Meeting of the American Anthropological Association, Atlanta, GA, and November 30 - December 4, 1994.

Carlos, Manuel L. and Melody L. Knutson.
1993 A Multidimensional Computer-Assisted Approach to Training Undergraduates in Ethnographic Field Research Methods at the University of California, Santa Barbara. Paper prepared for presentation at the 92nd Annual Meeting of the American Anthropological Association, Washington, and DC November 16-20, 1993.

Carlos, Manuel L., Juan Jose Gutierrez, and Melody L. Knutson.
1992 Ethnographic Field Research in the Age of Computers: Development of an Electronic Multimedia Ethnographic Databank and its Application in the Queretaro Research Project. Advances (Journal of the University of Queretaro), July, 1992.

Carlos, Manuel.
1996 The Application of Computer Technology to Undergraduate Curriculum in Cultural Anthropology: Simulated Ethnographic Field Research" presented by Manuel L. Carlos, Juan José Gutierrez and Phil C.McCarty at the 1996 Annual Meetings of The Society for Applied Anthropology, March 27, 1996

Emerson, Robert M., Fretz, Rachel I., and Shaw, Linda L.
1995 Writing Ethnographic Fieldnotes. Chicago, Illinois: University of Chicago Press.

Johnson, Jeffery C.
1990 Selecting Ethnographic Informants. Newbury Park, California: Sage Publications, Inc.

Lewis, Oscar.
1951 Life in a Mexican Village: Tepoztlan Restudied, Urbana: Univeristy of Indiana Press..

Redfield, Robert
1930 Tepoztlan – A Mexican Village, University of Chicago Press

The Influence of Pretrial Publicity on Juror Decision-Making: A Meta-Analysis

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High-profile trials in recent years have generated interest in the impact of pretrial publicity on a defendant's right to a fair trial. This project is a meta-analytic review of the research literature on pretrial publicity effects. Meta-analysis produces a statistical test of the complete data set, allowing conclusions about the overall status of a hypothesis across multiple tests of the hypothesis. At present, 15 studies have been found which test the hypothesis that negative pretrial publicity increases the likelihood of "guilty" verdicts by jurors. In support of the hypothesis, a significantly higher level of guilty verdicts occurred in subjects exposed to negative pretrial publicity, compared to control subjects, $Z_{re} = 11.23$, $p < .0001$. The overall effect size, $r = .17$, indicates a small effect across the studies. Additional analyses address moderator variables, such as type of publicity, while discussion focuses on the application of the findings to courtroom decision-making.

The news media--television, radio and newspapers--continually inform us of crime in today's society. The media cover dramatic crimes, focusing on attention-grabbing events and thereby bringing only the most sensational and bizarre crimes to the public attention (Conklin, 1992). It is not surprising then that people react to news of sensational crimes and their trials with a great fascination. For the society as a whole, trials are often seen as the essence of the drama and dynamics of the culture (Friendly & Goldfarb, 1967).

According to Carroll, Kerr, Alfini, Weaver, MacCoun, and Feldman (1986), the growth of print and electronic media has significantly complicated the free press-fair trial dilemma, putting a heavy burden on the trial judge who must balance the interests of both media and justice. The problem arises when potential jurors are exposed to and influenced by information prior to trial. The courts find themselves in the difficult position of maintaining the defendant's Sixth Amendment right to a fair trial without infringing on the Constitutional guarantee of freedom of the press (Otto, Penrod, & Dexter, 1994).

Information about the impact of pretrial publicity is necessary to the judge's decision-making. Researchers have traditionally used two common approaches for studying the influence of pretrial publicity: surveys and jury simulations. For example, research done by Nietzel and Dillehay (1983) provided the results of surveys for five murder trials. They found that a higher percentage of respondents in the venue counties had heard or read about the case, hence concluding that the possibility of bias would be greater in those venue counties than in other counties. Similar results were found in Costantini and King's research (1981) where respondents with greater knowledge about a case were found to favor the prosecution.

The second approach used to study the effect of pretrial publicity on juror decision-making involves the use of jury simulations which attempt to approximate the trial experience for mock jurors in a controlled experimental environment (Otto et. al., 1994). Following exposure to pretrial publicity, subjects are asked to evaluate video tapes of mock trials (e.g., Kramer, Kerr, & Carroll, 1990), a short written summary of trial proceedings (e.g., Sue, Smith, & Gilbert, 1974), or a reenacted trial (Dexter, Cutler, and Moran, 1992). Researchers have found that negative pretrial publicity increases conviction rates even for subjects who underwent an extended voir dire.

Although both surveys and jury simulations offer information, these methods are not without problems. Survey research suggests that pretrial publicity does influence the juror's decision about the verdict, however only the extent of exposure to pretrial publicity is assessed. At the same time, even though the simulation method enables the researchers to vary the types and amount of pretrial publicity given to subjects in the experiment, it does not always demonstrate clear effects for pretrial publicity.

Additionally, a number of studies (e.g. Greene & Dodge, 1995; Greene & Wade, 1988; Kramer & Kerr, 1989) suggest that certain types of pretrial publicity are more likely to create bias than other types. According to Otto et al. (1994), the American Bar Association (ABA) in 1968 identified a number of categories of pretrial publicity which

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could compromise a defendant's right to a fair trial, including prior criminal record, statements about the defendant's character, reports of confession, statements from potential witnesses, and others. A summary of the research which would address these variables would be useful at this time.

In fact, Fulero (1987) argues that researchers have collected enough evidence about the effects of pretrial publicity that their findings can be used to address judicial concern about the influence of pretrial publicity. The purpose of this research is to determine the extent to which negative pretrial publicity affects juror decision-making. Fifteen studies have been located to address the effects which negative pretrial publicity has on juror verdicts. These studies examined similar variables and hence allowed application of the statistical procedures used in meta-analysis, specifically: (1) assessed the overall probability of a relationship between negative pretrial publicity and post-trial verdict, and the size of this effect; and (2) identified gaps in our knowledge and necessary areas for future research.

METHOD

Sample

Several steps were taken to locate potential studies, including a computer search of five abstract services, PsychINFO, SOCIAL SCISEARCH, FirstSearch, InfoTrac and Lumina. A manual search of relevant references cited in any of the previously located articles was performed. Finally, some authors of primary articles were contacted by electronic mail (e-mail) and asked to send any relevant works, published or unpublished. The final sample then included 13 published reports, one conventional paper, and one unpublished report each representing the unit of analysis of this research study. The articles were selected for inclusion in the review if the author(s) examined different levels of negative pretrial publicity with verdict as a dependent measure. For the purposes of this study, pretrial publicity was defined in either of two ways: (1) negative information about the character, credibility and reputation, or prior criminal record of the defendant (25 tests), or (2) negative information about the type of crime in general (4 tests). The final sample represented approximately 5,406 subjects.

Study characteristics

Various methodological and theoretical characteristics were recorded, including the source (published report, convention paper, or unpublished manuscript), author, date of the study (between 1974 and 1996), sample size, variable operational definitions (negative pretrial publicity as the independent and post-trial verdict as the dependent variable), specifics of research design, and statistics.

Statistical Analyses

According to Rosenthal (1984), an overall probability level associated with the observed pattern of results was calculated by combining Z-scores of individual tests of the one-tailed hypothesis. When unreported by the authors, Z-scores were calculated for each test by converting the statistical data reported in the original articles. The overall Z-score (Z_{ma}) provided an estimate of the overall probability level (see Appendix A).

The effect size is a statistical indicator of how large the relationship is between the variables. In this case, the effect size for each individual hypothesis test was the correlation coefficient *r*. In order to calculate the mean effect size, the summation of individual effect sizes was divided by the number of effect sizes reported (Rosenthal, 1984).

As mentioned earlier, a fail-safe *N* was calculated due to the possible selection bias in the studies. According to Rosenthal (1984), this method results in an estimate of the number of additional tests that would be needed in order to bring the significance level attained through the meta-analysis to a value larger than .05.

RESULTS

The 15 studies (29 tests) which dealt with the impact of pretrial publicity on juror decision-making yielded a Z_{ma} of 11.23 ($p < .0001$), indicating that subjects who were exposed to negative pretrial publicity were significantly more likely to vote for a guilty verdict ($N_{fs} = 1{,}323$).

The overall effect size for the 29 tests of hypothesis included is .17 [CI (95%) = .11 to .22]. Although this is a relatively small effect size it is still an important indicator of the influence of pretrial publicity since it is different from zero.

At the time of writing, the author is investigating moderator variables including

(1) the two approaches most common for studying the effects of pretrial publicity on juror decision-making, survey vs. simulation, and (2) the type of information about the defendant (general vs. specific to the defendant). Just two studies including five tests (Costantini & King, 1980/81, Moran & Cutler, 1991) used a survey. These five tests produced $Z_{ma} = 10.17$, $r = .39$; while the remaining 24 tests used simulations $Z_{ma} = 7.70$, $r = .12$. Twenty five tests included specific information regarding the defendant ($Z_{ma} = 10.86$, $r = .17$), while only four tests included general information producing $Z_{ma} = 3.09$ and $r = .13$.

DISCUSSION

This study was designed to test the extent to which negative pretrial publicity affects juror decision-making. Fifteen studies together offered survey research and jury simulations. The results demonstrate that negative pretrial publicity does affect juror decisions regarding defendant's guilt. Although the overall effect size generated ($r = .17$) can be judged as small (Cohen, 1988), it is relatively consistent across the studies as indicated by the confidence interval. Examination of moderator variables demonstrates significant Z_{ma}-scores when looking at either method used in the studies (survey vs. simulation), and both types of information about the defendant (specific vs. general). However, it is interesting to note that there is a larger effect size for survey studies. On the other hand, type of information (specific vs. general) produced similar effect sizes.

These studies suffer from methodological limitations, according to Linz & Penrod (1992). First, the subjects are not real jurors but often students or adults selected from voter registration lists. Second, the stimuli used in many studies may not be representative of real trials since the subjects have been exposed to selectively prepared and presorted videotapes of trials, written statements about evidence, or summaries of criminal proceedings.

However, the studies considered in this meta-analysis offer useful insights into the influence of pretrial publicity on juror decision-making. The research suggests that information about prior convictions and confessions, or emotional and sensational descriptions could be detrimental to criminal defendants. Jurors having knowledge of these facts through pretrial publicity may be biased against the defendant. A social psychological explanation of this bias is provided by the primacy effect. According to Zimbardo and Lieppe (1991), initial impressions of jurors form a mental schema, a biasing filter, through which subsequent information is selectively noticed and interpreted. In order to make decision about the case, jurors must form a mental representation of the event. The information first received will serve as a building block of the schema, thus the primacy effect will have an important impact on overall formation of schema. Therefore, when jurors receive negative information about the defendant, they then interpret subsequent information selectively and remember only what supports their initial impression.

In conclusion, the present study provides evidence that negative pretrial publicity has an impact on jurors' judgments of the defendant's guilt in a moderately realistic trial simulation and survey research. Future research should consider remedies for these effects, as well as additional moderator variables which may influence the results and remedies.

The question as to whether constitutional rights to a free press and a fair trial can be balanced is still present since the clash between the First and Sixth Amendments is still present. In order to address the problem it is necessary to employ powerful methods to capture pretrial publicity effects which influence juror decisions. According to Linz and Penrod (1992), there is a need for research with greater external validity that emphasizes a reliance on methods and procedures that both maximize experimental control and realism, and thus maximize both internal and external validity. These studies should seek to test empirically the social-psychological assumptions underlying the presumed effects of pretrial publicity given by the ABA in its Rules Code (Linz & Penrod, 1992). Furthermore, studies should be conducted to test the effectiveness of attorney strategies and judges' instructions for remedying the bias arising from exposure to pretrial publicity.

APPENDIX A: SUMMARY OF STUDY CHARACTERISTICS

Study	Date	Status	Effect size	Z-score	Total N
Costantini & King	1980/81	published	.22	2.81	323
			.66	9.15	369
			.49	6.81	367
Dexter et al.	1992	published	.11	.92	68
Greene & Wade	1988	published	.13	1.19	80
			.09	1.06	140
Hoisberg & Stires	1973	published	.08*	1.07*	310
			.11*	1.44*	312
Hvistendal	1979	published	.15	1.64	127
			.19	2.17	127
			.00	.05	122
Kramer & Kerr	1989	published	.10	2.05	overall 449
			.14	2.96	
Kramer et al.	1990	published	.21	5.62	702
Moran & Cutler	1991	published	.32	2.33	535*
			.27	1.65	100
Ogloff & Vidmar	1994	published	.32	3.70	58
			.21	1.65	60
Otto et al.	1994	published	.21	3.18	overall 227
			.02	.30	
			.03	.45	
			.15	2.27	
			-.03	-.45	
Otto et al.	1991	unpublished	.01	0.18	overall 358
			-.22	-4.08	
Polvi et al.	1996	unpublished	.30	3.78	154
Riedel II	1993	published	.01	.14	84
Sue et al.	1974	published	.20	2.85	202
Sue et al.	1975	published	.31	3.60	132

*estimate

REFERENCES

Carroll, J. S., Kerr, N. L., Alfini, J. J., Weaver, F. M., MacCoun, R. J., & Feldman, V. (1986). Free press and fair trial: The role of behavioral research. *Law and Human Behavior*, 10, 187-201.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Hillsdale, NJ: Erlbaum.

Conlkin, J. E. (1992). *Criminology.* New York: Macmillan Publishing Company.

*Costantini, E., & King, J. (1980/81). The partial juror: Correlates and causes of prejudgment. *Law and Society Review*, 15, 9-40.

*Dexter, H. R., Cutler, B. L., & Moran, G. (1992). A test of voir dire as a remedy for the prejudicial effects of pretrial publicity. *Journal of Applied Social Psychology*, 22, 819-832.

*Friendly, A., & Goldfarb, R. L. (1967). *Crime and publicity.* New York: The Twentieth Century Fund.

Fulero, S. M. (1987). The role of behavioral research in the free press/fair trial controversy. *Law and Human Behavior*, 11, 259-264.

Greene E., & Dodge, M. (1995). The influence of prior record evidence on juror decision making. *Law and Human Behavior*, 19, 67-78.

Greene, E., & Wade, R. (1988). Of private talk and public print: General pre-trial publicity and juror decision-making. *Applied Cognitive Psychology*, 2, 123-135.

*Hoisberg, B. C., & Stires, L. K. (1973). The effect of several types of pretrial publicity on the guilt attributions of simulated jurors. *Journal of Applied Social Psychology*, 3, 267-275.

*Hvistendal, J. K. (1979). The effect of placement of biasing information. *Journalism Quarterly*, 863-865.

*Kramer, G. P., Kerr, N. L., & Carroll, J. S. (1990). Pretrial publicity, judicial remedies, and jury bias. *Law and Human Behavior*, 14, 409-438.

*Kramer, G. P., & Kerr, N. L. (1989). Laboratory simulation and bias in the study of juror behavior. *Law and Human Behavior*, 13, 89-99.

Linz, D., & Penrod, S. (1992). Exploring the First and Sixth Amendments: Pretrial publicity and jury decision making. _Handbook of Psychology and Law_, 3-20.

*Moran, G., & Cutler, Brian L. (1991). The prejudicial impact of pretrial publicity. _Journal of Applied Social Psychology_, 21, 345-367.

Nietzel, M. T., & Dillehay, R. C. (1983). Psychologists as consultants for changes of venue. _Law and Human Behavior_, 7, 309-355.

*Ogloff, J. R. P., & Vidmar, N. (1994). The impact of pretrial publicity on jurors. _Law and Human Behavior_, 18, 507-525.

*Otto, A. L., Penrod, S. D., & Dexter, H. R. (1994). The biasing impact of pretrial publicity on juror judgments. _Law and Human Behavior_, 18, 453-469.

*Otto, A. L., Penrod, S. D., & Hirt, E. R. (1991). _The influence of pretrial publicity on juror judgments in a civil case_. Unpublished manuscript.

*Polvi, N., Jack, L., Lyon, D., Laird, P., & Ogloff, J. (1996). _Mock jurors' verdicts in a child sexual abuse case: The effects of pretrial publicity_. Paper presented at the Biennial Convention of American Psychology-Law Society, Hilton Head, South Carolina.

*Riedel II, R. G. (1993). Effects of pretrial publicity on male and female jurors and judges in a mock rape trial. _Psychological Reports_, 73, 819-832.

Rosenthal, R. (1984). _Meta-analytic procedures for social research_. Beverly Hills, CA: Sage.

*Sue, S., Smith, R. E., & Gilbert, R. (1974). Biasing effects of pretrial publicity on judicial decisions. _Journal of Criminal Justice_, 2, 163-171.

*Sue, S., Smith, R. E., & Pedroza, G. (1975). Authoritarianism, pretrial publicity, and awareness of bias in simulated jurors. _Psychological Reports_, 37, 1299-1302.

Zimbardo, P. G., & Lieppe M. R. (1991). _The psychology of attitude change and social influence_. New York: McGraw-Hill, Inc.

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[*] Studies used in the meta-analysis (N = 15)

North America by Bus:
A Study of Interaction and Personal Space

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Abstract

People engage in social interaction almost everyday. Whether this be through conversations, facial expressions, or merely eye contact, there are informal rules that guide their behavior. These rules also guide matters of personal spacing. On a Greyhound bus, the passengers are, for the most part, strangers to one another. Because of this, there is little clue to the background information of those around you. This lack of information causes the normal process of interaction to break down, and new informal rules become instituted and followed. Because of the limited amount of space designated to each passenger, the added factor of one's physical proximity to these strangers plays a part in the emerging interaction. By looking at both verbal and nonverbal communication, the rules become apparent and the ensuing interaction becomes patterned. This leads to the creation of new social worlds by those on the bus---worlds that are created from the shared experiences of the passengers. This research focuses on the way these new social worlds are developed and the manner in which the passengers engage in them.

Introduction

There have been a myriad of studies done on interaction between strangers, and some of these have concentrated on the arena of public transportation. Yet, nobody has conducted a study of cross-country or prolonged bus travel. This is an interesting area on which to focus because of the unique circumstances that arise on the bus---circumstances that become shared realities to the passengers on board. In the summer of 1996, the author took the Greyhound bus to more than thirty states in order to see how interaction was initiated, and then how it was either encouraged or ignored. The manner in which passengers negotiated their personal space within the context of a small amount of public space was also a subject of interest.

Methodology

The only way to do this study was through participant-observation, because there was no other way to gauge the involvement of the passengers except to actually be one of them. Ethnography and participant-observation were the best methods for this research because they enable one to watch as styles of interaction become patterned, and to then study the subsequent social worlds that develop from this. Doing this research as a Greyhound passenger can provide one with the chance to observe not only how people interact with each other, but also how they react to those who behave outside the norm. Furthermore, any observed anomie reinforces what the norm is, which enables one to focus on the specific behavior that is valuable to the research.

By taking fieldnotes during the trips, it becomes apparent that there is a certain pattern that arises on the bus. This paper will be able to concentrate on only a small piece of this pattern and it will draw primarily from the works of Erving

Goffman and Edward T. Hall. Using the theories of Goffman and Hall, this paper will examine how one chooses a seat and the significance behind that choice.

Theoretical Background

The least involved type of social encounter can be seen in the form of "civil inattention." Goffman (1963) explains:

> What seems to be involved is that one gives to another enough visual notice to demonstrate that one appreciates that the other is present (and that one admits openly to have seen him), while at the next moment withdrawing one's attention from him so as to express that he does not constitute a target of special curiosity or design (p.84).

This latter point is important in understanding an individual's stance when among strangers. By showing others the courtesy of civil inattention, one is claiming that he or she has no reason to fear, suspect, dislike, or want to avoid an other; and through this hopes to ensure that he or she will be treated likewise. One also finds that the need for civil inattention becomes stronger if the individuals are close to one another in proximity; and, conversely, the further away one is, the more license one has, for example, to stare.

An infraction of civil inattention is staring. A good example of this is when one is caught staring at another who was unaware that he or she was being scrutinized. At this point, the offender will either look away with some amount of embarrassment or try to cover it up as the "normal" process of scanning one's environment. Goffman (1963) sees staring as a form of social control. He believes that this is a common means of negative sanction and that it is often the first warning the offender receives that he or she is not following the proper norms.

Out of civil inattention comes the capacity for what Goffman (1963) calls "focused interaction" or an "encounter":

> An encounter is initiated by someone making an opening move, typically by means of a special expression of the eyes but sometimes by a statement or a special tone of voice at the beginning of a statement…The engagement proper begins when this overture is acknowledged by the other who signals back with his eyes, voice, or stance that he has placed himself at the disposal of the other for purposes of mutual eye-to-eye activity (p.91-92).

Thus an encounter usually begins with prolonged eye contact. This ritual can happen almost simultaneously, as when two people glance at each other at the same time. When this occurs, neither can be seen as the initiator, and therefore, neither can feel rebuffed if the engagement does not take place.

Mutual eye contact makes up the most common type of interaction between strangers: "Eye-to-eye looks, then, play a special role in the communication life of the community, ritually establishing an avowed openness to verbal statements and a rightfully heightened mutual relevance of acts" (Goffman, 1963, 92). Avoiding someone's eyes sends the message that no contact is desired. The lack of eye contact alone is often enough to keep communication from establishing because it avoids the "cooperative claim" that the seeker is trying to initiate.

Once the encounter has begun, eye contact must be maintained in order to make the participants feel they are truly engaged. That is, eye contact is often used to gauge how involved the participant is in the conversation. As in the initial avoidance, lack of or lessening of eye contact can be taken as a sign that the other wants to disengage from the encounter. If the participants are fully involved in the encounter, the subject matter at hand becomes their main focus and all attention is given to the conversation itself.

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Results

Finding a seat on the bus was probably the most stressful part of the trip, especially when boarding a bus that was already full of passengers. The best way to see one's seating options was to get stuck behind someone trying to put their luggage in the overhead rack. This gave the new passenger time to look around the bus and see any empty seats. If there were no empty seats, the passenger could use this time to "size up" the other passengers and decide which people looked like acceptable seat partners. Goffman (1971) gives an example of the time one stops to pay the fare on a city bus as being used for the same purpose. Lyn Lofland mentions in her book, *World of Strangers* (1973), that Americans do not feel comfortable "taking a reading," which makes the need of a *reason* to stop even more important. If the bus was full, the game of "choosing" a seat begins. Goffman (1971) would call the bus seat a "stall;" it is public and meant to be shared, but would often be guarded by the first one there as completely his or her own. The easiest way to keep one's stall to oneself is through the use of possessional territory. Simply put, place your bags, your jacket, or any "personal effect" on the seat next to you and stare out the window. By doing this, the passenger was "marking it for his own and obliging competitors to move (or ask to have moved) something that symbolizes another" (Goffman, 1971, 34).

The avoidance technique employed most often on the bus was that of refusing eye contact to those seeking it. Merely making eye contact opens up an individual for interaction of some kind. When a new passenger was seeking a seat, any mutual glance could be taken as a sign of welcome. This "principle" was understood to some extent by nearly all of the passengers. Thus, by staring out the window, focusing on a book, or avoiding eye contact in some other manner, the seated passenger could successfully discourage new passengers from inquiring about the availability of the seat. Making eye contact could be taken as a sign of permission to be seated, and many passengers feigned sleep when new passengers were boarding, further discouraging any interaction.

Other passengers, however, would stare directly at the new arrivals. This method also proved to be effective, especially when the passenger was able to manage his or her face in a way that showed that no seatmate was desired. That is, many were able to make their faces expressionless, except for the glare in their eyes. It was rarely an outright look of anger, but more of a "don't even think about it" look that effectively warned new passengers that they were not welcome. It soon became apparent that this method was used more often on buses that were extremely crowded. At these times, even passengers who already had seatmates would glare at the new boarders in an unfriendly way. This seems to be a direct result of the discomfort passengers felt at having to compromise large amounts of what they considered their personal space.

The choice of a seat partner (when it actually was a choice) seemed, in most cases, to be based on a certain set of criteria. Often, people of the same ethnic background appeared at ease approaching one another (see Goffman, 1963, 131). However, this did not hold true for Anglo-Americans. Instead, approachable conversation partners seemed to be based on the old cliché of judging a book by its cover. Lyn Lofland (1973) calls this criteria "appearential ordering," which is categorizing people through visual clues like dress, hair, age, etc. (p.27). Good examples of this would be the way older women tended to sit with each other and also the manner in which "college-looking" people tended to group themselves together toward the back of the bus.

In *The Hidden Dimension*, Edward Hall (1966) discusses the concept of personal space, which is best defined as an invisible boundary around one's body that cannot be crossed without

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provoking some reaction. Hall believes that these reactions are culturally learned, and this research will be concerned only with those considered "normal" in a Western paradigm (i.e. the United States). The reaction to an intrusion of one's space relies mainly on the relationship between the intruder and the intruded; it seems far more acceptable, even desirable, for one's lover to cross the line than for a complete stranger to do so. However, it is important to note that certain circumstances allow for acceptable boundary crossing (such as when one goes to the doctor), but this does not necessarily mean that these situations are any more comfortable, regardless of their validity. Individual reactions to the invasion of personal space usually include discomfort, anxiety, anger, or arousal.

Throughout his book, Hall gives examples of the ways in which people react to intrusion of their personal space. While his theories reinforced the findings of this study, they also had to be expanded to include the fact that the bus is a small amount of public space on which the passengers are continuously trying to negotiate their private space. Once seated, the negotiation of personal space became a never-ending battle for both of the passengers. What area technically belonged to whom had to be worked out tactfully and non-verbally.

The fixed seating on the bus is designed in a way that forced strangers to be within close personal distance of their seat companions; one could see, hear, smell, and feel the stranger. When they did have to share a row, the close physical proximity between strangers often caused anxiety and discomfort to the passengers. The close personal distance is one that is usually reserved for people who like each other, or at least know each other. On the bus, none of the normal starting points or mechanisms were there---strangers were forced into close proximity in an already confined setting. This proximity to strangers encouraged the development of strategies to bring some sense of order or comfort into an uncertain environment. When faced with this situation, passengers either tried to avoid interaction altogether or, conversely, seemed to feel compelled to talk to their seat companion. In the first, the passenger would become rigid and try to maintain his or her personal space through extreme body maintenance, such as turning one's body away from the intruder as much as possible. The focus here was on discouraging conversation, so any eye contact or touch was avoided. The second reaction was the exact opposite. The passenger seemed to feel the need to be engaged in conversation with the other as a way of feeling comfortable. In this situation, it appeared that the passenger was trying to make the situation "normal": he or she realizes that this distance was for close friends and therefore engaged in conversation because this is what one would normally do in this zone.

Conclusion

Seating on the bus led to close physical proximity between strangers. How people expected space to be used often caused anxiety and discomfort to the passengers who found themselves sitting with such strangers. When faced with this situation on the bus, passengers usually tried their best to keep their stalls to themselves, either by avoiding eye contact or, conversely, through staring. If this did not work and the passengers were forced to share "their" row of seats---their space---they would either try to avoid interaction altogether or, conversely, they seemed to feel compelled to talk to their seat companion. Both strategies were ways for the passengers to gain control of their social surroundings. These techniques were ways for the passengers to feel comfortable in a situation that they could not control.

Works Cited

Goffman, E. (1963). Behavior in Public Places: Notes on the Social Organization of Gatherings. New York, United States: The Free Press of Glencoe.

--- (1971). Relations in Public: Microstudies of the Public Order. New York, United States: Basic Books, Inc.

Hall, E. T. (1966). The Hidden Dimension. New York, United States: Doubleday.

Lofland, L. (1973). A World of Strangers: Order and Action in Urban Public Space. New York, United States: Basic Books, Inc.

The Assessment of College Students' Attitudes Toward The Social Aspects of Their Own Aging

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ABSTRACT

For several decades, researchers have reported that the attitudes of young adults toward the aging population vary. These positive, negative, or mixed attitudes are based on the prejudices and stereotypes held by the young adults and possible personal experiences with aging adults (Cavanaugh, 1997). Most research has focused on the young adults' views of aging adults over 65 and not on the young adults' views of their own aging process. As people grow older, they must learn to deal with various losses, such as loss of health, loss of job, and loss of family members (Barrow, 1996; Cavanaugh, 1997; Ferraro, 1990). Older people also face diminishing social roles due to these losses. The observance of these role losses and changes may contribute to the stereotypes held by young people. Several studies (Collins, 1991; Generations, 1993; Gilbert, Cobern, & Staik, 1989) found that young adults hold both positive and negative stereotypes of aging. Positive stereotypes tend to focus on personality traits while negative stereotypes tend to focus on physical traits.

In the present study, we were interested in assessing the perceptions of college students toward the social aspects of their own aging. We developed a scale on a criterion-referenced basis from an extensive review of college level aging texts and their contents. The Likert formatted 20-item scale consists of items relating to one's own aging. Response choices are as follows: 1= Does not bother me at all, 2= Bothers me somewhat, and 3= Bothers me a great deal. The scale was administered to two college courses in the Fall of 1996. The scale, as well as a demographics form, was administered to 83 psychology students at the University of Montevallo in the Fall of 1996. The participant responses show that college students experienced high levels of concern about all aspects of aging, but that concerns surrounding the social changes inherent in the aging process were reported as the most disturbing. For example, students responded to an item about diminishing night vision and its effects on night driving for older adults, with 36.1% reporting that it did not bother them at all, 34.9% reporting that it bothered them somewhat, and 28.9% reporting that it bothered them a great deal. This finding contrasts with the pattern of responses found for social changes, such as with an item involving loss of close emotional / social bonds in the last years of life: only 6% reported that it did not bother them at all, 20.5% reporting that they were somewhat disturbed, and 73.5% reported that it bothered them a great deal. This latter pattern was typical throughout the items related to social changes, while the "vision item" pattern was noted for the physical changes related to aging. Future directions for research and applications in the classroom are discussed.

INTRODUCTION

For several decades, researchers have found varying attitudes of young people toward aging that are based on stereotypes and/or personal experiences of the individual. The purpose of the current study is to assess the attitudes and feelings of college students at the University of Montevallo toward various aspects of their own aging with a specific focus on social interaction and relationships.

Young adults often foretell their own life course by "perceiving" the courses of others (Erikson, 1987). Erikson (1987) wrote, "In cultures where to become old makes sense, there is a definite perspective on the whole of life. In our country, for most young people, the idea of becoming old and unable to advance further represents a questionable future." Undoubtedly, young adults are affected by what they observe from aging adults.

As people grow older, they must learn to deal with the various losses that begin to occur. Several researchers (Barrow, 1996, Cavanaugh, 1997; Ferraro, 1990) have found the losses of older people to include loss of health, loss of job, loss of independence, and the loss of spouse, friends, and family members. Older people also face diminishing social roles. Individuals "relinquish" many roles of adulthood by the time they reach old age and experience a decline in "societal significance" due to the loss of these roles (Cavanaugh, 1997). Work is one of the most important roles given up because one's job reflects how the individual is viewed by others and the individual's personal view of self (Cavanaugh, 1997; Ferraro, 1990). Nevertheless, the roles of older people are not completely lost, although these roles may change. For example, an older adult may be faced with raising grandchildren or caring for a surviving parent (Barrow, 1996).

Due to these losses, as an individual ages, he or she begins to depend more on family members for interaction (Schaie, & Willis, 1996). According to a number of researchers (Barrow, 1996; Ferraro, 1990; Schaie, & Willis, 1996), this is especially true when one loses a spouse. A newly widowed person often experiences loneliness during this time. Therefore, the older person may turn to other family members for help in fulfilling the needs once met by the spouse. Although these needs cannot be met by surviving family members, the remarriage of older people for this lost companionship is often discouraged (Barrow, 1996). Reasons for this discouragement include that many widows will lose the monthly benefits left by the deceased spouse if they remarry. A second factor is the discouragement of children who do not want the surviving parent's assets to go to the new spouse when death occurs. Another factor is the reluctance of the older person to remarry out of respect for the deceased spouse (Barrow, 1996). And so, all of these role losses and changes are observed by young adults.

Many studies have been conducted to assess the attitudes of adults toward aging. One study conducted in a southwestern community surveyed attitudes of adults, whose ages ranged from 18-92, toward aging and found positive and optimistic views about aging. Subjects agreed that they look forward to getting older, do not mind aging, and can control what happens to them as they get older. Subjects denied being afraid of getting "old," feeling that it is sad to get older, and feeling that older people are very boring and do not do much. However, they did agree that older people depend more on others and disagree that life is easier for older people (Harris, Page, & Begay, 1988).

Another view held by young adults emerged in several studies by Collins (1991) that found these adults hold both negative and positive expectations about aging. The first study by Collins found that subjects viewed their own (future) old age positively--more positively than their description of other older persons. A second study followed up by having subjects make predictions about their old age on a range of dimensions including social satisfaction; these results showed positive expectations with a bias in favor of self. The study by Gilbert, Cobern, and Staik (1989) and a study printed in Generations (1993) both found that American college students in class exercises typically characterize "old people" in terms of both negative and positive stereotypes. The negative stereotypes include physical traits such as "slow" and "feeble." Positive stereotypes tend to focus on personality traits like "sweet" and "caring." These positive traits are typically passive, viewing older people as "pleasant" and "storytellers." When asked to describe a particular older person, students generally wrote positive portrayals, often about healthy, active individuals. They tend, however, to think of these older people as exceptions to the rule, rather than changing the "rule" or their views of older adults. Gilbert, Cobern, and Staik (1989) also concluded that the number of positive descriptors of older people given by college students decreases as the age of the older person increases. These stereotypes may contribute to the attitudes and feelings of young adults toward their own aging.

These stereotypes may be part of the reason why the study done by Heckhausen and Baltes (1991) found that groups of young and middle-aged adults believed that aging-related increases in undesirable attributes were relatively less controllable than what the older adults believed. It seems likely that this view may have evolved from the negative stereotypes of aging. Collins' (1991) study results also suggest that previous research emphasizing attitudes toward and reactions to institutionalization painted too negative a picture of young people's feelings toward old age. Older adults may be less likely to endorse such a negative stereotype because of personal experiences that modify their views of aging (Heckhausen & Baltes, 1991).

The above research shows the variety of attitudes of young adults toward aging. However, the current study assessed the feelings and attitudes of young adults toward their own aging, not aging in general.

METHOD

Participants

The participants in the current study consisted of 83 students enrolled in two psychology courses at the University of Montevallo during the Fall of 1996. Subjects represented the age range of 18 to 47 with the mean age being 22 years. There were 61 females and 22 males.

Materials

A 20-item experimenter created, Likert scale questionnaire was used consisting of items concerning the attitudes toward one's own aging with response choices as follows: 1=Does not bother me at all, 2= Bothers me somewhat, and 3= Bothers me a great deal. Sample items on the questionnaire are:

"When older people no longer feel useful in a work setting, they feel depressed and worthless."

"Older people have a smaller number of friends unless they live in places where the proportion of older adults is high (e.g., retirement communities, public housing)."

"Many older adults have experienced the death of their spouse/partner."

"Because of vision changes which cause older adults to have difficulty in glare from oncoming headlights, they tend to decrease night driving."

Procedure

The students signed a consent form, filled out a demographics form, and completed the questionnaire. The above forms were placed by the students in envelopes to insure anonymity.

RESULTS

A principle components analysis was conducted on the questionnaire as a part of scale refinement. An orthogonal rotation of the items into two factors yielded factor loading at the .4 level or above, which could be used to define the factor structure. A factor loading represents the simple correlation (r) of the scale item with the hypothetical underlying factor.

Fourteen items loaded on factor one. The content of the items loading on factor one suggest a pattern of concerns about general major age changes. Six items loaded on factor two. The content of these items suggest a pattern of concerns about death and traumatic loss. See Table I for presentation of scale items used to define factors one and two.

Table I: Attitudes Toward Social Changes Due To Aging

Scale Item Number	Description	Factor I Loadings	Factor II Loadings
07	fewer new friends	.81	
11	fewer friends, in general	.78	
10	increase losses of loved ones	.72	
16	retirement / fewer friends	.66	
20	relying more on family	.65	
01	fewer relationships	.64	
03	death of parents		.64
05	discouraged from dating	.63	
06	no work / depressed		.63
13	loss of driving	.62	
14	hearing changes	.62	
18	without close family ties	.61	
08	death of sibling		.59
17	vision changes / driving	.54	
04	financial dependency	.53	
19	time in nursing home	.53	
15	death of partner		.50
12	death of children		.44
09	not in own home	.43	
02	divorce		-.36

DISCUSSION

Past research focused on young adults' views of aging adults over 65. The Attitudes Toward Social Changes Due To Aging scale was developed and used at the University of Montevallo to assess the perceptions of young adults toward the social aspects of their own aging. Results of this quantitative research effort indicated that young adults experience high levels of concern about all aspects of aging, but that concerns surrounding the social changes of the aging process are the most disturbing. For example, students responded to an item about diminishing night vision and its effects on night driving for older adults, with 36.1% reporting that it did not bother them at all, 34.9% reporting that it bothered them somewhat, and 28.9% reporting that it bothered them a great deal. This finding contrasts with the pattern of responses found for social changes, such as with an item involving loss of close emotional / social bonds in the last years of life: only 6% reported that it did not bother them at all, 20.5% reporting that they were somewhat disturbed, and 73.5% reported that it bothered them a great deal.

Although males and females responded very similarly on virtually all items, there are a few exceptions. For example, an item about society's discouragement of older adults dating and "falling in love" showed 18.03% of females responding that it did not bother them at all, 18.03% responding that it bothered them somewhat, and 63.93% responding that it bothered them a great deal. However, males responding to this item showed 22.73% were not bothered at all, 40.91% were somewhat bothered, and 36.36% were bothered a great deal.

While further refinement could lead to greater certainty about the validity of these subscales, the preliminary analysis suggests that the factor patterns discussed are quite appropriate. This result is not surprising since the Attitudes Toward Social Changes Due To Aging questionnaire was developed on a criterion-referenced basis from an extensive review of college level aging texts and their contents.

The findings of this study could be used by other researchers to learn more about the attitudes of young adults toward the social aspects of their own aging and to expand the study by assessing how different age groups feel about this topic. This research would also be useful in the classroom when discussing the aging process, what is "normal," and what the implications for students and education in general are.

REFERENCES

Barrow, G. M. (1996). Aging, the Individual and Society (6th ed.). St. Paul, Minnesota: HarperCollins.

Cavanaugh, J. C. (1997). Adult Development and Aging (3rd ed.). Pacific Grove, California: Brooks / Cole Publishing Company.

Collins, C. L. (1991). Conditions under which young adults regard old age and old people favorably (Doctoral dissertation, Stanford University, 1991). Dissertation Abstracts International, 52, B5016.

Erikson, E. H. (1987). A Way of Looking at Things: Selected Papers From 1930 to 1980. (Schlein, S.). Markham, Ontario: Penguin Books Canada Ltd.

Ferraro, K. F. (1990). Gerontology: Perspectives and Issues. New York: Spinger Publishing Company, Inc.

Gilbert, K., Cobern, M., & Staik, I. (1989). Attitudes of college students toward the elderly: A look at ageism. Paper presented at the Southeastern Undergraduate Psychology Research Conference, Vanderbilt University.

Harris, M. B., Page, P., & Begay, C. (1988). Attitudes toward aging in a southwestern sample: Effects of ethnicity, age, and sex. Psychological Reports, 62, 735-746.

Heckhausen, J., & Baltes, P. B. (1991). Perceived controllability of expected psychological change across adulthood and old age. Journal of Gerontology: Psychological Sciences, 46, 165-173.

Images of aging: A cross-cultural perspective. (1993, Spring / Summer). Generations, 17, 51-54.

Schaie, K. W., & Willis, S. L. (1996). Adult Development and Aging (4th ed.). New York: HarperCollins.

Untitled. (1993, Spring / Summer). Generations, 17, 5.

Exploring the "GenderedPerspective" in Early Adolescents' Interpretations of Popular Music

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Our research question focuses on young people and popular music: it was bourn of an interest to further explore the early adolescent stage of gender formation and adherence to popular culture combined with common allegations in the social arena that popular music lyrics adversely affect listeners.

Music lyrics have been the object of criticism for much of the last four decades, during which time, references to sex, violence, and drugs have increased (Took and Weiss 1994). Although concern for the messages that popular music is sending to its listeners has remained present over the years, surprisingly little research has been done on the effects of listening, particularly in the role of gender messages portrayed. Most study, attention, and regulation has been directed toward extreme songs not aired on the radio; many of these are from heavy metal or hard core rap music categories.

Because of studies done by music researchers Peter Christenson and Peter De Benedittis (1986), which state that early adolescence is a time of increased hours of radio listening and preference for "Top 40" hits, we chose to focus our examination of children's interpretation of music lyrics on mainstream, popular music. Studies done have estimated that one-third of fifth and sixth graders listen to the radio for two or more hours per day; others report afternoon radio listening among 83 percent of fourth and fifth graders (Christenson and De Benedittis 1994). Radio is a form of media that children listen to avidly during early adolescence; radios are cheap, portable, and accessible to children of all ages. 68% of fourth and fifth graders have a radio in their bedroom. Radio listening among early adolescents, unlike television viewing, occurs primarily away from the presence of adults. With estimates of between 71 and 92 percent of radio listening occurring while young people are alone, with friends, or with siblings, radio is very much a medium that is self-regulated and defined (Christenson and De Benedittis 1994).

While it is no doubt that radio and popular music are very common among children entering the stage of early adolescence, the extent to which those messages are heard and how they are understood remains unclear. Messages conveyed in the media about popular culture and adulthood are particularly important at this stage of young people's gender and social role development. Genderization, the process of identifying self with gender, begins to occur in early adolescence. This is a crucial period of time in which a person's interactions with their surroundings, messages of parents, peers, teachers, and media outlets formatively shape what a young adolescent identifies as female or male and how to incorporate those roles into the formation of their own ideas and actions of gender.

Perhaps more important for children in early adolescence is a myopic desire to fit in with peers who willingly or unwillingly imitate and circulate media messages through play and discussion of favorite movies, T.V. shows, songs, media artists and commercials. As the psychologist Peter Blos describes, "fitting in establishes a pattern of interaction between self and surroundings which slowly shapes individuality and personal uniqueness" (Blos 1979). Peers, who quite typically mirror the popular culture, and the media monopoly have possibly more influence than parents in a child's development of gender (Beal 1984). This is especially pertinent when evaluating this life stage in terms of the child's, "propensity to copy and imitate the actions of others" to facilitate the learning and socialization process which the early adolescent is negotiating (Siann 1994). Yet, as Christenson and De Benedittis indicate in their study on the impact of popular music on young [illegible]e, parents generally remain unconcerned about what their children are listening to on the radio and [illegible] not to be present when children are listening to radio music, leaving kids to process and create meaning from songs either alone or with friends and siblings (Christenson and De Benedittis 1994).

Our research project was designed around the premises that media, in this case popular radio music, is an ever-present and formative part of the lives of individuals and groups in early adolescence and that groups of children of separate genders may extract different messages from radio music as they negotiate, explore and create gender roles for themselves. Our project is an initial step in the exploration of this area which attempts to determine whether a small group of early adolescents are interpreting and viewing popular songs differently by gender.

Our project employed a focus group methodology to six gender-specific groups of fifth grade students from two inner-city grade schools in Seattle, WA. Each group was composed of 6-7 students. Three popular songs (as identified by the researchers and a DJ from a local radio station) were played for each of the groups; these included "Unbreak my Heart" by Toni Braxton, (a slow, melodic ballad), "'Da Dip" by Freak Nasty, (a fast, up-beat dance-song) and "Wannabe" by The Spice Girls (an energetic dance song). The groups, interviewed in school, were asked to listen to the words of the songs and to write down any lyrics that they particularly liked or hadn't noticed before. After each song was played, a written survey was administered which asked if the listener had heard the song before, if they had seen the video, how the song made him/her feel, their favorite line or part of the song, what kind of person would write such a song, and whether the listener could identify with any feeling or activity described in the song.

Each song was discussed in a focus group setting immediately after the short written survey was completed. The group was presented with the same questions to guide group discussion: What was this person singing about? Pick out some lines that illustrate this. Who is the singer speaking to in the song? What do they want that person to do or hear? Do you identify more with the person singing or the person being sung to? If this person were singing to you what would you do? Do you think that this is a happy or a sad song? What are some good things about this song? What are some bad things about this song? What are some of your favorite lines of the song? Although these questions guided discussion and were asked in each group, most groups brought up other themes in the course of discussion and were encouraged to explore them as well.

After each of the songs were discussed in this manner, a final written survey was administered which inquired about demographic information on each of the participants, music preferences and familiarity, and beliefs about the genderization of certain household and professional activities. These surveys indicated that the majority of the participants in our survey reported their ethnicity as African-American. While one-half of the participants are from households in which their mother is the only parent, an additional 29% of participants live with both parents, and the remainder live with grandparents or a single father. Approximately one-third of participants in the study are the only child in their household with an additional one-third from households with two or three children and the remaining third from households with four or five children. The demographic information revealed the the majority of the children live in the area immediately surrounding their schools, both located in an urban, inner-city setting. The questions on the degree to which participants adhered to genderized beliefs of professional and household role participation revealed that the girls in our groups had more stereotypically genderized beliefs about women's roles and activities, while the boys in our groups had more stereotypically genderized beliefs about men's roles and activities.

Several significant themes and differences came up between genders in the discussion and analysis of each of the songs. In the discussion of "Unbreak my Heart" many of the boys were open to more lucid translations of who Toni Braxton may have been singing to; their interpretations included the possibility of her singing to God, angels, her mother, sister, birds or a dog. Although the song's lyrics repeatedly plead, "Unbreak my heart, say that you love me again/Undo this hurt that you caused when you walked out of the door," boys were able to more easily rationalize who she was singing to and why she was singing. As one male child explained, "(She was singing to) her animal (that) could have died or got stolen." Although girls did bring up the possibility of the singer singing to either God or her mom and dad or siblings, they generally adhered to the assumption that Toni Braxton was singing to a lost lover, boyfriend, or husband and did not discuss their interpretations at any length.

Included in the discussion of "Unbreak my Heart," when asked what they would do if this person were singing to them, the girls groups invariably responded that they would return to the person because it seems that he's really sad and feels badly. The boys groups, however, appeared "put off" by the imploring messages of the singer. Those who responded to this question said that they would not return to the singer or that they would "brickwall her", meaning ignore her. One boy responded, "I would go back and then leave. Because, I'd want to speak to her about it and then kiss and stuff and leave her."

The girls tended to draw out more positive interpretations of this love ballad. Primarily, they hailed the singer's ability to express herself in a time of a sadness and went on to discuss the merits of such a strategy in their own life. "(It) makes you feel better to tell someone your problems, then you can go kick it and have fun, go places." One group of boys, however, seemed to have a counter interpretation of women and expressing pain. Collectively, they agreed that

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women dwell longer in periods of sadness and "can't go on to another." To paraphrase the words of one boy, women are weaker than men because they take a month to get over a painful breakup, whereas men recover in a week.

"'Da Dip by Freak Nasty brought out discussions of a more sexual nature. Lines such as, "slip that money under that skirt," and, "lick you up and lick you down/I ain't finished girl turn around" were repeatedly pointed out by the participants to illustrate the "freaky" nature of the song. This was also a tool in which the girls attempted to differentiate themselves from the women portrayed in the song. When asked who Freak Nasty was addressing, many girls suggested that he was singing to, "the girls and the freaky women that like him putting money up their skirts...strippers." Boys did not make the same distinction. They believed that he was singing to his girlfriend, wife, or to girls in general.

Both boys and girls in every group identified misogynist views in this song. The girls who were opposed to the overt messages of this song stated that in simply listening to the song they felt, "harassed" or "nasty," yet still classified "'Da Dip" as a "happy" song. Despite misgivings about the lyrics of the song, girls made claims such as, "the only thing that we like is mostly the music," perhaps indicating that they were able to enjoy the beat without paying attention to or being bothered by the lyrics. When asked what they would do if someone were singing, "'Da Dip" to them, most girls seemed excited and responded (often emphatically), "I'm not ready for that," claimed one girl, "I'm not doing that." Another responded, "I'm not doing that. I am a free person." Another girl, perhaps continuing the quest to differentiate herself from the women being sung about, stated, "If someone would do that...I would be sad. Because they can't really live a life." However, the theme of sex as a necessary part of the life cycle was identified by one girl in response to another group member who derode sex as "nasty", "I'm happy," she replied, "Because my mom had to do that to have me. And if it wasn't for that I wouldn't be here." Girls in each group identified ways in which the relationships and interactions between males and females in this song were not what they considered acceptable or desirable.

The Spice Girls' song brought forth interesting differences in interpretation between genders. The chorus of "Wannabe" repeatedly declares, "If you wanna be my lover, you gotta get with my friends." This line spurred debate about the meaning of the term, "get with" in groups of boys and girls. Most boys understood the term, as used in this context, to mean, "have social sex" or, "have sex with a lot of people." The boys described this message as a negative one. Girls interpreted the term "get with" to mean, "be friends." With this understanding, they derived a very positive impression of the song. "I would think it was great because then I would get to have more friends," one girl responded. One girl began a sentence in which she was entertaining the idea of "get with" as having sex, but was cut-off by her female peers and abandoned the idea.

There are several themes that arose in the discussions and interpretations of all of the songs. The ability to separate the music video from the interpretation of the actual song was a problem that arose in each group and a limitation of this method of research. Although, as reported in the written survey, girls had seen all three videos at a greater rate than had boys, girls seemed more able to drop discussion of the video and to interpret the song as they'd heard the lyrics. It was a consensus that the video was a more correct interpretation of the song than individual insights. As one boy exemplifies in his attempt to explicate the meaning of "'Da Dip", "It's about girls and boys, it's a kind of dance. I don't know...I haven't seen the video."

The boys in the groups that we interviewed seemed to subscribe to what we later identified as an, "earned" view of relationship, seeing relationship as prize. In "Unbreak my Heart", the boys were more likely to see the failed relationship as somebody's fault, most frequently that of the woman singing. The man had left her, quite simply, because the singer had done something wrong. When asked the question, "What would you do if the singer were singing to you?", one boy indicated that, "she probably did something wrong. She shouldn't have done it." Another responded that he would, "take her money and leave." Although none of the boys could elaborate on what it might have been that the singer had done "wrong", they obviously viewed failed relationships as the fault of one of the partners. The theme of having to be worthy carried over into the discussions about "Wannabe". The boys seemed collectively thoroughly offended with what they interpreted as an ultimatum being set by the singers of the song. They voiced that they lyrics, "If you want to be my lover, you gotta get with my friends" appeared to be a dogmatic order with which they did not care to comply. Comments such as, "You gotta earn his love. What if he don't like 'em (her friends)? He don't have to be friends with everybody!" Responses such as this typified responses by other boys.

To grasp the meaning of the songs, girls typically related the situations presented in the music lyrics to experiences in their own lives. Girls would frequently discuss circumstances in their own lives or the lives of family members in which they had felt or observed a similar emotion to the one being conveyed by the song. When discussing "Unbreak my Heart," and the pain that the singer felt, one girl offered, "Just like when my mom's dad died, she was sad and stuff for a week, 'cause me and my brother talked to her and she felt better." When responding to the question of what "Unbreak my Heart was about, one girl said, "Me and [illegible] cousin had to sing this song for church and it had to do with when you can't hold all the pain [illegible] heart." Another girl, in attempt to explain the "happy" feeling that she had when listening to [illegible]Da Dip," compared it to a time that she'd shared with one of her friends in the group saying, "remember that time we went to the movies, we went to the dollar stores downtown?" When answering the written survey administered after each song, many girls revealed that they had felt similar feeling to those portrayed in "Unbreak my Heart" when they had moved to Seattle or when they had broken up with a boyfriend. One girl shared, "I broke up with a boy that loved my heart...when I had to leave my bomb (attractive) boyfriend that's in Louisiana where I came from."

Another aspect of the adolescent experience for boys is rebuking those [illegible] attempt the exploration of the societal norms of same-sex attractions. As revealed [illegible] discoursing with the boys and in the studies of gender specialist Gerda Siann, "There was considerable stigmatization of children, particularly boys, who cross sex boundaries. Re[illegible]d to this is the phenomena whereby... marginal boys may be [illegible]ased and mocked as bei[illegible]issy' or sometimes in the American setting 'fags' (Siann 1994)." In discussing the song, "'Da Dip," boys repeatedly harbored the notion that the singer was actually wanting to touch boys when he, "put his hand up on your hip." One boy excitedly yelled out, "He did it to a boy! He did it to a boy!" Another boy employed the same interpretation when attempting to answer what he would do if someone where singing this song to him, "I would tell him, man, you better get away from me because I am not dipping with boys." This could also point to this boy's inability to translate the gender of the singer into a female as proscribed by the question, but it also exemplifies the fear of being identified with perceived unacceptable social behaviors, particularly in a group setting. Boys were also careful to monitor the other children who spoke of questionable societal relationships. When a soft-spoken boy raised the idea that the Spice Girls were singing about "social sex", other boys scolded him, "Ewh, your gay!", although his comment did not touch issues of homosexuality, it seemed that they were uncomfortable with his comment and sought, what they viewed as a deviant label for the dissenter. However, the discussion of same-sex relationships of women did not receive the same stigmatization by the boys discussing them. One boy believed that the Spice Girls were directing their song to other women. When asked why he believed this he responded, "Same reason (another boy) thought they were singing to a boy," and discussion continued without any comments from other boys in the group.

Although our study is not definitive due to a small and relatively homogeneous sample size, we do believe that this study identifies several areas that merit further investigation. Our study was developed with the intent to listen to children and to begin to identify whether there is, indeed, evidence for differing perspectives between boys and girls when listening to and discussing popular music. We believe that we have identified an appropriate range of questions and themes to use for larger-scale, future research. The idea of "earned love" that came up in each of the boys' groups would be important to test with different songs than those that we used; perhaps, a ballad by a male artist. Investigating the idea that girls relate more to experiences in their personal lives when interpreting popular music in a group setting would require a larger sampling of children. Although there was an adherence to the interpretation set up by the music video for each of these songs and occasionally confusion in interpretation due to lyrical intelligibility, our research did find that kids actively construct messages from the music that they hear. Due to the amount of time that most early adolescents invest in listening to popular music and the crucial lifestage of gender role formation in which they are located, the area of popular music's influence on and interpretations by early adolescents is an area of crucial study that certainly merits future research.

RESOURCES CONSULTED

Beal, Carol. Boys and Girls: The Development of Gender Roles. McGraw-Hill Inc., NY: 1994.

Block, Jeanne H. Sex Role Identity and Ego Development. Jossey-Bass, San Francisco: 1984.

[illegible] Peter. The Adolescent Passage: Developmental Issues. International Universities Press, Inc. NY: 1979.

Chris[illegible], Peter and Peter De Bennedittis. "'Eavesdropping' on the FM Band: [illegible]ren's Use of Radio." Journal of Communications. 1986, Spring, 27-

Cooper, V[illegible]ia W. "Women in Popular Music: A Quantitative Analysis of Feminine

Images Over Time." Sex Roles. 1985, 13:9/10, 499-506.

Desmond, Roger Jon. "Adolescence and Music Lyrics: Implications of a Cognitive Perspective." Communications Quarterly. 1987, 35:3, 276-284.

Feldman, S. Shirley and Glen R. Elliott. At the Threshold: The Developing Adolescent. Harvard University Press, Cambridge, MA: 1993.

Freudiger, Patricia and Elizabeth M. Almquist. "Male and Female Roles in the Lyrics of Three Genres of Contemporary Music." Sex Roles. 1978, 4:1, 51-65.

Oosterwegel, Annerieke and Louis Oppenheimer. The Self-System: Developmental Changes Between and Within Self-Concepts. Lawrence Erlbaum Assoc. Hillsdale, NJ: 1993.

Rosenberg, Morris. Conceiving the Self. Drieger Publishing Co. Malabar, FL: 1979.

Stann, Gerda. Gender, Sex and Sexuality: Contemporary Psychological Perspectives. Taylor and Francis, London: 1994.

An Examination of Gift Giving in Post-Modern Society

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This study examines the techniques used at the Development Office of a small liberal arts college in upstate New York to make bureaucratic gift soliciting seem personal. Through field research, it has been found that giving at a small liberal arts college is personalized by syncretizing bureaucracy and personalism.

Gift giving, as a face-to-face relationship, helps establish personal relationships and sustain order. In traditional societies, several rules have applied to gift giving: Gifts are given, not solicited; they define social roles; a gift of equal value must be returned to the giver. In industrial and post-industrial America gift giving has taken on an added dimension: Gifts are now solicited.

Researching changes in gift giving, Harry Murray (1990:14) argues that "hospitality is no longer a virtue, it is an industry." In his study of the *Catholic Worker*, Murray found that what had once been personal has become institutional and bureaucratized. Could gift giving now be both personal and bureaucratic? Need it be either one or the other?

Through ten weeks of fieldwork consisting of interviews and observations in the College Relations division of a small liberal arts college, it was discovered that gift soliciting shows syncretism between personalism and bureaucracy. On the one hand, gift soliciting has become routinized--a process that can be taught--in which the people solicited, mainly alumni/ae, are objectified. While, on the other hand, personalism still pervades the gift solicitation process. This duality is successfully maintained by keeping bureaucracy and personalism separate, a process explained by Goffman's (1959) Dramaturgical Theory of life-a-theater, in which interaction spaces are divided between front and back stages. Accordingly, the impersonal bureaucracy of gift soliciting is kept out of the prospective donor's view--in the backstage. An entire vocabulary, analogous to gardening is used in the backstage to describe the gift soliciting process:

> Like farmers, [we see] people [as] the seeds--we plant them, water them (by inviting them to an event), and sometimes we do some major watering (giving them an

948

> honorary degree, or a major recognition). The plant them grows, or it doesn't. This is the part where we try to form a reciprocal relationship, some respond and some don't. With all people it is the same.... to release the gift. [This takes]...cultivation.

The potential donor sees only the frontstage, which is personalized and seemingly unbureaucratic. The objective of gift solicitors is to keep these interaction spaces separate from one another, a process described by college relations solicitors as a "dance." Solicitors interact with potential donors in a way that balances contrived compliments with genuine "sincerity." One solicitor explained that when meeting with people,

> There is lots of complimenting that goes on...--[a person's] achievements, taste, activities--it is like giving them an "A." There is a dance involved in the process, and the dance is one of sincerity to create the trust. You want to compliment, yet gain the trust of the person at the same time. First and foremost is sincerity. I am an ambassador to the institution and I have to be careful when doing the dance.

That some compliments are not sincere points to a moment in which the bureaucratized backstage can be thrust into the frontstage, potentially causing a moment of tension for solicitor and potential donor. At this moment, the solicitor must appear sincere, not letting the potential donor see the planned "script" for this "performance."

The "dance" that balances front and back stages involves using information and ideas generated in the backstage--on how to raise money, on the prospective donor's financial status and interests--to entice donations while still maintaining the image of a personal, charismatic, and sincere frontstage. So that this contrived "dance" is not be recognized by the potential donor, the solicitor must successfully balance front and back stages so as to minimize what Goffman labels "definitional disruptions"--where contradictions expose "an individual who implicitly or explicitly signifies that he has certain social characteristics," in this case sincerity and interest in another, when he does not (Clark and Robboy, 1992:120).

While gift soliciting in the front stage has its personal side, this study reveals that modern gift giving supports Max Weber's (1964) theory of routinization: It has become routinized to the point that solicitors are expected to follow scripted behaviors and demonstrate a scripted charisma to prospective donors. Seeing gift soliciting as an occupation, Weber (in Murphy, 1989:170) might describe the gift solicitor in these terms:

> [the] general evolutionary process...in human society....[has] brought about increasing depersonalization of relations,... growing division of labor, the emergence of the individual as a legal entity, greater specificity of roles, and a loss of solidarity based upon common sentiment.

By combining Goffman's Dramaturgical (1959) and Weber's (1964) routinization theories we can better understand modern gift giving. By keeping routinized gift solicitation in the backstage, personalism can still appear to characterize gift giving even as the process becomes increasingly routinized and impersonal.

REFERENCES

Clark, Candace and Howard Robboy, eds. 1992. *Social Interaction: Reading in Sociology*. New York, St. Martin's Press.

Goffman, Irving. 1959. *The Presentation of Self in Everyday Life.* New York: Doubleday.

Murphy, Robert. 1989. *Cultural and Social Anthropology, 3rd Ed.* New Jersey: Prentice-Hall.

Murray, Harry. 1990. *Do Not Neglect Hospitality: The Catholic Worker and the Homeless.* Philadelphia: Temple University Press.

LEARNING TO HATE YOURSELF:
HOW HOMOPHOBIA TEACHES GIRLS TO DEVALUE WOMEN

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INTRODUCTION

Recent research suggests that with the onset of adolescence many girls begin to exhibit both a loss of confidence in themselves and their abilities, and a highly critical attitude toward their bodies. As a result, these girls dramatically reduce their personal and educational expectations for themselves and other girls. Based on works which chronicle these disturbing results, such as Peggy Orenstein's *Schoolgirls* (1994), Myra and David Sadker's *Failing at Fairness* (1994) and Lyn Mikel Brown's and Carol Gilligan's *Meeting at the Crossroads* (1992), a student colleague, Cinnamon Reiheld, and I developed and implemented a pilot curriculum for girls ages 11-15 at a local summer YMCA Teen Camp at the University of Toledo. Its primary focus was to help the girls learn to reconceptualize their bodies, their personal talents and accomplishments, and their future goals in positive, women-centered terms by providing them with the language and tools necessary to think critically about the position of girls and women in our male-centered society.

Despite extensive reading, however, I was unprepared for and overwhelmed by the homophobia which seemed to taint their relationships with one another, and to perpetuate their negative stereotypes of girls and women. To these girls, the terms "woman" or "woman-centered" were stigmatized as "lesbian," and to make significant the subject of women, their accomplishments, or their legitimacy as role models was labeled "gay." This homophobia became particularly evident in their responses to exercises in which women were presented as role models, or in which we promoted any female-centered group bonding. In addition, many daily incidents in the camp environment, particularly incidents with adolescent boys, served to generate and reinforce the homophobic responses and attitudes present. In this paper, I will present a framework in which to understand the homophobic social climate we observed through the girls' responses - responses I believe help ensure that adolescent girls learn to devalue themselves and ultimately the women they will become.

PROGRAM FORMAT & PARTICIPANT PROFILE

The Teen Camp program was comprised of nine one-week summer sessions. Although some teens attended the camp for more than one week, a total of 390 different teens, 250 girls and 140 boys, attended the camp throughout the summer. Teen Camp participants ranged in age from eleven to sixteen years old, with an average age of twelve. Approximately 1/2 of the teens lived in two parent homes (including step families), 1/4 lived in single parent homes, and 1/8 lived in the foster care system. The remaining teens lived with other relatives. In terms of socio-economic status, the majority of Teen Camp participants came from middle class backgrounds. A smaller number came from upper and lower income level backgrounds. About 1/4 of participants received financial assistance in the form of partial scholarships to pay their Teen Camp fees. Finally, twelve teens with special needs, including autism, physical impairments, and mental disabilities, participated in the Teen Camp program.

Our workshop, *What Little Girls Are Really Made Of*, took place weekly on Mondays and Fridays. Each session lasted approximately two and a half hours, and consisted of a combination of activities from our curriculum. Typically, each group consisted of twenty to thirty girls, which we then split into two smaller groups in order to better facilitate the activities.

ANALYTICAL FRAMEWORK

In the works I read prior to the workshop, homophobia was virtually unmentioned, even when similar exercises were used. For instance, our gender journey exercise, which asked the girls to imagine how their life would be different if they had been "born a boy," was adapted from *SchoolGirls* and *Failing at Fairness*. Neither of these books mentioned similar responses or ways to address homophobia in general. Yet, when we carried out the exercise, the issue of sexual orientation, once introduced, dominated the discussion. The girls scoffed at the notion of "being born a boy" because they would "have to like girls." Because the homophobia was so prevalent, either implicitly or explicitly, in response to other exercises in which women were presented as role models, or in which we promoted any female-centered group bonding, it became increasingly important to discover a framework that would explain the cultural forces that teach women and girls to devalue and stigmatize their relationships with other women, and to fear their collective power in such relationships. The work of Adrienne Rich and Susan Moller Okin not only provided the framework that would allow for such investigation, but highlighted the necessity to include these discussions of homophobia in other feminist scholarship as well. I will present a simplified version of their arguments to be considered as a framework of analysis for the homophobia I observed and its implications for girls and women.

In her article, *Sexual Orientation, Gender, and Families: Dichotomizing Differences*, Susan Moller Okin describes the intricate relationship between the dichotomization of sexual difference and the stigmatization of activities and relationships labeled as homosexual (Okin, 30). According to Okin, the view that men and women are "opposites" forms the rationale for gender inequality in our society (Okin, 37). She further states that because we learn to dichotomize masculine and feminine attributes, and to privilege the former, we learn that men and women's social roles are complementary and that heterosexual relationships are indeed "natural" (Okin, 30, 42). As a control mechanism, then, behavior that deviates from these sex role boundaries is stigmatized as homosexual regardless of a person's actual sexual orientation (Okin, 32). Within this framework, homophobia serves to uphold the gender inequalities present in our society by stigmatizing relationships and activities that are not congruent with traditional sex role norms (Okin, 38).

Adrienne Rich expands this framework in *Compulsory Heterosexuality and Lesbian Existence*. She explains that the inequality inherent in a view of women and men as opposites teaches girls to place men and boys above women and girls, "including themselves, in credibility, status and importance in most situations" (Rich, 645). Likewise, girls learn to view interaction with women and girls as a "lesser form of relating on every level," and to understand heterosexual involvement with men and boys as primary and compulsory (Rich, 645). In this context, homophobia is understood as the stigmatization of any individual action or relationship that serves as a source of power for women and girls to "change the social relations of the sexes, to liberate ourselves and each other" (Rich, 657).

A careful reading of Rich and Okin then reveals a structure through which to understand homophobia and its function in maintaining gender inequality in our society. I believe there are three interrelated components to this structure:

(1) dichotomizing sexual difference,
(2) devaluing relationships with women and girls, and
(3) perpetuating gender inequity through homophobia.

I will use this structure to analyze the girls' responses to specific exercises in order to demonstrate how homophobia maintained gender inequality within the camp, and the implications of this inequality for the girls and the women they will become.

DICHOTOMIZING SEXUAL DIFFERENCE

The first, and perhaps most crucial element in the structure of this 'homophobic feedback loop' is the dichotomization of sexual difference. Two exercises in particular demonstrated the extent to which the girls had learned both to dichotomize masculinity and femininity and to privilege the former in our society: "Word Wheels" and the "Gender Journey" (Okin, 39).

Adapted from the *Action Guide for Girls' Education*, "Word Wheels" was an exercise in which we asked the girls to make a list of personality attributes associated with the words "girl" and "boy" (Bay Area Network, 8-11). Through their responses, the girls described a social world in which boys and girls, women and men, were viewed as virtual opposites. Although there were notable exceptions, girls were generally described as sweet, sensitive, loving, nice, and understanding while boys were described as mean, intelligent, weird, tough, messy, and above of all "perverted." A few girls even supplemented their lists with statistics: "99% of boys are perverted, 1% of girls are." To the girls, "perverted" was code for "sexual,"

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meaning boys had the right both to have sexual feelings and to act on them; girls do not have such rights. The significance of this comment lies at the heart of our rape culture mentality: women and girls are to act as the moral force in relationships between women and men, they must stop men from acting on their natural, "perverted" impulses, and they are in control of the level of sexual expression in any relationship. When they fail to maintain that control they choose to subject themselves to the "perverted" male, and deserve the consequences. From this exercise, it is clear by age twelve that these girls know and understand the warped logic by which we define women's and men's sexuality. Even more disturbing was that the girls described all these characteristics as "naturally" being associated with one sex or the other, not social constructed, and not subject to change (Okin, 36).

In a corollary to this exercise, the girls were also asked to make a list of the occupations women and men hold. It was apparent from their responses that the girls had learned to believe that their different, if not opposite, personality characteristics equip girls and boys for different jobs when they become women and men. Although two of approximately twenty girls believed that women and men could hold "the same jobs," the majority of girls listed occupations consistent with their stereotyped view of women and men as opposites. Women were described as nurses, "cleaning ladies", waitresses, secretaries, models, teachers, baby-sitters, moms, and actresses while men were described as construction workers, mechanics, executives, doctors, custodians, plumbers, principals, presidents, "bug killers", professional athletes, firemen, garbage men, and police officers. The obvious economic, power, and status differentials between these male and female occupations is one of several indicators of the implicit knowledge girls have of gender inequity in our society, and the consequences of that inequality for girls and women.

The "gender journey," which asked the girls to imagine how different their lives would have been if they had been born as boys, demonstrated the extent to which the girls' view of boys and girls as opposites caused them to value boys' lives over their own. Their responses, which fell into four categories, clearly reflected a sense of advantage in terms of personal freedom, access, and leisure for boys, and disadvantage for girls. The first category of response testified to the tyranny of appearance in the lives of adolescent girls:

> "We could sleep in because we wouldn't have to spend so much time getting ready."
> "We wouldn't have to worry about whether our clothes matched perfectly or not."

The girls were clearly jealous of the "free time" boys enjoyed as a result of not having to tend to their appearance in this manner. An important question to ask is what boys do with this free time, what does it means that the girls are slave to a time and energy consuming physical perfectionism that boys are not. Another category of response revealed the extent to which girls consider themselves biologically vulnerable in our society:

> "We wouldn't have periods, or have to worry about getting pregnant."
> "We wouldn't have to worry about our weight as much."

Issues of weight management were extremely important to these girls as over half of them testified to being on a diet at least once, and not one girl was over the age of fourteen. A third category demonstrated the greater physical, behavioral, and attitudinal freedom boys enjoy over girls, and the value girls place on that freedom:

> "We could be more aggressive."
> "We would have to play war and G.I. Joe."
> "We wouldn't have to do as many chores around the house."
> "We could always play ball; we wouldn't have to prove that we were good enough."

The final comment, once introduced, completely dominated the discussion:

> "If we were boys, we would have to like girls!"

This possibility of "liking girls" was met with total horror by the other girls, and was followed by a stream of homophobic comments. These comments might well have been dismissed as social immaturity, however, they quickly became comments condemning even homosocial activities between girls. The magnitude of force behind these comments indicated that if "women liking women," even in intense friendship, was so forbidden, then "women hating women" must be the norm. At an age when they are encouraged to abandon their relationships with girls and women in favor of relationships with boys and men, these girls have learned that the more they stigmatize female-centered relationships, the easier it is to abandon them. In light of the structure provided by Rich and Okin, I believe this incident was illustrative of how a dichotomization of the sexes in which the male is privileged led the girls to view interaction with one another as lesser, almost deviant, and to privilege their relationships with men instead (Okin, 30; Rich, 646).

DEVALUING WOMEN & GIRLS

The extent to which the girls devalued positive interaction with women and girls, the second element of the structure for understanding homophobia, was demonstrated by two specific exercises, the "Women in American History Lesson" and "Your Everywoman," an exercise in which the girls were asked to identify a woman they admire and why. The goal of these exercises, to help the girls identify positive female interaction in their lives, came into direct conflict with their view of relationships with woman as lesser, deviant, gay. The girls were clearly very uncomfortable with focusing on women as positive role models in these activities. Over and over, the girls stressed verbally that they "look up to men," and that they "don't like thinking about women or hanging out with them much." They explained that they were "at an age when they should be thinking about boys," and that they were upset by this exercise for two reasons: "we don't like being separated from the boys" and "it's gay" to think about women. These overtly homophobic feelings indicate that not only have these girls learned to stigmatize relationships with women as valued companions and role models, they are highly sensitized to and terrified of situations which even promote such relationships (Rich, 657). According to Rich, the consequences of this homophobia have been severe: it has meant the loss of relationships that provide the power for women and girls "to change the social relations of the sexes, to liberate (themselves) and each other" (Rich, 657).

MAINTAINING GENDER INEQUITY THROUGH HOMOPHOBIA

An exercise about appropriate sex role boundaries revealed the entire structure of how homophobia maintains gender inequity in our society, including the severity with which transgressions against the structure are punished. In an adaptation of Matina Horner's 1969 study, we split the girls into several groups and asked them to devise a skit around a particular situation. The situation followed as such:

> After report cards are handed out in class, Molly (Brian) finds out that she (he) has gotten straight A's again, for the third grading period in a row. Describe what follows in the classroom.

One group of girls acted out the situation involving Brian, another group involving Molly. When Brian received straight A's, there were no negative consequences for Brian in the classroom. He merely exchanged a "high five" with his friend Ryan, who also received straight A's. The group of four girls who received the situation involving Molly, however, devised the following skit:

> Molly walks up to her three best friends, tough girls who are smoking. Overjoyed, she tells them that she just got all A's again. The girls pull Molly by the arm, tie her to a tree, pour gasoline on her, and light her on fire with their cigarettes.

This horrific characterization of the consequences of female success conveyed two important messages. Foremost, acting outside of the appropriate sex role boundaries, girls and women as successful for example, was a punishable offense for these girls. Also, attempting to celebrate that success with other girls required those girls to respond with hostility and force. Using Rich and Okin, we are able to understand this incident as a homophobic reaction designed to teach women and girls to devalue and stigmatize their relationships with other women, and to fear their collective power in such relationships, thus nearly eliminating the possibility that women will work collectively to end gender inequity in our society.

CONCLUSIONS

The implications of uncovering this structure for understanding how homophobia maintains gender inequality can be observed in the way it manifested itself in the teen camp environment. Three specific types incidents occurred on a daily basis in the camp environment which generated and reinforced one or all of the elements necessary to maintaining a homophobic climate: lack of camp programming for boys, name calling and sexual harassment.

Because our program worked exclusively with the girls, the Teen Camp staff agreed to provide alternate programming, character development exercises, for the boys during this time period. However, we soon discovered that this programming not only did not exist, but was replaced with activities, such as sports activities or free time, that worked directly against the stated goals of our workshop. The boys frequently played in the field adjacent to our workshop, and as a result distracted the girls from our exercises. The girls questioned why the boys were getting "free time," choosing their activities, "being loud and playing" while they had to "sit still, listen, pay attention, and behave?" One day in particular we addressed this problem by playing an all-girls kickball game, and having a great time. However, it was incredibly difficult within this environment to challenge the girls' negative stereotypes of women and relationships with women when the camp programming and management served to reinforce those very stereotypes.

In the camp, the words "girl," "girly girl," or "feminist" were the most derogatory insults that could be used against both girls and boys alike. According to the girls' explicit definition, a "girly girl" is a "girl who acts too much like a girl, wears dresses too much, is afraid of spiders, and doesn't like sports enough." Obviously, an overindulgence in what is considered "girl" is bad. That the girls insulted each other in the same manner the boys insulted one another with the word "girl," indicates that the girls have an implicit knowledge of the lack of power inherent in stereotyped feminine behavior and attributes.

If use of the word "girl"indicated a lack of female power, then the use of the word "feminist" as an insult indicated the contempt and negative stereotyping with which female power was confronted in the camp environment. During free time, a group of boys and girls were gathered around a table making popular necklaces and bracelets out of beads and string, when one boy began discussing his dislike for a particular girl at school. Loudly, he exclaimed "she is a feminist, because she doesn't shave her legs," to which I responded "I am a feminist." The boy looks at my legs, notices them shaved, and doesn't speak for almost five minutes. An amusing but telling story of the manner in which feminism, and by extension relationships and activities that foster a sense of power for women, was confronted and devalued in the camp environment.

Even more prevalent than the name calling were the daily incidents of sexual harassment. These incidents included a game called "Nervous" which each new girl had to play on the bus in order to be initiated by the boys into Teen Camp. The game began when a boy, usually a very popular boy, placed his hand on a girl's ankle, and moved up her legs, down her arms, and toward her breasts and genital area. Throughout this humiliating touching, the boy continually asked, "Are you nervous yet?" The point at which the girl answered "yes" determined her status as a prude, cool girl, or slut. Although the girls outnumbered the boys nearly two to one every week, they did not have a sense of collective efficacy to stop the sexual harassment. Standing up for yourself or another girl meant alienating yourself and running the risk of being labeled "gay." Also, the camp counsellors were less than supportive of the girls who had exposed sexual harassment in the camp. They defended the boys and accused the girls of seeking retaliation against boys who would not date them. Under these circumstances these girls learned to fear their collective power in relationships with other girls to end sexual harassment - the ultimate use of homophobia ensure the maintenance of gender inequality in our society.

An understanding of the structure through which homophobia maintains gender inequity in our society does more than illustrate the problems girls and women face; it also provides hope and direction for substantive change. If we as a society no longer viewed women and men as opposites, we could judge the appropriateness of aggressive or assertive behavior, for instance, "in accordance with the circumstances, not the sex" of the individual (Okin, 32). As a result, women and men who demonstrated interests, talents, and personal styles that are not consistent with stereotypical sex role norms then would not be stigmatized as homosexual (Okin, 32). And most importantly, women and girls would no longer have to devalue and stigmatize their relationships with other women, giving them access to a source of knowledge and power they have never known.

Works Cited:

Brown, Lyn Mikel and Carol Gilligan. Meeting at the Crossroads. New York: Ballantine Books, 1992.
Okin, Susan Moller. "Sexual Orientation, Gender, and Families: Dichotomizing Difference."Hypatia 11(1996): 30-48.
Orenstein, Peggy. SchoolGirls. New York: Anchor Books, 1994.
Rich, Adrienne. "Compulsory Heterosexuality and Lesbian Existence." Signs: Journal of women in culture and society 5 (1980): 631-660.
Sadker, Myra and David Sadker. Failing at Fairness. New York: Touchstone, 1994.

The Effect of the "Year of the Woman"on the 103rd Congress

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In 1992, the "Year of the Woman," women doubled their representation in the United State Congress. Yet, to what extent did this increase in representation result in greater attention to "women's issues?" For the purposes of this paper, "women's issues" are defined as those which have been the focal point for the various stages of the Women's Rights Movement. This historical movement includes the Suffrage Movement, the Civil Rights Movement, and the issues which highlighted the "Year of the Woman" in 1992. This paper examines the "Year of the Woman" in the context of this historical movement and assesses the extent to which the electoral gains in 1992 resulted in concrete actions to befit the label. The analysis shows that women in the 103rd United States Senate did not sponsor a significant among of legislation on women's issues. Yet, the research helps clarify the effect of the 1992 elections on the United States Senate and enhances the understanding of women's issues in the context of current public policy dilemmas.

BACKGROUND

In almost every culture, roles are defined for individuals based in a large part on gender. In turn, these gender roles contribute to different experiences and different priorities for women and men. To define women's issues, this paper examines what issues were predominate in the Women's Rights Movement from its earliest stages through the "Year of the Woman" in 1992. The three major stages in the Women's Rights Movement include the Suffrage Movement, the Civil Rights Movement, and the "Year of the Woman."

The Suffrage Movement began in 1849 with the Seneca Falls Convention and continued through the New Deal reforms in the 1930's. The Seneca Falls Convention allowed women to call for equality and to document women's issues in their Declaration of Sentiments and Resolutions (Chafe 1991, Dubois 1978, Gurko 1974). These issues included equality in their professions, in marriage, and in legal rights (Porter 1918). Since these issues paralleled racial minority issues, the Abolitionist Movement and the Suffrage Movement worked together for equality in the Constitution. Yet, when the Thirteenth, Fourteenth, and Fifteenth Amendments were ratified to the Constitution, they supported race not gender (Crocco 1995). This sparked the movement's call for women's right to vote to be included in the Constitution. This issue resulted in the ratification of the Nineteenth Amendment in 1920. Thus, women addressed the right to vote issue and it resulted in policy.

Women continued the Suffrage Movement to address more women's issues related to greater society concerns such as social reforms and fair labor standards in the New Deal. The country as a whole was addressing the greater society concerns because of the Great Depression, but women augmented these reforms because of their promotion of individual and family well-being as women's issues (Ware 1981). President Franklin Roosevelt recognized women's increased political participation when he appointed Frances

Perkins as the Secretary of Labor. Under the Department of Labor, she included women in the construction of legislation addressing women's greater society issues such as the Social Security Act of 1935 and the Fair Labor Standards Act of 1938. Thus, women's issues were reflected in the New Deal reform policies headed by Frances Perkins. As seen in the previous examples, women's issues in the Suffrage Movement became policy because of women's motivation and organization. Women continued this trend in the Civil Rights Movement.

Women again joined forces with racial minorities in the Civil Rights Movement in their quest for equal rights in 1960-1970. The Civil Rights Movement addressed the issues of racial and gender discrimination. The movement's discrimination issue resulted in policy when The Civil Rights Act of 1964 passed. Although this act included women's issues, women reintroduced the Equal Rights Amendment which exclusively addressed women's issues. This amendment did not pass, but women continued to address women's issues which helped to establish the "Year of the Woman" in 1992.

The "Year of the Woman" label stemmed from the political arena centered around women's issues (Crispell 1992, O'Reilly 1992, Roberts and Cohen 1992). These issues included Anita Hill's allegations of sexual harassment during the Clarence Thomas conformation hearings, and abortion because of the recent Supreme Court abortion decisions.

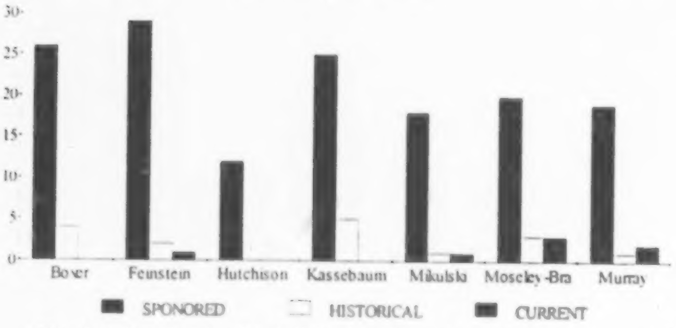
Women's rights groups and candidates campaigning for the 1992 election recalled the Clarence Thomas conformation hearings to emphasize the issue of sexual harassment. This was evident in *Newsweek*'s public opinion polls that in 1991 showed only twenty-seven percent of women believed Thomas had harassed Hill compared to fifty-one percent in 1992 (Salholz 1992). As seen in this poll, the issue of sexual harassment addressed in the Thomas conformation hearings was highlighted by many women's groups and women candidates in the 1992 election.

The abortion issue had its primary impact in the Supreme Court system as seen in *Roe v. Wade* (1973). Since this landmark decision, the Court has defined abortion through many cases in the 1980's and the early 1990's. The developments in the early 1990's cases caused abortion to become a primary issue in the 1992 election. This was evident in the women's groups that formed and grew with the abortion litmus test. Starting in 1991, Women in the Senate and the House (WISH) supported pro-choice women in either party. By March of 1992, it had raised $180,000 and enlisted 250 members (McDowell 1992). Also, Early Money Is Like Yeast (EMILY's List) reached its annual fundraising intake in the first few months of 1992. The political emphasis placed on sexual harassment and abortion by women's groups and women candidates resulted in women doubling their representation in Congress (Githens, Norris, and Lovenduski 1994). Because of the increased representation, this paper analyzes legislation introduced in the 103rd United States Senate by the women elected in 1992 to see if it policy changed concerning women's issues.

ANALYSIS

Given that the primary issues in the historical Women's Rights Movement were addressed in associated legislative policies, this paper assumed that the issues raised in the "Year of the Woman" would result in relative legislative policies. Using the issues defined in the Women's Rights Movement as definitions of women's issues, this paper conducted a content analysis of the bills sponsored by the women in the 103rd United States Senate to determine if the issues addressed in the "Year of the Woman" became policy.

To better analyze this assumption in the chart below, the first column indicates the total number of bills sponsored by each woman. The second column denotes historical women's issues such as greater society concerns noted in the Suffrage Movement. The third column records the current women's issues addressed in the "Year of the Woman" including sexual harassment and abortion.



BILLS SPONSORED

The chart illustrates that the analysis of the vast majority of the bills sponsored by women in the 103rd United States Senate did not address current women's issues. While the Women's Rights Movement has contributed to defining key issues in each of its major stages, the issues which lead to the unprecedented electoral gains in 1992 did not directly or immediately translate into new public policies. This is evident in the content analysis of the sponsored bills below.

Barbara Boxer's bills concerned environmental issues, tax issues, and women's historical issues. Environmentally, Boxer's bills gave federal protection to certain lands and species. Her bills concerning taxes designated tax breaks for certain tax categories. Finally, she did address women's historical issues in crime prevention and health care related bills. In S 470 she sought to amend Chapter 41 of Title 18, United States Code, to punish stalking. In S 765 she wanted to amend the law to provide women employees the opportunity to be notified of material coverage restrictions and remedies for violations of benefits under group health plans. In S 1454 she addressed the issue of breast cancer research. Lastly, in S 1506 she wanted to provide training for the health profession's students on the identification and referral of domestic violence victims.

Dianne Feinstein's bills centered around Defense Base Closures and Realignment Act of 1990. Feinstein wanted to amend the Defense Base Closures and Realignment Act of 1990 to reduce its impact on her state. She addressed historical women's issues in the law and child support. In S 2162 she wanted to provide for protection from sexual predators. This protection was for everyone, but it affected women because of the rape issue. In S 2528 she was concerned with improving and strengthening the child support collection system. This affects women because they are the ones who usually collect child support for their children. She addressed current women's issues in S 1864 by trying to prevent sexual harassment in the work place.

Kay Bailey Hutchison's bills centered around economic issues. This included tax cuts and incentives for businesses. She did not sponsor any bills in regards to historical or current women's issues.

Nancy Landon Kassebaum's bills concerned a variety of areas such as economics and issues in her state. She sponsored five bills that included historical women's issues. In S 325 the goal was to reform health care for easier access. In S 1746 the issue was establishing a youth development grant program. In S 2010 the incentive was to allow easier access to effective drug treatments for children. In S 1950 the plan was to update OSHA regulations. Last, in S 1891 the objective was welfare reform.

Barbara A. Mikulski sponsored bills that concerned an assortment of issues including federal employee benefits. She addressed historical women's issues in S 1310 by extending grants in the Public Health Service Act to breast and cervical cancer. She addressed current women's issues in S 1463 by amending the Elementary and Secondary Education Act of 1965 to address gender equity in math and science.

Carol Moseley-Braun sponsored bills concerned mostly her state's interest as a whole. She addressed historical women's issues in S 922, S 1460, and S 2034. In S 922 the goal was to modify child support court orders between states. In S 1460 the issue was to amend the Elementary and Secondary Education Act to include child abuse protection. In S 2034 the objective was to improve libraries. She addressed current women's issues in S 1466, S 1468, and SJR 188. The intent in S 1466 was to improve gender equality in secondary education. The objective in S 1468 was to improve gender equality in higher education by amending the Higher Education Act of 1965. SJR 188 designated 1995 as the year of the Girl Child.

Patty Murray sponsored bills that centered around a variety of issues including the fishing industry. She addressed historical women's issues in S 2505 by trying to improve Washington State health care through state preemption of national health care. She addressed current women's issues in S 1037 and S 1079. S 1037 wanted to amend the Civil Rights Act of 1991 with respect to its application. S 1079 tried to require that employers post information for their employees concerning sexual harassment under Title XII of the Civil Rights Act of 1964 (Congressional Record 1993, 1994).

This content analysis clearly shows that women's issues, either historical or current, were not the primary concern for the women elected to serve in the 103rd United States Senate. Thus, this paper considers the reasons for the discrepancy between the expected results and the actual results.

CONCLUSIONS

This paper assumed that since women significantly increased their representation in Congress, issues from the 1992 election would be the primary focus for the women elected to the Senate. Yet, the analysis of the bills sponsored by the elected women did not agree with this assumption. Instead, the bills centered around a variety of issues from military base closures to the fishing industry, most of which had very little to do with the issues which define the Women's Rights Movement.

Three reasons for the disagreement between the hypothesis and the results of the content analysis include: (1) women's representation did not increase enough to warrant isolated emphasis of women's issues, (2) the elected women have to represent their constituents' interests before their own, and (3) the limitations of the research methodology in this thesis.

One possible reason for the disparity between the expected results and the actual results is that although women's representation doubled, it was still not enough of a significant gain to warrant women's issues receiving isolated emphasis (Darcy, Welch, and Clark 1995). While women made substantial gains in 1992, they still only held seven of the one-hundred seats in the United States Senate. Thus women should continue to increase their representation so they can emphasize their issues. They can accomplish this by organizing at the grass-roots level to elect more women to Congress and/or to make their concerns heard.

Another reason is the fact that these women had to represent their constituents before their own interests. If these women were elected from states that were all women, they could just represent women's issues. But obviously, all states are comprised of women and men. Thus, the issues they addressed centered around issues that concerned both women and men in their particular state. This is the ideal way for the United States electoral system to work, thus the limited attention women's issues received is understandable.

The methodology applied in this thesis had several shortcomings. This thesis only examined bills sponsored by women in the 103rd United States Senate. A more extensive analysis would include the activities of women in the House of Representatives, would examine bills sponsored over several years following the election, and would analyze voting records as well as sponsorship patterns. Future research using more sophisticated and comprehensive methods might reveal a relationship between the 1992 electoral gains and the advancement of women's issues through public policy.

Fortunately, there are many ways to measure the impact of women's issues in society. Women's issues have increased in importance since the Seneca Falls Convention in 1849; thus, women have gained in their quest to address their issues and more clearly define their roles in society This thesis recommends that women continue their political participation to attain their full potential Congress and other institutions

REFERENCES

Chafe, William H *The Paradox of Change: American Women in the 20th Century* New York Oxford University Press 1991

Congressional Record 103rd Congress , 1st session , 1993

Congressional Record 103rd Congress , 2nd session , 1994

Crispell, Dianne "Will Women Vote for Women?" *Working Woman* (October 1992) 21

Crocco, Margaret Smith "The Road to the Vote," *Social Education* 59(5) (1995) 259

Darcy R , Welch, Susan, and Clark, Janet *Women, Elections, and Representation* Lincoln The University of Nebraska Press 1994

Dubois, Ellen Carol *Feminism and Suffrage* Ithaca Cornell University Press 1978

Githens, Marianne, Norris, Pippa, and Lovenduski, Joni *Different Roles, Different Voices: Women and Politics in the United States and Europe* New York Harper Collins College Publishing 1994

Gurko, Miriam *The Ladies of Seneca Falls: The Birth of the Woman's Rights Movement* New York Macmillan Publishers Co , Inc 1974

McDowell, Jeanne "Turmoil Under the G O P Tent," *Time* (May 1992) 36

O'Reilly, Jane "Womanifesto," *The Nation* (July 1992) 77-78

Porter, Kirk H *A History of Suffrage in the United States* Westport Greenwood Press 1988

Roberts, Steven V and Cohen, Gary "Will 1992 be the Year of the Woman?" *U.S. News and World Report* (April 1992) 37-39

Salholz, Eloise "Did America 'Get It'?" *Newsweek* (December 1992) 20-22

Ware, Susan *Beyond Suffrage: Women in the New Deal* Cambridge Harvard University Press 1981

Popularity The Crisis and Culture of Adolescent Girls

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A girl's coming of age in Western culture is defined as a crisis contextualized by popularity which effects an individual's perception of who she is and what she can accomplish The popularity crisis creates a culture of competitiveness where it is "every girl for herself" In Making Connections (1990) Carol Gilligan writes that "the central problem—feeling abandoned by others—[is] a problem of disconnection, and often [leads] to desperate actions at connection" (Gilligan, 9) As a summer intern, I witnessed the process of girls battling with the issues surrounding the culture of "every girl for herself" These girls *needed* to be popular at all costs This need manifested itself through hurting each other verbally and emotionally The paper theorizes in terms of Gilligan's paradigm "connection"

During the summer of 1996, I worked with adolescent girls in workshop I developed with a student colleague, entitled "What Little Girls are Really Made Of" The goal of the workshop, which we implemented in a YMCA day camp, was to heighten girls' awareness of their capabilities through self-realization and gender awareness The co-educational camp was for 11-16 year-olds and the girls' ages ranged from 11 to 15 years The workshop, which was conducted for three-four hours a day, twice a week, ran from July 8, 1996 to August 16, 1996 The number in attendance for the workshop varied from fifteen to twenty-five girls The girls differed in socio-economic status, ethnic groups and familial structures From the time we walked in, it had already been determined who was popular and who was not Unfortunately, we didn't see it so clearly on the first day It took a while before we identified the division between the girls as one of status--the elite and those longing to be the elite The girls had labeled the division as "Popularity"

The basis of this intervention was research done by Carol Gilligan at The Willard School for Girls, documented in the book Making Connections (1990) Our intent was to explore Gilligan's theory of connectedness, which examines the conflict in adolescent girls between their connection with themselves and their connection with others In analyzing the girls' responses to exercises I will later describe, I began to realize that the issue of popularity was so central and so large that it requires its own individual theory Gilligan defines a girl's coming of age in Western culture as a crisis In studying her work and through the workshop, I found that an integral piece of the phenomenon she was uncovering is what I theorize as the crisis of popularity

Popularity is the state of being accepted into the highest group of peers, the elite Popularity is an on-going competition for a very small space into which others are constantly trying to crowd The more "popular" people there are, the less popularity is valued If everyone can be popular, then popularity has no value By definition, popularity depends on others' exclusion, while striving to maintain personal inclusion Thus, both achieving and maintaining popularity is time-consuming, costly, and essentially traumatic The crisis of popularity is the detrimental compromise of one's and others' feelings, thoughts, and ideas for the sake of acceptance of a group This crisis damages a girl's sense of self-worth, at the same time that it appears to be essential to this worth, which in turn affects her perception of who she is and what she can accomplish Popularity can justifiably be termed a crisis because of several factors, beginning with the observation that popularity defines the underlying structure of girls' relationships It requires continual preoccupation, it is engulfing and it produces ongoing stress Every day girls walk, talk, and hold their head according to their popularity The way they interact with each other and the way they present themselves revolves around their acceptance, or lack of, or aspiration towards, a particular group They feel a compelling need to behave a certain way to either maintain their status or to hide their non-popular status These behaviors are not usually read as signifiers of popularity Yet in examining these signifiers and the girls, they become a key point in understanding the crisis of popularity In fact, they were recognizable to us from our own remembered experiences in adolescent peer groups This popularity problem was revealed as we watched not only a division between the girls but also mistreatment of some by others, which was having a greatly negative effect on the girls being mistreated This was the crisis going on within teen camp and the girls' lives Because this issue of popularity appeared to my colleague and me to be so central, we developed an exercise to further explore this issue of status. I am going to begin by describing that exercise and what it revealed. I will then analyze the girls' responses to that and three other exercises in terms of what they uncover about the central trauma of popularity.

The girls were given an unfinished statement, "In order to be considered popular a girl has to....", and asked to write down how they would finish the statement. Michelle, one of the elite, wrote that in order to be popular, a girl has to "have cool clothes, be pretty, and be stuck up." Other responses included:

-You have to have cool hair
-You have to talk with an attitude and act like you are "all that"
-You have to be prep or a slut
-You has to be stuck up
-Depending on your school you have to either be smart or act stupid

As a side note, I would like to address the affect of popularity on academics. As you can see from the last statement, popularity does effect a girl's performance in the classroom. The girls also wrote in this exercise that getting good grades is low on the priority list when being or attempting to be "cool". These two comments together are related directly to popularity with boys. The girls held firmly the idea that men don't like smart women or female competition. Girls striving for acceptance are willing to compromise their academic success, which as we know, correlates with collegiate success and choices and, in turn, career choices and success. Girls are not realizing their potential to do amazing things because of their struggle for acceptance. This reiterates my point that popularity can be defined as a crisis.

The types implicit in this list will be later discussed. In the discussion after the exercise, Michelle added that one must be "mean" to the unpopular people and act like a "slut." In the same breath, she claimed her popularity was gained by being good at sports. When confronted with the obvious inconsistency between her written answer and her personal method of attaining the same goal, she claimed that although what she had written was true, she had beaten amazing odds to join the ranks without filling any of the criteria she listed. Michelle then admitted that she had acquired status by being mean to people that were not as "cool" as she. Lisa, a popular girl, wrote that you have to "respect yourself and others, but sometimes you have to make fun of people." No one could answer my question of who decided who was going to be made fun of and who was going to be respected. In comparison, Vikki, a non-popular girl, wrote that you have to be stupid, or have no common sense, you have to have lots of money or be liked by those that do. Other non-popular girls wrote that you have to be mean, act like you are "all that", and act, dress, and do your hair "cool". One girl wrote you have to wear clothes from the Gap. Lindsay, a popular girl, added to our discussion that you have to "have a good personality and be well taken care of", which they translated as meaning you have to be clean, have nice clean clothes, and do your hair and make-up. The importance of image was very prominent in these definitions.

These contradictory statements accompanied the comments above:

-Be yourself
-Try not to act like someone else
-Respect yourself and others
-Realize that people who only like you for your looks are not your real friends

Reprinting these later in the weekly magazine created using the girls' work, as an alternative to the popular teen magazines, my partner and I wrote an article commenting on how the second list contradicted the first list. We asked the girls how they were to "be themselves" if they were all wearing uniforms from the Gap. In the discussion following the exercise, many girls described a system of "types" a person can be. They named the following categories:

- prep: well dressed, well made up and taken care of. The most desired of all categories for majority of girls. Can be a combination of this and another acceptable type.
- girly-girl: behaving too much like a girl
- slut: behaves in extreme sexual ways. Exploits herself for boys.
- tomboy: likes boys' things; like sports and worms. This behavior is expected to be outgrown by high school. After that point, it becomes unacceptable, uncool

- skank: unclean, not well taken care of, troublemakers. Lower class
- goody-goody: excels academically, tattletale, teacher's pet
- nerd: similar to a goody-goody, but lacks the air of a goody-goody, more self-conscious
- bitch: unable to get along with others. Boyfriend stealer. A general term that can be used in any situation
- wannabe: a determined outcast although tries to imitate the popular.

Of these types, only three—the prep, slut, and tomboy—were considered popular. The tomboy turned non-popular at a certain time in a girl's growth and the slut required the girl to either sexually exploit herself for boys or others must believe she has sexually exploited herself for boys. All the girls knew of and understood these labels. Outlining acceptable behavior and labeling girls in such ways evolved the crisis of popularity.

These defined categories framed the meaning of an exercise in which each girl was paired up with another she would not normally talk to or interact with--in essence, a popular girl was paired with a non-popular one. We had wanted the girls to have a chance to get to know someone they would not simply because they were not of the same status. We thought having them in pairs would lessen the influence being in a large group would have and they might open up to each other more. They were to separate into these pairs and talk for ten minutes. At the end of the ten minutes, they were to come back together and each was to "become" the other girl by introducing herself as the other to the rest of the group. Attempting this exercise removed all doubt, if there was any, that popularity status was of the utmost importance in the girls' social structure. The idea of being paired up with an unpopular girl revolted the popular girls. They screamed, argued, pouted and blatantly refused to talk to someone "out of their league." In turn, when some of the popular girls acted this way, the non-popular girls reacted in the similar ways. The non-popular girls I watched lowered their heads knowing that their partners felt this way about being paired up with them. They then become more aggressive as a group and physically moved together and expressed same idea that the popular girls had—they did not want to be paired up with them, either. Their reasoning, however, was different. They did not want to appear to be the pathetic end of the stick. Thus, they acted revolted at the idea also, but in fact, they wanted the opportunity to become friends with the "cool" girls in hopes that they would join the "cool" rank. If nothing else, they just wanted to be friendly with the girls so they would stop being so mean to them.

An example of the behavior of the popular girls can be shown through the actions of Mirra, a popular eleven-year-old, who was astoundingly cruel to the girl we had paired her up with. Mirra refused to go with her partner and begged to switch partners. Her behavior allowed the other girls to stand around waiting to see if I would give in to her plea. Mirra called her partner "stupid" and "ugly" in front of her, and whispered and laughed at her with the other popular girls. Katie, the inflicted partner, sat quietly with her head hung in embarrassment. A quick refusal on my part forced Mirra and the others to break into the pairs that we had put them into. After a period of forced dialogue, the group gathered and introduced their partners. When it came time for Mirra to introduce herself as Katie, she told how many brothers and sisters she had, where she went to school, and what grade she was in. Mirra had not learned anything about Katie, especially how she had made Katie feel. My colleague asked Mirra, "Katie--how did Mirra make you feel when she didn't want to work with you?" Mirra answered that she was not really Katie so she could not answer a question like that. Mirra then told Katie in the form of a question that if Mirra had hurt her feelings Katie would have told her--"right?" Having already been humiliated, Katie was not about to admit that Mirra had hurt her feelings; that would be subjecting herself to even more humiliation through vulnerability. By admitting her feelings had been hurt, she would be allowing Mirra to inflict more embarrassment. Letting Mirra know that she could make Katie feel bad was, in Katie's mind, social suicide.

This episode reinforced Michelle's earlier claim that a criterion of popularity was the ability to be mean to those "beneath you". It would be easy to say that these girls simply did not have a conscience, that they had no regard to each other's feelings and they were simply innately cold-hearted, but it went deeper than that. One girl that made this apparent was Lindsay, on whose face you could see a tinge of guilt for being exclusionary and mean to others. The discussion following the exercise was led by Lindsay. Lindsay was popular and stated that she did not enjoy being mean to others, but her fear of losing her status and being treated like "those other girls" was too great to stop her behavior. It was apparent that Lindsay was developing conflicted feelings as she tried to sort out her behavior Forcing Lindsay, through questioning her explanation, to verbalize her actions made her see how destructive her behavior was to the other girls' feelings. As for the other girls, they were informed by Lacey, the youngest girl in the group, that the goal of the exercise was to learn the importance of giving all girls a chance, because not doing so was not fair to either girl. She concluded that not doing so would result in someone getting treated badly for no reason and someone else missing out on a good friend. I do not believe I could have said it better than this insightful eleven-year-old.

Referring back to the "types" the girls, I pointed out that not are they only are a limited number of categories, but only three of the total were acceptable. The next exercise reveals and reinforces my concept that a limited acceptable "typing" system can effect a girl's sense of self and what she can accomplish. An exercise that illustrated this was titled "Draw a Scientist," from the Action Guide for Girls' Education developed by the San Francisco Bay Area Network for Girls. The task was to draw a scientist. The girls from the workshop repeatedly drew men, and not only men, but men with crazy hair standing on end with exploding chemicals or fires. All the girls drew unattractive people, most males, and all being stereotypical depictions of the mad scientist. This image was completely at odds with the image a girl must maintain to be popular. The popular stereotype of a "scientist" not only excluded women, but made the field of science seem "uncool" and "unfeminine." Mirra, after noticing her neighbor draw of one of the few women, said outright, "Girls can't be scientists!". Holly drew a female scientist working in the Pond's Institute of Technology. This was a welcome departure, yet implied that particular girl thought women could only be scientists in a pink-collar environment, like a cosmetics company. In this crisis of popularity, one cannot expect a girl who thrives off acceptance to pursue a field that is unaccepted by her peers. Breaking out of the acceptable roles, the types the girls identified, jeopardizes a girl's chance to attain this most wanted prize of being popular.

The next exercise was designed to demonstrate to the girls how it felt to be in different roles, roles like the ones they put on each other, unsubstantiated, with no basis. The girls were split into two groups and each group was to create a product and decide how to sell it. Unknown to them, our specific aim, based on their own description of popularity, was to reverse the treatment each received as a popular or non-popular girl. Taped to the forehead of each girl was a note card she had not seen, with instructions telling the others how to treat her. An example of the instructions on the cards were as follows:

-Treat me like I don't know what I'm talking about
-Treat me like I think I'm all that
-Ask me what I think
-Tell me what great ideas I have
-Laugh at everything I say

This array of treatments reflected what girls said they faced every day in school and in their peer groups. It was decided beforehand by my colleague and me that we would give them cards that either illustrated how they themselves usually treated other people or exposed them to better treatment than they usually received, depending on their popularity status. The announced goal, to create a product, necessitated abundant interaction. The non-popular girls enjoyed the exercise, where as the popular girls did not. In one group, several incidents occurred that can be linked to popularity. Lindsay, one of the popular girls, had the card "laugh at everything I say." She was visibly frustrated but kept saying aloud that she didn't care and what we were doing was stupid. Mirra and Erika, two popular girls, instigated an argument with another girl, Nicole. Nicole, a non-popular girl, was enjoying the opportunity to put down those who were routinely mean to her. When an argument arose among the three girls regarding an outside factor not pertaining to the exercise, it seemed as if playing out this role reversal gave Nicole an inner strength that made her stick up for herself against Mirra and Erika. The argument was quickly dissolved when a Teen Camp staff member approached them, and removed Mirra from the group. The popular girls were, for the most part, able to treat the unpopular girls with respect throughout the exercise. They shed the qualities Lindsay claimed were necessary to retain their popular status. I was excited to see them positively interacting with girls they did not usually interact with.

Afterwards, the girls were asked how they felt about getting treated the way they did. Katie, on whom Mirra had inflicted such horrible treatment during the introduction exercise, said she loved getting asked what her ideas were, it made her feel good even if she knew people were doing it only because they had to I posed the question that if the popular girls did not like being treated badly, what gave them the right to treat someone else that same way? This question received a few lowered heads from the popular girls and glowing smiles from the non-popular girls. The point was proven. Giving the girls tools to make their own behavior apparent let them realize how hurtful they could be. The fact that all of them saw it simultaneously meant that no one girl had to be the martyr, or stand up and declare their behavior unfair and demand they all change their ways. Such a protest had never occurred before because, as Lindsay said, there was a fear that if one were to cross the popularity line and say something, she might lose her status and become unpopular, and what girl would take that kind of risk? Understanding the notion of how hurtful and frustrating being declared unpopular can be, one must consider that asking a girl who has made it to popular status to compromise that status means asking her to knowingly set herself for the same horrible treatment she has delivered to another girl. Again, this perpetuates the crisis of popularity.

In the next exercise girls' telling work revealed yet another connection between aspects of their lives and popularity. To deconstruct stereotyped behavior for girls, I read "Girl" by Jamaica Kincaid to the girls and asked them to write their own version. "Girl" is a mother's voice, as heard by her young daughter, explaining how to be female in their culture. The intent of this exercise was to confront stereotypes placed on them because they were girls. Each of them was able to list many demands made on them simply because they were girls. One non-popular girl, Vikki, with much insight, wrote her version of "Girl":

> *Wash your face with soap, not just water. Wash your hair every day.*
> *No kissing like the boy you are so bent on becoming. Iron your dresses.*
> *Talk softly and sweetly not yelling and laughing loudly like the boy you*
> *are so bent on becoming. No playing sports. Instead knit and do*
> *embroidery. Walk slowly. Don't run like the boy you are so bent on*
> *becoming. Be nice and sweet. Be ladylike around boys and*
> *I'll bet you get a good man. "But why do I need a man at my age?"*
> *So you can get married and have a good life.*

Like Kincaid's "Girl", these were instructions Vikki's mother had given her. Yet many of these items did not appear on the popular girls' list of demands. They were already part of their regular behavior, for example, they already washed their face with soap, which was not a priority for Vikki. She was not "well-taken of." Vikki did not comply with these rules, she liked playing sports and sweating, she did not like to sew, and she certainly did not like to be ladylike around boys. Therefore, her peers, even her own mother, to whom this was a disappointment, did not consider her popular. Upon meeting Vikki's mother, it was apparent that she was embarrassed by her daughter's physical appearance. Vikki must have been aware of this disappointment and embarrassment on her mother's part to write such a piece. This revealed a reinforcement of the expectations put on a girl by her adolescent peers, their mothers.

Each of these examples given reinforced the reason the workshop was created and, in turn, also lessened the barriers popularity put on the girls. This workshop, lasting only a few short months and each session not being very long, had made a visible difference. We had helped them grow by giving them tools to realize, on their own, how their behavior effects them and/or those they mistreat, along with the original intent of the workshop to help girls discover the wonderful possibilities that lie within each of them. The girls who spent just the summer at the workshop and no longer have exposure to this kind of work are more likely to lose sight of what they did learn. I find this not surprising because the pressure of this crisis-forming behavior is so intense, a long ago workshop will inevitably lose out. This is why I believe in the importance of understanding this crisis, so it can be addressed and deconstructed continually, rather than in selective workshops. Addressing the issue of popularity, which I have theorized as the crisis of popularity, gave the workshop the edge that completed the circle to understanding why many times girls do not see all they are made of. To give girls an early edge over what lies ahead for them is essential in combating this crisis that I have defined.

REFERENCES

Action Guide for Girls' Education. San Francisco Bay Area Girls' Education Network. 1995.
Kincaid, Jamaica. At The Bottom of the River. "Girl". p. 3-5. Vintage Books, New York. 1978
Gilligan, Carol, Nona P. Lyons, and Trudy J. Hanmer. Making Connections The Relational Worlds of Adolescent Girls at Emma Willard School. Harvard University Press. Massachusetts. 1990

Production Scheduling of Flexible Manufacturing Cells

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A Flexible Manufacturing Cell (FMC) consists of a small number of individual computer controlled machines which can perform a variety of metal cutting operations under the supervision of a central computer. In this research, four different heuristic scheduling approaches for FMCs were formulated and their performances compared. A sophisticated computer simulation model was used to simulate an FMC. The best scheduling approach for the FMC under consideration is recommended based on statistical analysis of the simulation data.

INTRODUCTION

The modern economy of the free world is driven by competition. Through competition, prices vary according to demand, new products are rushed to market, and costs are low in order to gain competitive advantage. When it comes to competition in manufacturing, the most successful organization is often the one that can best create economies of scale without sacrificing product variety. Manufacturers in the United States have traditionally relied on mass production of standardized goods to achieve economies of scale. However, achieving the flexibility of offering large variety of products requires small batch sizes.

One possible solution to the classic productivity and flexibility dilemma is the use of flexible automation. Flexible automation differs from traditional job shop or flow shop and combines the advantages of both. Many different types of flexible automation exist, ranging from the modest stand-alone Computer Numerically Controlled (CNC) machine to the complex Flexible Manufacturing System (FMS). Flexible Manufacturing Cells (FMCs) are manufacturing systems smaller in scope than the FMS and consist of several CNC machines linked by an automated Material Handling System (MHS). Flexible automation is at the heart of the concept of the "factory of the future" which allows for an increased production rate, a wider variety of products, and uninterrupted round-the-clock operation. In addition to increased productivity and high variety of products, the benefits of flexible automation include reduction in the number of machines and equipment, plant space, skilled labor for machining operation, work-in-process inventory, and associated costs.

Flexible automation, however, creates an entirely new set of problems. Due to the complex nature of the machinery involved, efficient scheduling methods must be developed for scheduling jobs on these machines. Since these sophisticated manufacturing systems are fairly new, appropriate scheduling methods for them are not readily available. As a result, traditional job shop scheduling rules are normally used for FMCs and FMSs. However, these computer controlled manufacturing systems require better scheduling approaches for efficient performance. The purpose of this research was to develop such scheduling approaches for an FMC. In the rest of this paper, we present the configuration of the FMC, a set of four heuristic scheduling approaches formulated in this research, the simulation experiments test the performances of the scheduling approaches, and statistical analysis of the simulation data. Finally, we recommend the best scheduling approach based on results of the statistical analysis.

THE FLEXIBLE MANUFACTURING CELL

The FMC modeled in this research is a cell with an arrival buffer, a central work-in-process (WIP) buffer, five CNC machines with an in-shuttle and an out-shuttle for each machine, and a robot for material handling. The layout of the FMC modeled is shown in Figure 1. The arrival buffer for the FMC was modeled with unlimited capacity to allow experiments with very high levels of buffer

966

congestion. The central WIP buffer inside the cell was modeled with a capacity to allow a maximum of 15 work-in-process parts in the cell (including the ones at the CNC machines) at any given time. The limited WIP capacity provided with the FMC is consistent with the goal of low WIP inventory in flexible manufacturing. The in-shuttle and the out-shuttle for a CNC machine were modeled with a capacity of one each.

The FMC modeled was assumed to process seven different part types. It is reasonable to assume that seven different part types provided sufficient degree of scheduling complexity in the simulation experiments conducted for this research. The number of operations for the parts varied randomly in the range from 4 to 10. These operations were selected randomly from a set of 15 operation types. The sequence of operation types for a part type was also determined randomly. Each operation could be performed by any of the five machines. The processing time (minutes) for each operation for a part was also specified.

The material handling robot serves the five CNC machines for transfer of parts from and to the machines. It does not transfer parts from the arrival buffer to the WIP buffer. This part transfer is handled by a separate transport device. The transport velocities of the robot for an empty move and a loaded move are not the same. For simplicity, it is assumed that the move times between machines, machine to WIP buffer, WIP buffer to machine, and machine to the exit station are the same, although the model has the flexibility of specifying separate move times. The computer code for the simulation model was developed by Naik (1995) using SIMAN/CINEMA modeling package.

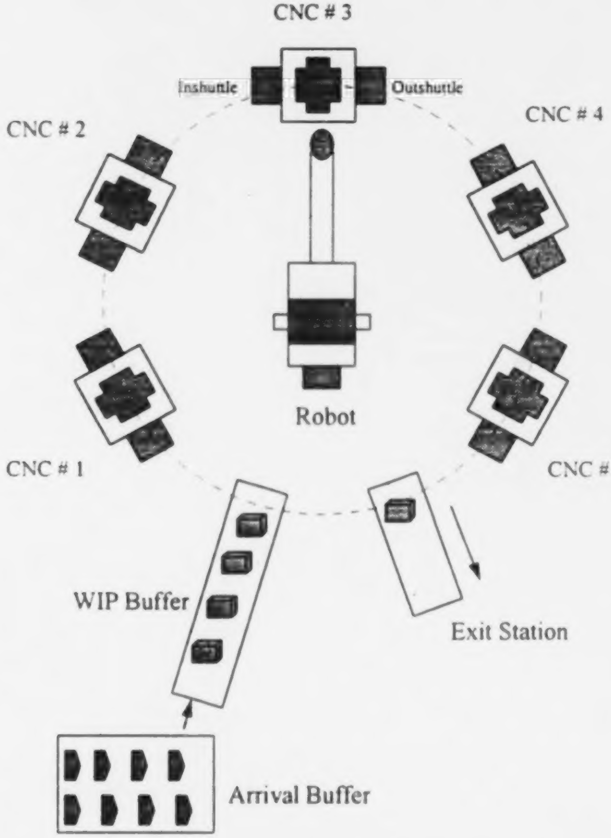

Figure 1. Layout of the FMC Used in This Research

FMC SCHEDULING PROBLEMS

FMC scheduling problems include determination of the sequence in which parts are input into the system, and determination of which operation of which part to begin processing on which machine at what time. The dynamically arriving parts have to be scheduled in an operation by operation basis or event by event basis in real time. Thus, real-time scheduling of an FMC essentially involves dispatching of individual operations of parts to available machines at any given scheduling point.

For the FMC studied in this research, the scheduling decision involves the following: selecting a job in the arrival buffer for moving to the WIP buffer when the space within the FMC becomes available as a result of finished jobs leaving the system, selecting a job in the WIP buffer to move to a machine when it completes its current operation and becomes idle, selecting a machine for a job when more than one machine become available to handle the same task. A set of four heuristic scheduling approaches were formulated in this research as described next.

H1 First-come-first-served (FCFS) rule was used for selecting a job from the arrival buffer and moving it to the WIP buffer. Earliest Due Date (EDD) was used to select a job from the arrival buffer to move to a machine that becomes available.

H2 FCFS was used to select a job from the arrival buffer. Shortest Processing Time (SPT) of the imminent operation was used to select a job from the WIP buffer.

H3 EDD was used to select a job from the arrival buffer and EDD was used to select a job from the WIP buffer.

H4 EDD was used to select a job from the arrival buffer and SPT was used to select a job from the WIP buffer.

If more than one machine became available for a job, the most underutilized machine was selected in each of the above four cases.

SIMULATION EXPERIMENTS

Simulation experiments were conducted for each of the four heuristic scheduling approaches described above. In addition, experiments were conducted for a benchmark case which used FCFS for the arrival buffer as well as the WIP buffer. Two performance measures were used to compare the scheduling approaches: mean flowtime and mean tardiness. The mean flowtime and mean tardiness values for the four heuristic scheduling approaches H1, H2, H3, and H4 were normalized with respect to the those for the benchmark case.

For each scheduling approach, experimental conditions were varied in 60 different runs for each case. Two different part type distributions, three different mean arrival time (exponential distribution), and 10 different random number streams (for the arrival process and part type distribution) were used resulting in 60 different combinations for each case. Each simulation run was carried out for a simulated shop time of 3 days (4320 minutes). A warm up period of 1 day (1440 minutes) was used and observations were recorded for 2 days (2880 minutes). Test runs indicated that these durations were appropriate.

STATISTICAL ANALYSIS OF DATA

A single factor ANOVA test was performed for each of the two performance measures: mean flowtime and mean tardiness. Four factor levels were used corresponding to the four heuristic scheduling approaches H1, H2, H3, and H4 described earlier. Type I error was specified at $\alpha=0.05$, and type II error was specified at $\beta=0.10$. Following an approach suggested by Neter *et al* (1990), the sample size of 60 was considered adequate in this research. The results of the ANOVA tests for the mean flowtime and mean tardiness are shown in Tables 1 and 2 respectively.

The results of the ANOVA test presented in Table 1 show that the performances of the four heuristic scheduling approaches are statistically equivalent. Since the F statistic is less than the critical value, there is no statistically significant differences in the average values of the mean flowtime. However, the results presented in Table 2 show that the average values of mean tardiness are not statistically equal since the F statistic is greater than the critical value. The lowest average value of mean tardiness occurs for H3 in this table.

CONCLUSIONS AND RECOMMENDATIONS

Simulation experiments were conducted using a computer model of an FMC. Data for the mean flowtime and mean tardiness performances of four heuristic scheduling approaches were obtained and analyzed statistically. No statistically significant difference was found in the mean flowtime performances of the scheduling approaches. The differences in the mean tardiness performances of the scheduling approaches were found to be statistically different. The mean tardiness performance of H3 was found to be slightly better than other approaches. Therefore, the scheduling approach H3 is recommended for the FMC studied in this research. Extensive further research with broader range of experimental variables is recommended for better understanding of production scheduling in FMCs.

Table 1: ANOVA Results for Mean Flowtime

SUMMARY						
Groups	Count	Sum	Average	Variance		
H1	60	54.42408	0.907068	0.034396		
H2	60	56.85404	0.947567	0.050253		
H3	60	52.52204	0.875367	0.043343		
H4	60	56.06074	0.934346	0.049135		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.18383	3	0.061277	1.38379	0.248385	2.642849
Within Groups	10.45049	236	0.044282			
Total	10.63432	239				

Table 2: ANOVA Results for Mean Tardiness

SUMMARY						
Groups	Count	Sum	Average	Variance		
H1	60	50.69331	0.844889	0.060285		
H2	60	60.58465	1.009744	0.121699		
H3	60	48.20681	0.803447	0.071745		
H4	60	58.5555	0.975925	0.112522		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.792745	3	0.597582	6.526475	0.000294	2.642849
Within Groups	21.6088	236	0.091563			
Total	23.40155	239				

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REFERENCES

Naik, B., 1995, A Knowledge-based Approach To The Management And Control of Flexible Manufacturing, Ph.D. Dissertation, The University of Wisconsin-Milwaukee.

Neter, J., Wasserman, W., and Kutner, H., 1990, Applied statistical Models, Third edition (Homewood, Illinois: Irwin).

Physical Attributions of Racial Stereotypes

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An experiment was conducted to investigate the effects of physical features on the priming of racial stereotypes. It was hypothesized that the presence of a picture would cue certain stereotypical racial schema in a participant and therefore he/she would respond more positively to statements consistent with a racial schema. Forty-six African American college students participated in the study. Participants were given a written text of a series of connected events that did not reference to any racial stereotypes. Half of the participants were given the text with a racially ambiguous picture attached the other half were not. Participants were given a questionnaire to asses their ability to recollect the events in the text. The questionnaire consisted of a variety of statements. The analysis indicates that there were no significant differences between the picture and non-picture groups as regards to the racially schematic statements. However, even in the absence to specific information, participants were more likely to reject the statements consistent with the Caucasian stereotype than the African-American stereotype $t(79)=2.23$, $p<.05$. These findings suggest that among African Americans, memory for events is influenced by racial schemas, possibly due to the nature, function, and consequences of prior social knowledge.

Racial stereotypes are a special case of interpersonal perception. They are usually simple, overgeneralized, and widely accepted (Brigham,1971). But stereotypes are often inaccurate. It is simply not true that all people with slanted eyes are Chinese or that all African Americans have big noses. Nonetheless, many social stereotypes concern highly visible and distinctive characteristics. These pieces of information are usually the first to be noticed in social interaction and can gain high priority for channeling subsequent information processing.

In 1954, Gordon Allport proposed that the stereotyping of racial and ethnic groups may be intrinsic to the cognitive system. That is, people over-simplify their experience by selectively attending to certain features of the information within the environment and by forming categories, concepts and generalizations to deal with vast quantities of available data. Tajfel and Wilkes (1963) found that identifying an individual as a member of a given group might engage the stereotype for that group, such that the individual's behavior would be interpreted in terms of the stereotype. For example, once you tag warm behavior as female, it may become motherly. The act of grouping persons into particular categories make the attributes of those categories especially salient.

The following experiment examines the role physical attributes play in the use of encoding information about people. Participants were given a written text of a series of connected events that did not make reference to any racial stereotypes. Participants were given a 40-item questionnaire to assess their ability to recollect the events presented in the text. Some of the items in the questionnaire were true statements, some were false statements, some were racially schematic statements, others were neutral statements that were equally likely to be consistent or inconsistent. It was hypothesized that the presence of a picture would cue certain stereotypical racial schema in a participant, and therefore he/she would accept statements consistent with a given racial stereotype.

METHOD

Participants

Eighty volunteers (46 women and 34 men) participated in the experiment. Some of whom were college students, others were adults from within one hour of the surrounding neighborhood. The average ages ranged from 18-60, (M=36).

Materials

Cover Task: The task required images to be formed of objects or people and rate the vividness of aspects of the images so formed. There were two groups of image items. Group 1: a dog, a radio, a house, and children in a playground. Group 2: a man, a clock, a supermarket, and a group of people in a hallway. The rating scale ranged form 1 to 5 , where a score of 1 implies an image as clear and vivid as normal vision and a score and a score of 5 implies no image formed at all. This task was used only as a cover task.

Story: A Day in the Life of Mr. X. A story was written to describe a series of events that could be describing the events in the daily life of a student, such as taking a quiz and shopping at the supermarket. The story was written in first person. A tape recording of the text was also used.

Questionnaire: A 40-item questionnaire was constructed. There were (1) 10 True statements that were rewordings of actual sentences that had occurred in the previous story; (2) 10 False statements that were contradictions of sentences that had previously occurred; (3) 10 Racial Inference statements were inference items related to the issue of racial schema. These schema-related inferences were of two types: either consistent with a Caucasian racial schema or consistent with an African-American racial schema. There were also (4) 10 neutral inference statements. Five of the ten inferences were positive, such that it was probable that it was a stated action or event in the previous story. The other five were inferences that were negative, were improbable or contrary to an action or event explicitly stated in the story.

Procedure

The subject was given the cover task before and after the story. The instructions for the cover task were told verbally. The experimenter explained that the experiment was a study of mental imagery, to asses one's ability to form mental images. They were then told to form mental images of the following objects or people and rate the vividness of aspects of the images formed. The range of the rating scale was explained. They were asked if they had any questions. If so, the instructions were repeated or paraphrased as often as necessary until he/she understood what was to be done. The subjects were then given the imagery items from group 1.

After that segment of the cover task was completed, subjects were then asked to listen and read a sequence of connected events and form mental images of said events. The experimenter placed the covered text in front of the subject. The text was not uncovered until a tape recording of the experimenter reading the text was activated. When the recording was finished, the experimenter stopped the tape recorder and removed the text from the subjects view. Subjects were then given the imagery items from group 2 of the cover task. The same instruction were told again verbally. Upon completion, the experimenter handed he/she the questionnaire. The instructions were read out loud.

> "Please read each statement carefully and indicate how each statement is consistent with the story that you heard and read. The scale goes from:-3 to +3. Where completely inconsistent would be -3 and completely consistent would be +3. A rating of zero was to be given if the statement is equally likely to be consistent or inconsistent with the statement." Two examples were given using a statement from the text. Then subjects were reminded, "Please note that this is not a questionnaire of how well you remember the exact information in the story. But the consistency to which your mental images coincide
> with story."

Each subject was not given a fixed time to finish the questionnaire. Subjects were run individually.

RESULTS

As shown in Table 1, the means and standard deviations of the types of statements illustrated that the subjects responded in accordance with the nature of the statements. Subjects tended to answer positively to the true statements, negatively to the false statements, and impartially to the neutral inference statements.

Table 1: Means and Standard Deviations of Types of Statements

	Total		Pitcure		Non-Picture	
Type of Statement	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
True	1.51	.61	1.40	.59	1.68	.62
False	-1.56	.69	-1.49	.84	-1.64	.42
Schematic Positive	.88	1.05	.68	1.08	1.12	.96
Schematic Negative	.61	.98	.69	1.05	.51	.89
Racially Schematic	-.35	.61	-.33	.66	-.38	.55

A t test was conducted, using the type of picture as a factor on the racially schematic statements indicated that there were no significant difference between the picture and non-picture groups. Also shown by Table 1, subject tended to reject or were indifferent to a racially schematic statement. However, it was found that the likelihood for subjects to reject the Caucasian schematic statements than the African American schematic statements was statistically significant, $t(79) = -2.23$, $p < .05$.

DISCUSSION

The hypothesis that the presence of a picture would cue certain stereotypical racial schema was not supported. There were no significant differences between the picture and non picture groups as regards to the racially schematic statements. Nevertheless, as illustrated by Table 1, there was a difference of True and Schematic Posistve statements between the picture and non-picture groups. The non-picture group responded more positively to the True and Schematic Positive statements. Participants who had not received a picture seemed to be more certian in their responses of what was consisitent and what was not consistent. The schema of the non-picture group was probably cued internally, by prior social knowledge, rather than cued externally, by the picture given. Also there was a difference between the neutral inference statements and racially schematic statements. Participants were able to recognize the neutral inference statements from the racially schematic statements, to classify which statement were probable and which just did not conform with thier racial schema.

The lack of a significant difference between the picture and non-picture groups, can possibly be attributed to the racial ambiguity of the picture shown. Participants denied the cue of a racial stereotype, perhaps because the cue itself wasn't adequately distinctive. If they had been shown a picture of a self-identified African American or a self-identified Caucasian, the cue would have been more pronounced and therefore, the categorization process more precise.

Even in the absence of specific information, surprisingly, participants were more likely to reject the statements consistent with the Caucasian stereotype than the African American stereotype. These findings suggest that among African Americans, memory for events is influenced by racial schemas. This can be explained by the fact that stereotypes structure the interpretation of ambiguous events so they can be assimilated to prior beliefs (Duncan, 1976). In a study by Duncan (1976), for example, Caucasian participants tended to describe an ambiguous shove as "violent" when the perpetrator was African American, but described the act as "aggressive" or "horsing-around" when the perpetrator was Caucasian. Secondly, stereotypes structure relatively unambiguous evidence in a self-confirming manner by the selective learning or selective remembering of events that corroborate the initial expectancies. (Duncan,1976).

Secord and Berscheid (1964), found that traits contained in the African American stereotype tended to elicit other stereotyped traits to a greater extent than they elicited non-stereotyped traits, regardless of the stimulus person's race. Tajfel, Sheikh, and Gardner (1963) showed that members of a stereotyped group are judged more similar on traits which are part of the stereotype than on traits which are not.

REFERENCE

Allport, G.W. (1954) The nature of prejudice. Addison & Wesley, Cambridge, Mass.

Brigham, J. C. (1971) Ethnic stereotypes. Psychological Bulletin, 76, 15-38.

Duncan, B. L. (1976) Differential social perception and attribution of intergroup: Testing the lower limits of stereotyping blacks. Journal of Personality and Social Psychology, 34, 590-598.

Secord P. R. & Berscheid E. S. (1963) Stereotyping and generality of implicit personality theory. Journal of Personality, 31 65-78.

Tajfel, H., Sheikh, A. A.,& Gardner, R.C. (1964) Content of stereotypes and the inference of similarity between members of stereotyped groups. Acia Psychologica, 22, 191-201.

Tajfel, H., & Wilkes, A.L. (1963)Classification and quantitative judgement. British Journal of Psychology, 54, 101-114.

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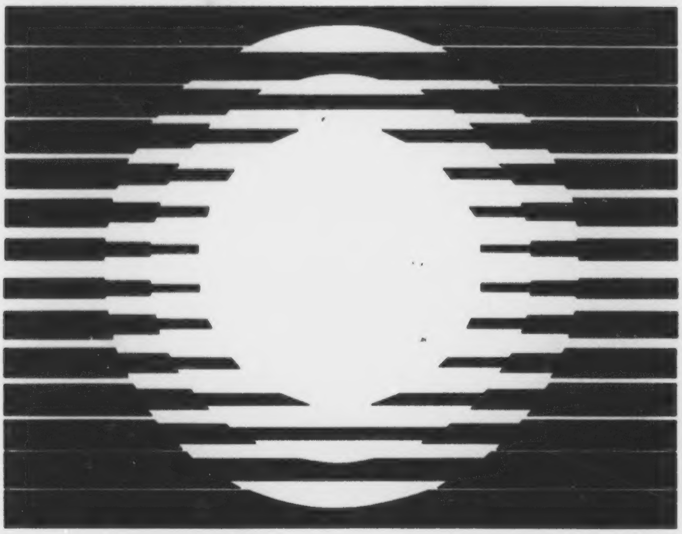

PROCEEDINGS

ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

Robert D. Yearout
Editor

Volume III

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THE UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE

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VOLUME III

THE UNIVERSITY OF NORTH CAROLINA at ASHEVILLE

JULY, 1997

Foreword for the

Proceedings of the Eleventh National Conference on Undergraduate Research

University of North Carolina at Asheville
April 24-26, 1997

The University of Texas at Austin was pleased to host the 1997 National Conference on Undergraduate Research, affirming its commitment to excellence in undergraduate education and to the research experience in particular. Over 2100 students and faculty attended some 1500+ oral, poster and performing or visual arts presentations scheduled over April 24-26. A special feature of NCUR '97 was a series of more than 30 presentations by faculty members from all disciplines demonstrating the integration of research and teaching with the new technologies. These presentations were capped by a performance on Saturday night of "Ears and Feet," a concert of new interdisciplinary work by student and faculty composers, choreographers, dancers and performers from the UT College of Fine Arts. Electro-acoustic music and modern dance explored interactivity of disciplines and technologies by allowing dancers' movements to control electronic music and robotic lighting by way of a touch-sensitive computer dance floor.

President Robert M. Berdahl opened the conference quoting a Chinese proverb: "I hear and I forget. I see and I remember. I do and I understand." Berdahl praised the research experience as the most practical and potent method to provide students the perspective of inquiry, innovation and exploration as they prepare "for a future that is not so much known to be uncertain, but instead, certainly unknown." That facts and methodologies become obsolete in a world in which developments and advances occur with dizzying rapidity points to the importance of incorporating research activity into the undergraduate experience.

Dr. Berdahl also praised the student-faculty relationships that are fostered by the research process, congratulating the faculty mentor for serving the educational needs of the talented and motivated students by participating in the adventure of exploration and discovery, of cooperation and collaboration which characterize academic life.

Five distinguished plenary speakers addressed conference participants throughout the three days. Dr. Steven Weinberg, Nobel laureate in physics and professor at the University of Texas at Austin, challenged listeners to consider the future of science by posing the questions "The End of Science?". Dr. Robert Williams, Director of the Space Telescope Science Institute, dazzled the audience with the most recent images from the Hubble Space Telescope. From the vastness of space to the minute complexity of genetic research, Dr. Steven McKnight of the UT Southwestern Medical Center at Dallas introduced conference participants to the fascinating work being done in gene regulation and cell differentiation. Friday night's fete "Texas Culture Swing" featured, in addition to an outstanding sampler of culinary and musical styles of the Lone Star state, a mini-plenary address on the multifaceted aspect of Texas border cultures by Dr. Rolando Hinojosa-Smith, distinguished author and professor of Creative Writing. NCUR 97 closed with a resounding standing ovation upon conclusion of "The Challenge of Leadership" by Sarah Weddington, J.D., former Texas legislator and White House assistant, now author, lecturer and adjunct professor.

The University of Texas at Austin is proud of the privilege to share our campus for these few days with the distinguished group of students and faculty whose work is presented here in published form. We congratulate you for your accomplishments and encourage you to continue to participate in the challenge of research.

Susan Wells Howard, Chair, NCUR '97

PREFACE

The 407 papers published in these five volumes are representative of the approximately 1825 papers and posters presented at the celebration of undergraduate research that was NCUR '97'. The faculty, staff and students of the University of Texas at Austin are to be commended for making NCUR '97' such an enriching experience. The student authors deserve recognition for their hard work and for their persistence in seeing their research through to its final publication.

Special thanks are extended to Dr. Susan Howard, Ms. Kelly Johnson and other members of the NCUR '97' staff. Their help during the days of the Conference was invaluable. Many thanks also to the members of the National Board, who reviewed a large number of papers submitted to the Proceedings under time constraints. Their continued efforts to standardize has raised the Proceedings quality. This project would have not been successful without their assistance.

I would also like to thank the UNCA Editorial Board, who put in many long hours reviewing, checking and organizing papers, and Tracy Walker, and Adam Bradley, who did all the cutting and pasting necessary for these volumes. I owe a special debt of gratitude to Katherine Whatley, Tracy Walker and Mila Cleverdon for their support, encouragement, and mentorship during the entire process of organizing the Proceedings.

To all the students who submitted papers to the Proceedings go thanks for their participation and congratulations for their achievements. Your enthusiasm and achievement will serve as role models for the next group of student researchers - whom we look forward to meeting at the Twelfth National Conference on Undergraduate Research at Salisbury State University, Salisbury Maryland.

Robert D. Yearout
UNC at Asheville
1 July, 1997

978

PROCEEDINGS OF THE ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

CONTENTS

VOLUME I

FOREWORD iii.

PREFACE iv

ARTS AND HUMANITIES

Collaborative Art: A Movement in the Twentieth Century 1
Kristen Jo Kerr (Jane-Allen Mckinney)

Nature and the Natural in the Paintings and Prints of Helen Frankenthaler 6
Danielle G. MacCartney (Debora Rindge)

A Comparison of Frank Lloyd Wright and Michael Graves: Furniture Influenced by Architecture 9
Nieya C. Wallace (Jane-Allen McKinney)

Art Education: Art is Underrated as an Instrument for Teaching Essential Learning and Cognition Skills 14
Jennimarie L. Ward (Jane-Allen McKinney)

Toontown: The Disney Tradition Continues 18
Jennifer Lugg (Dianne S. Macleod)

Political Ideologies of Harlaxton Gardens, Harlaxton, Lincolnshire, England 23
Nicole L. Stutzman (Shirley Schwarz)

Reminders of Death and Lessons for Life: Vanitas and Memento Mori Paintings of the Spanish Golden Age (1556-1700) 27
Wendy Singer (Susan V. Webster)

Visualizing the Human Form: Art and Anatomy in Eighteenth-Century England 31
Erin M. Loos (Philip Wilson)

The American Canon: Great Male Playwrights and Their Female Characters 34
Michelle McGovern (Mark Pizzato)

Henry Purcell's Dido and Aeneas: A 1689 Composition Endures Controversy 39
Stacy M. Dieckman (Patricia Kazarow)

Determining the Authorship of the Toccata and Fugue in D Minor, BWV 565 44
Aaron Juhl (Patricia Kazarow)

Plains Attire: The Individual Expression of Culture, the Cultural Expression of Identity 48
Sherri A. Mainord (Anne Guernsey Allen)

Victim vs. Participant: A Comparison of Dmitri Shostakovich's Lady MacBeth of Mtsensk and Katerina Ismailova 53
Heather Miller (Charles McKnight)

New Possibilities in Composition Through Computer Technology 56
Christopher Watts (Daniel Koppelman)

The Conception of "Poet" in the Work of Bei Dao 61
Jennifer L. Berry (Martin Backstrom)

Bei Dao's Poet 66
Jennifer L. Berry (Martin Backstrom)

"There Is No Loneliness Like Theirs": James Wright's "A Blessing" and C.K. Williams' "On Learning of a Friend's Illness" Examined 71
Kirsten C. Bender (William Aarnes)

Embrace of Dionysus The Presence of African Art In D.H. Lawrence's Women in Love 76
Kristin A. Frey (Eric Chandler)

A Poststructural Analysis of Richard Wright's "Big Black Good Man" 80
James S. Guignard Jr. (Jill Sessoms)

William Shakespeare's Othello: The Moor of Venice A Case Study in the Thermodynamics of Evil 85
Roger A. Harris (Linda K. Barlow)

Wilde's Christ: Exemplifying Aesthetic Morality 89
Elizabeth M. Hendershot (Daniel Born)

Pearl's Scarlet Soul: The Influence of Spenser's Una on Hawthorne's Ideal Vision of Daughters 93
Tracy Ann Kennedy (John C. Bean)

Agrarianism in the American South: From the Vanderbilt Agrarians to Wendell Berry, A Shift from Regional Myth to Practicable Ideal 98
Robin Kidd (John Cawelti and David Hamilton)

Margaret Fuller's Women in the Nineteenth Century: An Appeal for the Inclusive Self 103
Jeanne Kolker (Sara McAplin)

The Paradox of the Crucifixion Allegory in Ben Franklin's "The Kite Experiment" 107
Sandra Argroves Watson (Steven L. Hamelman)

The Doorway to Wildness: Four Poems by Muriel Rukeyser and Adrienne Rich 112
Trace V. Wilson (Richard Chess, Michael Gillum, and Jeff Rackham)

The Relationship Between Cognitive Growth, Journal Writing, and the Development of Critical Thinking 117
Lynn Herink and Anna Long (Larry Nichols)

Images of Health in Health Magazines 122
Travis Bebout (Sarina Chen)

Blissfully Rude: The Diatribe of ACT-UP 127
Mark S. Buchanan (Suzanne E. Lindsey)

Eyewitness vs. Pseudo Reality: A Comparative Analysis of Student's Accounts and the Media Reports of a University Disturbance 132
Ben L. Daniels (Sarina Chen)

Light in the Crevice Never Seen: The Indigenous Voice and the Rhetoric of Resistance Literature 137
Blayne M. Higa (Catherine A. Collins)

Marketer's Use of Semiotics and Symbolic Representation of Children's Packaging 142
Reagan Turok and Heidi Redeker (Lois Smith)

Same-Sex Marriage Politics: The Politicizing of Sexual Orientation 147
Kari Wagener (Phillip Voight)

"Do As Little As Possible" The Transformation of Film Noir's Myths in Chinatown 151
Karen Demski (Chris Hassold)

Outside Looking In: Sacred Space of Taos Pueblo 157
Brenda L. Hanson (Anne E. Allen)

Directed By and Starring Cindy: Sherman's Performance Photography 161
Jennifer Lemmer (Cris Hassold)

Reinterpreting Roman Morality 166
Ryan Pesch (Marleen Flory)

Edna St. Vincent Millay: A Feminine Perception of Love 170
Mandy C. Carlson (Lysbeth Em Benkert and Jay Ruud)

The Romantic Paganism of Niccolo Ugo Foscolo: Infancy, Greece, Venus, Exile, Pain, and Death in the Foscolian Artistic Sensibility 174
Mark Anthony Espinosa (Andrea Baldi)

Subject Pronoun Usage in Mexican Spanish in South Texas 179
Javier M. Morin and Carla Chapa (Sandra Baumel-Schreffler)

I, Tituba, Symbol of the Antilles 183
Debbie Officer (Margarite Fernandez-Olmos)

A Profound Cultural Exchange: The Mexican Muralist Movement and the Harlem Renaissance and its Modernist Descendants 187
Alice Psirakis (Raysa Amador)

The Issue of Status in Puerto Rico: Internal Strife in the Search for Status 192
Mandy Robinson (Paul Simon and Maria Dolores Goddard)

Multinational vs. Global Organizations: A Case Study of the Corporate Culture of IKEA 197
Katherine J. Ross and Saturnia Alcala (Peter Hackbert)

The Creation of Christianity: Exploring the Role of Women in the Development of the Ancient Church 202
Jennifer L. Borden and Kevin S. Minoli (John R. Lanci)

For Better or For Worse: The Case For Gay Marriage 205
Kathrine Ehrlich (Laura Purdy)

The Mother-Daughter Relationship of Harriet Taylor Mill and Helen Taylor 210
Amy M. Kuhl (Jo Ellen Jacobs)

Pragmatic Faith in John Dewey and Fyodor Dostoevsky 215
William D. McCracken (Stuart E. Rosenbaum)

Epistemological Conditions: How Plato Anticipates Gettier 220
Andrew T. Cronan (A.M. Weisberger)

Adversity and Sacrifices: The Examination of Two Lives 224
Patience Adibe (Harriette Pipes McAdoo)

The Acquisition of Knowledge According to the Theory of Jean Piaget 229
Donna M. Cain (Ralph Carlson, Dalinda Rodriguez, Raymond Welch, and Keith Turner)

A Descriptive Survey of the Three Contemporary Approaches to Fluency Disorders 234
Peter Golleck (Raymond Welch, Barbara Johnson , Teri Mata-Pistokache, Timothy Meline, and Keri Parchman-Gonzalex)

Cosmos and Chaos: An Analysis of Themes and Issues in Doris Lessing's The Fifth Child 238
Anna C. Long (Hamida Bosmajian)

Toni Morrison's Sula: The Pharmakos of Her Community 243
Joseph Van Mieghem (Hamida Bosmajian)

Proceedings — NCUR XI (1997)

The Search for Innocence in the Art of Jean Cocteau 249
Erin Nicole Parisi (Alexandra Wettlaufer and Jonathan Bober)

Preferences of Positive Reinforcers Among Elementary Students 253
Kelly Schutte (Lian-Hwang Chiu)

Implementation of Civil Rights Policy in Education 257
Autumn Stewart (Carter A. Wilson)

Jewish Resistance to the Nazi Occupation of Lithuania and Belarus during World War II 260
Phillip C. Alloy (L. Wilcox)

Peddling Public Assistance: The Children's Bureau and the Aid to Dependent Children Program in the Social Security Act of 1935 263
Katherine E. Anselmo (Helen Wheatley)

A Case Study of the Tax Reform Initiative by Marylanders 268
Juanita Maria Banks (Abdul Karim Bangura)

Famous and Forgotten: The Life and Death of the Dubuque Dial, 1934-1935. 272
Katherine Dietrich (Michael Anderson)

The Stonor Letters and the Wars of the Roses: Violence and Politics in Fifteenth-Century England 276
Michelle Dowd (Richard Kaeuper)

Thomas Becket and King Henry II A Medieval Drama with a Contemporary Application 281
Lorie Fratz (George Sochan)

The Mushroom of Feeling: American Public Reaction to the Atomic Bomb, 1945. 285
Jason C. Gaskill (Larry Lipin)

Henry Laurens: The Making of a Revolutionary 289
James Hutchinson (Bruce Greenawalt)

Beyond the Imperialist V Anti-Imperialist Dichotomy: American Intellectuals and Fin De Siecle Expansionism 294
Robert James Kijewski, Jr. (David Worbel)

"Being Madame is a Miserable Job" The Letters of Liselotte von der Pfalz, 1672-1722 299
Christie King (Caroline Castiglione)

Fencing out the Foreigner: Influences on the Eighteenth Legislature of Wyoming and its Exclusion of Foreign Physicians 304
Susan Macki (Eric Kolher)

A Woman's Place: Female Tavern and Inn Keepers in Early Pennsylvania 310
Sarah E. Morgan (Larry Eldridge)

The Debates and Arguments Leading to the Passage of the Seventeenth Amendment 314
Tara M.E. Yencha (Deborah A. Rosen)

Jane Addams: Women-Based Political Actor as Role Model 320
Oona Besman (Susan Harrison)

Lesbian Perspectives on Love, Sex and Relationships: Adult vs. Youth 325
Angelica Victoria Hernandez (Mary L. Alpaugh)

Women's Body Image: Effects of Media Imagery and Anorexia Nervosa 330
Grace Lager (Susan Harrison)

Testing the Effects of Sample Composition and Context on Radiocarbon Dating from Mammoth Cave, Kentucky 335
Sarah McCloskey (Kenneth B. Tankersley)

Three-Dimensional Mapping of the Bluff Greathouse Archaeological Site 339
Natasha Psenicka (Lawrence B. Conyers)

Scholarly Sightseeing in Rome, Ravenna, and North Africa: The Differences in Early Christian Centrally Planned Vaulted Structures 344
Benjamin D. deLee (Christine Colley)

Self-Perceptions and Representations of Hawaiian Identity, Ke Kanaka and Ke Kane Ikaika 349
Cheryl Nohealani Olivieri (Margarite Fernandez-Olmos)

Mexican Catholicism: The Syncretic Result of the Spanish and Indigenous Religions in Contemporary Mexico 352
Helena E. Colyandro (Susan Deans-Smith)

Rocky Road: The Long Journey to Educational Freedom in Prince Edward County 357
Randy A. Jones (George Bagby and Lowell Frye)

VOLUME II

SOCIAL SCIENCES

Preclassic Maya Pottery From Colha, Belize 362
Sharon Hankins (Fred Valdez, Jr.)

Deciphering the Secrets of Skeletal Remains from Hellenistic Abdera, Greece 367
Thomas P. Bolioli and Tara M. Kirkpatrick (Anagnosti P. Agelarakis)

Japanese Unknown Women Under the Japan's Alliance Capitalism: The Complementarity of the Pre-Existing Structures and the Changing in Identity 373
Yumi Kobayashi (Jeffrey Broadbent)

Window Into the Past: Diachronic Aspects of Three Ancient Human Skeletal Populations from the Khao Wong Prachan Valley in Central Thailand 377
Anna Konstantatos (Anagnosti P. Agelarakis)

Whole Vessels from Kichpanha, Belize: Implications of Increasing Social Complexity 382
David A. McDow (Fred Valdez, Jr.)

Form and Function of Late Preclassic Maya Pottery 387
Angela Milliman (Fred Valdez, Jr.)

Southern Plains Powwow Culture: Exploring the Identity of the Drum 392
Cindy Stout (Sue Tuohy)

The Sexual Oppression of Women in South Korea 397
Tuesday M. Tamburri (Leslie Miller-Bernal)

Evaluation of a Summer Orientation Course for New College Students: Critical Reading and Reasoning 403
Hernan E. Diaz (Sharon L. Pugh)

The Association of Peer Acceptance and Social Behavior in Early Childhood 406
T. Gayle McLemore (Leslie Phillipsen)

The History of the Civil Rights Movement in Prince Edward County, VA (1951-1964) 411
Steven L. Turner (Susan H. Bagby)

Qualitative Research on the Teaching Methodology of Genetics 348: A Hands on Approach 416
Tia Fluegge (Sandra Tutwiler and Presley Martin)

Spatial Distribution and Socio-Economic Profile of Asian Indians 421
Aaron Otto (Jayati Ghosh)

Intra-Asian Direct Investment and Indian Economic Liberalization 426
Susanne Peters (Jayati Ghosh)

The Spatial Distribution of the Hispanic Population in the United States: An Analysis at Various Geographic Scales 431
Stephanie M. Sheetz (Robert Douglas)

A Quantitative Study of Communication Apprehension and Self-Esteem 436
Mattie Marie Butler (Abdul Karim Bangura)

Attraction Factors Involved in Internet Relationships 441
Karen Chain, Christopher Gill, and Dawn Kujawski (Dean Thomlison)

Wartime Benevolence: A Portrait of Northern Philanthropy During the Civil War 446
Kevin Davis (Bruce S. Greenawalt)

Media and the Construction of Identity: Young Women's use of "Friends" 451
Kristi L. Eaves (David B. McLennan)

Dress and Nonverbal Communications 456
Barbara Heinemann (Joanne B. Eicher)

Confronting Learning Disabilities: A Proactive Approach for Parents 461
Holly Kapp (George Sochan)

Public Perceptions of Television Versus Newspaper Credibility: A Local Study 465
Andrea Lawson (Mark D. West)

The Evidentiary Impact of the Likelihood Ration and Assessment of Diagnosticity 470
Nir Liberboim (Jonathan Jay Koehler)

Solitary Confinement: A Study of Prisoners' Access to the News Media 475
Michael O'Sullivan (Ann Marie Major)

The Conveyance of Socioemotional Cues in Computer-Mediated Communication: A Content Analysis of Internet Relay Chat 480
Kimberly K. Schaefer (Denise Bostdorff)

You Eat What You Are: An Investigation of Key Environmental Variables on Food Choice 485
Laurel Y. Shamaman (James Brancato)

The Nurse-Patient Continuum: A Nursing Model 489
Jackie Boak, Elizabeth Dickerson, Melissa Jackson, Teri O'Quinn, and Cathleen Fabiani (Margaret Erickson)

Assessing the Effects of HIV/AIDS Peer Education on High School and College Freshmen 493
Cara Catalino, Erin Clune, Megan Gordon, and Marie Neilan (Patricia A. Bailey and Donna R. Carpenter)

Relationships of Self-Perception of Balance, Technological Measures of Balance, and Fall Events Among Individuals with Parkinson's Disease 496
Kativa L. Leal (Nancy E. Dayhoff)

Depression: Prevalence, Causes, Manifestations, and Repercussions Associated with Elderly Disability 501
Nicole Lovell (Clyde B. Killian)

Medical Costs and Correlates of Gunshot Wounds in Travis County, 1995 506
Jennifer L. Moren (L. Michelle Issel)

Family Caregivers' Perceptions of Pallidotomy Surgery: Expectations, Satisfaction, and Health Dysfunction 511
Polly K. O'Brien (Jane Backer)

Living on the Health Care Drawing Board: An Analysis of the Availability of Health Care to Low-Income Families in Los Angeles 515
William Ortiz (Leslie Howard and Cheryl Swift)

Fathers, Food, and Fun: A Nutrition Education Program for Low-Income Urban Fathers and their Children 520
Donald C. Sweet, Lisa Gemlo, and Jennifer Ruffing (Debra Palmer Keenan)

Accounting for the Effects of Hurricane Hugo 523
Tulani Giscombe (Mary Jones Phillips)

Changes in Smokeless Tabacco Utilization Patters Among School-Aged Children 526
Mark A. Robinson (Don Lisnerski, Bob Yearout, and Cheryl McClary)

Detecting Hidden Periodicities in Business Cycles of Fifteen Countries Using Fourier Analysis 530
Peter Hlavaty (Edward Gamber and James DeVault)

Effects of Foster Care on Perceptions of Family and Family Functioning 534
Judy Meyer (Beverly Curry)

Retailer Country Bias Cues: An Experimental Approach 538
Erin C. Miller (Sherry L. Lotz)

Matching Cultural Value Orientations to Ad Appeals: Exploring the Role of Individualism-Collectivism in the USA Versus Mexico 543
Michael Mosley (James M. Munch and Gary D. Gregory)

Vertical Integration and Profitability 548
Cecelia Ruth Buchanan (Stephen Schmidt)

NAFTA and Jobs in the United States 553
Kristina Carrico (Rutilio Martinez)

Gender Differences in Investment Expectations 558
Teresa D. Harrison (Rosemary T. Cunningham)

Do Dollars Make a Difference? The Relationship Between Expenditures and Test Scores in Pennsylvania's Public Schools 563
Jonathan M. Klick (Charles Zech)

The Income Distribution Effects of IMF Balance of Payments Stabilization Tools: A Case Study of Monterrey, Mexico 569
Charlotte Opal (Perry Patterson, Michael Lawlor, and Dan Hammond)

Tests of the Induced Innovation Hypothesis in Indian Agriculture 574
Anthony Walsh (Kailash Khandke)

A Qualitative Study of the 1994 Voter Turnout in Prince George's County Executive Election 579
Kirk A. Gordon (Abdul Karim Bangura)

A Test of the Efficacy of the University of Maryland College Park Affirmative Action Program 584
Shamica Monique Jackson (Abdul Karim Bangura)

From Critique to Consensus: Stephen White's Pursuit of a Postmodern Politics 589
Ingrid A. Jendrzejewski (David Gugin)

A Quantitative Study of the High School Attrition in Prince George's County, Maryland 594
Dorothy Lyons-Wilson (Abdul Karim Bangura)

Race in the Balance: Case Study of Escambia Treating Company 599
LaRuby May (Carolyn Johnston)

Aid in Transition: Explaining Post Cold-War Trends in House Foreign Aid Voting 604
Scott R. Meinke (John R. Baker)

A Quantitative Study of the Essence of Federalism: Who Does it Benefit? 609
Kim Odoms (Abdul Karim Bangura)

The Concepts of Community and Individualism in Twentieth-Century Presidential Nomination Acceptance Speeches and Inaugural Addresses 614
Stephen V. Potenza (James E. Underwood)

A Comparative Study of the Levels of Political Socialization of Children in Two New Hampshire Towns 619
Kathleen M. Ridolfo (Clark Hubbard)

A Qualitative Study of Minority-Majority African-American Congressional Districts and African-American Representation in Congress 623
Marvin M. Silver (Abdul Karim Bangura)

A Quantitative Study of the Longevity of Vietnam-Era Disabled Veterans 628
Joseph L. Singleton, Jr (Abdul Karim Bangura)

The 1996 Albanian Elections: Corruption? Or a Catalyst for Democracy? 632
Christopher Thomas Johnson (Karen Vogel)

The Role of the International Law of the Non-Navigational Uses in International Watercourses in Resolving the Disputes Over Access to Freshwater in the Middle East 637
Jason Woolwine (Gary Prevost)

Trends in the Eisenhower Administration: A study of Inflation, Unemployment, and Presidential Popularity 642
Shadya Y. Yazback (James Lindeen)

Strategizing Advocacy: Theoretical Frameworks in Grass Roots Social Organization 646
Tamie M. Aceves (Manuel Carlos)

Peering into the Success of Peer Feedback: Understanding how Feedback Works in Elementary-Aged Writers 651
Laura Angyal (Matthew Olson)

The Impact of Acculturation Type, Stress, and Social Support Among Mexican-American Adolescents 655
Elsa C. Arroyos (Enedina Garcia-Vazquez)

Physiological Responses to Racist Stressors Among African-American College Students 660
Jamar Barnes, John A. Oliver, and Foye Smith (Vernessa R. Clark)

Gender Differences in Perceptions of Marital Infidelity: Sexual Versus Emotional Cheating 664
Anne-Marie Bartos and Allison D'Auteuil (Ralph J. McKenna)

Childhood and Adolescent Abuse, Fear of Negative Evaluation, and Social Interaction Self Statements: A Correlational Analysis 670
Patti Beth (Barbara Beaver)

Coping Strategies Among African-American and Caucasian Female College Students 675
Ayannah A. Brower, Afiya Ricks, and Foye A. Smith (Vernessa R. Clark)

The Effects of the Administration of Methysergide and Ritanserin, Two Serotonin Antagonists, on the Behavioral Repertoire of Zebra Finches (Taeniopygia guttata) 679
Megan B. Bruther (Wendy L. Hill)

Context and Quality of Social Interaction of Children with Severe Language Delays in a Full Inclusion Preschool Program 684
Amy Buchanan and Krista DeZerega (Lawrence V. Harper and Karen McCluskey)

Characteristics Associated with Premature Drop Out in Client-Centered Play Therapy 689
Valerie A. Campbell, and David B. Baker (Sue Bratton and Jennifer Cleveland)

Helping Behavior Rates and Demographics: A Comparative Analysis 694
Jennifer D. Carlson-Weiberg (Nancy Steblay)

Parents' Marital Status, Father-Daughter Intimacy and Young Adult Females' Dating Relationships 698
Kristen J. Clark (Korrel Kanoy)

Investigating Physiological Responses to Sexual Harassment 703
Shaunta K. Clark, Carina De Fazio, Jamar D. Barnes, and Foye A. Smith (Vernessa R. Clark)

Peace Builders Case Study: Combating Violence Through the Exercise of Positive Choices in an Elementary School in California 707
Charlotte M. Contreras (Manual Carlos)

The Psychobiological Effects of Narcolepsy: Its Causes and Treatments 711
Sara Cronin (Charles Kutscher)

Racial Similarity, Cost to Helper, and Sex as Determinants of Helping Behavior 717
Heather A. Dooner and Margaret M. Blake (Patricia Oswald)

Sex Role Type and Effectiveness of Women Speakers at a Religious Presentation 722
Catherine E. Dundas (Lynn New)

Alpha-Ganzfeld: An Experimental Study on Alpha Rhythms Under the Ganzfeld Condition 727
Darin Dutcher and Joshua Johnson (Dorothee Dietrich and Matt Olson)

The Relationship Between the Extent to Which Adolescents are Taught Not to Trust Strangers During Childhood and Interpersonal Skills 732
Laurie Harrier (Francis Terrell)

The Relationships Among Eating Attitudes, Loneliness, and Self-Monitoring 737
Patricia L. Hart (Cynthia Crown)

Readability of Websites with Various Foreground/Background Color Combinations, Font Types and Word Styles 742
Alyson L. Hill (Lauren F.V. Scharff)

The Relationship Between the Protestant and Catholic Religions and Guilt 747
Caramin C. Johnson (Emily Hause)

Locus of Control and Superstitious Behavior: A Visit to the Putting Green 751
Mark W. Jones (Ralph J. McKenna)

Effects of Long-Term Ad Lib. Feeding on the Weight and Health of Differentially-Reared Laboratory Rats 756
Gary L. Lawrence & Kimberly M. Murrell (Karen E. Brakke & Jeanne M. Stahl)

Drug State Dependent Performance of Rats on a Hampton Court Maze 761
Shawana N. Lewis and Gary L. Lawrence (Karen E. Brakke and Jeanne M. Stahl)

Child Abandonment in St. Petersburg, Russia: Effect of Early Intervention 766
Natalya M. Lvoff (H. Banis)

Parent and Adolescent Relationships as Predictors of Post Divorce Functioning 770
Marisa Manzi, Joan Garten (Michelle Wierson)

Doing Field Research in an Electronic Environment 775
Tracee S. Matlock (Manuel Carlos)

Irrelevant Speech Eliminates the Word-Length Effect 779
Rebecca Mazzorana (Ian Neath and Aimee Surprenant)

Activational Effects of Testosterone On Sound-Guided Spatial Navigation 782
Eric J. Moseley (Mark C. Zrull)

Effects of Employment on College Students' Academic Performance and School Involvement 787
Laura A. Schwarber (Cynthia L. Crown)

Gender Differences In Coping Strategies and Cardiovascular Responses to Stress 791
Eric Shaw and Foye Smith (Vernessa R. Clark)

An Extension of the "Two-Baskets' Theory of Self-Cognitions to Native Americans 794
Mandy D. Smith (David Trafimow)

The Relationship Between Self-Esteem and Extraversion 797
Wendy S. Peterson (Cynthia Crown)

Chicano Gangs in California: Analytical Analysis of the Structure and Dynamics of Chicano Gangs from Street Corner to Prison Cell 801
Brenda J. Pobre (Ruben Mendoza and Manuel Carlos)

The Relationship Between Parents' and Adolescents' Values 807
Heather Reynolds, Corinne Auman, Ilona Teleki, and Laura Batz (Maureen Vandermass-Peeler)

Attitudes of College Students Toward Using Animals in Research 813
Katina V. Robinson and Lisa Harris (Karen E. Brakke and Jeanne M. Stahl)

Transitive Inference in Undergraduate College Students 818
Rhea Watson (Julianna Lancaster and John Batson)

Conflicts of Interest in the Early Stages of Intimate Relationships 822
Susan Russell (Renate Klein)

Social Adjustment of Children and Adolescents with Juvenile Rheumatoid Arthritis: Parent Report 826
Stacie M. Arthur (Robert B. Noll)

The Relationship Between Nicotine and Alcohol Dependence: Treatment Implications: 831
Meenakshi Garg (Barbara J. Mason)

Social Isolation of Nursing Home Residents and Their Perceived Health 833
Jennifer Langford (Jerry Pankhurst)

The Effects of Minority Influence on Group Polarization 838
Kelly Murphy (Jennifer J. Dose and Jeff Ratliff-Crain)

Scottish Soccer Violence and Religion 843
Megan O'Neill (Len Berkey)

A Content Analysis of Children's Television Commercials 848
Rachel D. Sgaglio (Michelle E. Barton)

A Critical Analysis of Current State Responses to the Problem of Child Maltreatment 852
Elise L. Siddell, Eileen T. West and Emma S. Gavino (Madeline Lovell)

The Assessment of College Students' Perceptions and Attitudes Towards Academic Dishonesty 857
Sarah Acton, Jennifer Thetford (Irene Staik and John Burling)

Changing Pedagogy: Using a Computer Simulator to Teach Ethnographic Methods 862
Gregory R. Blaza (Manuel L. Carlos)

The Influence of Pretrial Publicity on Juror Decision-Making: A Meta-Analysis 866
Jasmina Besirevic (Nancy Steblay)

North America by Bus: A Study of Interaction and Personal Space 871
Lisa Marie Bosner (Natalie Rosel)

The Assessment of College Students' Attitudes Toward the Social Aspects of Their Own Aging 876
April M. Chambers and H. Perry Swindall (John Burling and Irene Staik)

Exploring the "GenderedPerspective" in Early Adolescents' Interpretations of Popular Music 881
Anastasia M. Pharris-Ciurej and Kristine M. Ward(Jodi O'Brien)

An Examination of Gift Giving in Post-Modern Society 886
Megan Kathleen Donovan (Martha Huggins)

Learning to Hate Yourself: How Homophobia Teaches Girls to Devalue Women 889
Jennifer L. Engle (Harriet Adams)

The Effect of the "Year of the Woman" on the 103rd Congress 894
Emily C. James (Nadia Rubaii-Barrett)

Popularity: The Crisis and Culture of Adolescent Girls 899
Cinnamon Reiheld (Harriet Adams)

Production Scheduling of Flexible Manufacturing Cells 904
Jeffrey D. Erickson (Bijayananda Naik)

Physical Attributions of Racial Sterotypes 908
Lori Dixon (B. Runi Mukherji)

Volume III

Mathematical and Engineering

Groundwater Nitrate Removal for the Main San Gabriel Basin, California — 911
Chad Blais, Katina Burl, Adam Nazaroff, Peter Tonthat, Vinh Truong and Justine Yu (Julie Wei)

Occupant Dynamics in Stationary and Moving Vehicles Subjected to Vertical Impacts: An Experimental Study — 915
Peter D. Layson (Toufic M. Hakim and Orion P. Keifer)

SubzeroCam: Design of a World Wide Web-Based Digital Camera for Sunrayce 97 — 920
James A. Johnson (Richard R. Schultz)

Using Java for Computational Electromagnetic Scattering — 925
Jared Martin (Lyle Long)

Flat Oceans and Satellite Radar Anomalies — 930
David L. Mickler (Chester J. Koblinsky)

Cyberprint: Creating Alternative Medical Visualization Tools Using Architectural Metaphors — 936
Jim Agutter (Julio Bermudez)

Sustainable Building: Planning and Design of a Family Residence and Education Center Using Local Building Materials — 940
Geoffrey B. Grace (Rebecca Fish Ewan)

An Analysis of Ancient Maya Obsidian Artifacts from Belize — 946
Rissa M. Trachman (Fred Valdez, Jr.)

Effects of Detention Time on Sedimentation Performance — 951
Ben Ehrhart (A.R. Jarrett)

Characterization of Waste Sites in Greater Newark Area Using Geographic Information Systems (GIS) — 956
Jelena Balorda (Sima Bagheri)

Electrochemical AC Impedance Technique to Investigate the Inhibition Efficiency of an Inhibitor for Steel Rebar in Concrete — 960
Octavio Cervantes, Elaine Lopez & Rudolph Martinez (Behzad Bavarian)

Prototype Designs of Concrete-Filled Steel Tube Composite Building Frames — 965
Katherine Fetterer (Jerome F. Hajjar)

Removal of Ammonia from Contaminated Air Stream by Biofiltration — 970
Annie W. Chou (Ruihong Zhang)

Comparison of Analysis Methods for Non-Classical Structures with Added Viscoelastic Damping — 975
James P. Horne (Douglas K. Nims)

Field Testing of Stone Masonry Arch Bridge #143 in Chester County, PA — 978
Allyson Karper (Thomas Boothby)

Determining Suitability of Irrigation in Developing Countries — 983
Carl McGloughlin (Roger Ruggles)

Development of a Generic, Robust, and Reliable Networking Protocol for a Motorola Microcontroller — 988
Mary Frances J. Austin (Charles Bennett)

Ideal Case Modeling of Optical Preamplifer Receivers at the 10Gb/s Data Rate — 993
Deborah S. Hart (Y.K. Park, Lucent Technologies, Lightwave Subsystems)

Nonlinear Filtering and Enhancement of Digital Ultrasound Imagery 998
Melissa L. Kurtz (Richard R. Schultz)

Mathematical Modeling of a Fuzzy V-Chip 1002
Daniel J. Landherr (Marian S. Stachowicz)

Effect of Thin Film Disk Texture on Magnetic Recording Head-Medium Clearance Measurements 1007
Daniel Yau (Chorng H. Chang)

A Self-Evaluation Tool for Life-Cycle Cost Analysis 1012
Fabiola Gaytan and Pablo Santos (John Wilson)

Excessive Noise Levels Enhance Special Effects, Are You Aware? 1017
K. Osborne (D. Lisnerski and R. Yearout)

Surface Estimation of Machined Parts 1022
Gustavo Perez (Prasad Gavankar)

The Use of the GRAFCET Approach to Automation of PLC Programming & Control 1027
Janice R. Sansberry (Shueh-Ji Lee)

Counting Arrangements of 2's and -1's 1031
Robert S. Sielken (Donald Bailey)

Magic Squares as Matrices 1036
April Warn (Donald Bailey)

The Structural Design and Electronic Control System for a Large Segmented Space Reflector Test-bed 1041
Anibal Jaimes and Efrain Velazquez (Helen R. Boussalis, Maj Mirmirani and Khosrow Rad)

The Effects of Stretching and Aging on the Tensile Properties of Al-Cu-Li (2195) Alloy 1046
Michael C. Abernathy and Clarence Adkins (Reza Mirshams and Zhixian Li)

Resolvents of m-Accretive Operators in Banach Spaces 1050
Eric Lehr (David Kerr)

Numerical Model for Ice Melting in a Rectangular Enclosure with Density Extremum Effects 1055
Makeda Smith (Khoudir Medjani)

Nanofabrication and Resistance Testing of Metal Coated Silicon Microcontact Arrays 1060
Jeffrey A. Yap (Jack M. Blakely)

The Effect of Razor Notching Techniques on the Fracture Toughness of Polymeric Materials 1063
Dora C. Arevalo (Carlos R. Corleto)

Assessment of In-Plane Strength of Carbon/Epoxy Laminates 1067
Jill Hahl (Ronald Bucinell and Alan Nettles)

The Design and Development of a Phantom Model for Hyperthermia Cancer Treatment 1071
Jennifer Lelas (Ann Anderson)

International Virtual Design Studio: Design of a Vehicle Without Wheels or Wheel-like Contact with the Floor 1075
Carmen McMurtry (Ronald B. Bucinell)

Heat Transfer Enchancement on a Printed Circuit Board 1079
Gretchen R. Voegler (Ann M. Anderson)

A Study of Data Issues in the GIS Environment 1084
Jesus Acosta and Lori Alvarado (Ann Q. Gates)

Quick Write vs. Quick Run: Implementation Methods for Goal Definition 1088
Kellie Alexander and Yolanda McCullough (Scott Anderson)

A Study of Environments for Successful Component Reuse in System Development 1093
Debbie Bowles (Mary Lynn Manns)

Digital Simulation of the Acoustic Guitar: A Physical Model Abstraction 1098
Adam D. Bradley (Wayne Lang)

A Parallel Solution of a Second Order Elliptic System 1103
Andre Da Breau and Lwanga M. Phillip (Okon H. Akpan)

Formulation of a Parallel Recursive Substructuring Method for Finite Element and Finite Difference Solutions 1108
Derek O. Bruff (Hayden S. Porter, Jr.)

Comparing a Particle-System Based Simulation to Other Methods in Modeling Special Effects 1113
Joshua Buckner and Ryan Mitchell (Gerald N. Pitts)

An Examination of Mentoring Methodologies in Object Technology 1118
Janet E. Cody-Mehaffey (Mary Lynn Manns)

3D Special Effects: Modeling Reflective Surfaces In Real-Time 1123
Daniel P. Cornell (Gerald Pitts)

Formal Methods for Software Specifications: A Case Study 1128
Michelle Dillinger (Ken Abernethy)

Truth Maintenance Techniques for Verification of Knowledge Bases 1134
Mark R. Finn (Neli P. Zlatareva)

Computer Assisted Data Reduction: Optimizing the Astrophysicist 1139
Dan Greenspan (Karen Magee-Sauer, Michael Mumma)

Hierarchical Planning with Definite Clause Grammars 1143
Tarik Vance-Harris (R. Raymond Lang)

Algorithm Animation: Programming on the World Wide Web Using Java 1148
Stephanie Hitchcock (Kevin Treu)

Formal Methods for Software Specification 1153
Amanda Hoffman (Ken Abernethy)

RSL, A Language for Distributed Parallel Solution of Sparse Matrix Systems 1157
Chad Huneycutt (Hayden Porter)

A Parallel Solution of a Parabolic System on a SIMD Processor 1162
Adrain Ironside and Ramaiz Mansoor (Okon H. Akpan)

Evolutionary Confusion: When and How to Apply the Genetic Algorithm 1167
Michael G. Jones (Gerald Pitts)

Visualization of a Global Atmospheric Model with Iris Explorer 1171
Elizabeth C. McAliley (Hayden Porter)

Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity 1176
Ramgopal Mettu and Yuke Zhao (Vijaya Ramachandran)

An Implementation of Particle Systems for Special Effects 1181
Ryan Mitchell and Joshua Buckner (Gerald N. Pitts)

Parallel Programming: A Disparate Architectures Approach 1186
Jason Pounds (Maurice Eggen)

A Traceability Tool: Linking Knowledge Programs 1191
Francisco Saenz and Tom Watson (Ann Q. Gates)

Commonsense Knowledge Representation for Russian Folktales 1196
Damon Stewart (R. Raymond Lang)

Godel's Incompleteness Theorem and Turing's Solution to the Halting Problem: Linking the Foundations of Mathematics and Computer Science 1201
Philip Rash (David B. Teague)

Java Security 1206
Hnatyshin Vasil (Bob Neveln)

DARWIN: Software to Identify Dolphins in Digital Images 1211
Daniel J. Wilkin (John H. Stewman)

Wavelength Division Multiplexing Coupler Based on Talbot Self-Imaging in Planar Optical Waveguides 1215
Cadet Diana Kuykendall and Cadet Christopher L. Reitsma
(Tristan J. Tayag, David M. Mackie, Lorna J. Harrison,
Gary W. Euliss, and Richard P. Leavitt)

VOLUME IV

BIOLOGY

In Search of Aspects of the Human Condition in Antiquity: The Case of A Hellenistic Population from Abdera, Greece 1220
Pia Economou (Anagnosti Agelarakis)

Abnormalities in Occlusal Surface Wear and Enamel Integrity in Tehuelche Dentition 1224
Alberto Silva (Silvia Dahinten and Daniel de Lamo)

Design of the Acetylcholinesterase Enzyme Using Brownian Dynamics Simulation: A Novel Therapeutic Approach to Alzheimer's Disease 1229
Brent A. Hanks (Walt Potter, Kerry Burns and Vicente Villa)

Postanesthesia Nausea and Vomiting 1234
Aaron Shaw III (Paul Loubser)

A Study of the Risk Factors for Cerebrovascular Accidents in African-Americans 1239
Tera R. Hurt (Dennis E. Daniels)

The Effect of Training Position on Leg Flexor Power in Untrained Males and Females 1244
Dawnelle Diedrich and Ryan H. Robinson (Anthony Caterisano)

Measurement of Anaerobic Power in Elite Wheelchair Athletes: Absolute Load Optimization of the Wingate Test Using the Monark 881 Arm Crank Ergometer 1247
Stephen E. Mercer (Pamela J. H. Beehler)

The Effects of the Raised Mutation of Sexual Behavior in Drosophila Melanogaster Females 1252
Jeannine Caesar and Joshua Bradner (Scott P. McRobert)

The Influence of Menstrual Cycle Phases on the Chaotic Behavior of Electrocardiograms in College-Age Women 1257
Maria M. Mountis, Meghan Ginty and Sharee Livingston (James J. Watrous)

Pollinated Maize Ovaries are Resistant to Infection by the Smut Fungus Ustilago maydis 1262
Margaret Carfioli (Karen Snetselaar)

Genetic Characterization of the AXR5 Gene 1267
Ibrahim Carvan, Donovan Chance, Joseph Mazzie, Rina Pineda and Shabnam Shah (Lawrence Hobbie)

The Competitive Relationship between the Perennial Cardaria draba and the Annual Lepidium virginicum 1272
Maria Conley (Steven Carroll)

Self-Incompatibility: a Model for Pollen- and Pollen Tube-Mediated Signal Transduction in Petunia inflata 1276
Chandreyee Das (Teh-hui Kao)

Investigating Temperature Sensitive Mutants of Ustilago maydis 1282
Janet Gervaiss, Jason Lotkowski (K. Snetselaar and M. McCann)

Partial Purification and Properties of Putrescine Oxidase from Candida albicans 1287
Uma Gunasekaran, Johnny Thomas, and Louis McDonald (Muthukumaran Gunasekaran and Elias K. Manavathu)

Role of Host Plants in Egg Hatching of the Soybean Cyst Nematode 1292
Renee Poupard and Lou Casta (Paul M. Tefft)

Coat Protein Analysis of Tomato Mosaic Virus (ToMV) 1297
Victor Huber, Nicole Kimmes and Jesse Barthel (N. Bharathan)

Feeding Behavior of the Tropical Stick Insect Extatosoma tiaratum: A Study in Palatability of Thirty-one North American Plants 1302
Karla J. Johannes (James Poff)

Monitoring the Release of Acid Phosphatase in Pitcher Plant Fluid after Feeding with Insects 1305
Matthew Jones (Diane Melroy)

Elucidating Mechanisms of Pulmonary Fibrosis: Intracellular and Extracellular Events when the Platelet-derived Growth Factor Receptor System is Up-regulated by Air Pollution Particles and Interleukin 1-beta (IL-1B) 1309
Patricia O. O'Brien, Annette Badgett and James C. Bonner (Sandra Gilchrist)

Determination of RNA Binding Domains of the Nucleocapsid Protein of Tomato Spotted Wilt Virus 1314
Patricia M. Stickler (Sandra Gilchrist and Tom German)

Characterization of an Auxin-Resistant Mutant of Arabidopsis thaliana 1319
Shabnam Shah, Ibrahim Carvan, Donovan Chance, Joseph Mazzie and Rina Pineda (Lawrence Hobbie)

Comparison of Microbial Consortia and Environmental Condition of Two Granite Outcrop Plant Communities 1324
Keri Randolph and Lisa M. Knauff (Sandra T. Bowden)

Characteristics and Purification of Agkistrodon controtrix laticinctus Venom 1328
Xavier G. Aranda, Elda Sanchez (John C. Perez)

The Purification and Characterization of Crotalus Viridis Oreganus Venom 1332
Gloria R. Chapa and Elda Sanchez (John C. Perez)

The Purification and Characterization of Agkistrodon piscivorus leucostoma Venom 1337
Celia Garcia and Elda Sanchez (John C. Perez)

Purification and Characterization of Crotalus viridis lutosus Venom 1342
Maria Susana Ramirez and Elda Sanchez (John C. Perez)

The Use of Electrophoretic Titration Curves as a Tool in Predicting the Separation of Crude Crotalus atrox Venom by High Performance Liquid Chromatography 1347
Maria Elisa Perez-Johnson (John C. Perez)

Development of a Rapid Detection Method for Determining Bacterial Guild Structure in Mining-Impacted Freshwater Sediments 1352
Todd Christensen (Frank Rosenzweig)

Purification and Biochemical Characterization of Antibacterial Antibiotics Produced by Soil Streptomyces 1356
Victoria C. Heverly (Robert W. Morris and Richard T. St. John)

The Microbial Activity in Saltmarsh Tidal Creek Waters Determined by Oxygen Metabolism 1360
Kenneth C. Hayes and Alan J. Lewitus (Eric T. Koepfler)

Efficiency of Latex Gloves as Barriers to bacterial and Viral Pathogens 1365
Erica Jo Hughes (Robert McLean and Carolyn Benjamin)

Oyster Reef Impact on Microbial Food Web Dynamics in Tidal Pools in North Inlet Estuary 1369
LeRoy F. Humphries, Alan J. Lewitus, Leah L. Gregory and Bonnie M. Willis (Eric T. Koepfler)

The Molecular Evolution of HLA-A 1374
Kristie A. Mather (Carrie Grimsley and Carole Ober)

Restriction Endonuclease Analysis of Plasmid DNA from Methicillin Resistant Staphylococcus aureus 1379
Janey Phelps (Betsy Wilson)

Macrorestriction Patterns and Genome Sizes of Two Strains of Bdellovibrio 1384
Theresa Scognamiglio (John J. Tudor)

Effects of Specific and Non-Specific Transport ATPase Inhibitors on Gill and Rectal Gland Tissues of the Little Skate, Raja erinacea 1389
Tanisha Wilkins (Gregg Kormanik)

Effects of Wood Frog (Rana sylvatica) Predation on Spotted Salamander (Ambystoma maculatum) Oviposition Site Selection 1392
Joyce E. Cacka (James W. Petranka)

Consequences of Opportunistic Predation by a Primary Consumer (Rana) on a Predator (Ambystoma) 1397
Andrea Rushlow (James W. Petranka)

The Role of Visual Cues in Determining Recognition Behaviors in Poecilia Latipinna and Poecilia Velifera x Poecilia Latipinna 1402
Joshua Bradner and Jeannine Caesar (Scott P. McRobert)

The Effect of the Lipid Content of the Diet of Blue Crabs, Callinectes sapidus, on Osmoregulation 1407
Sarah E. Hazzard (Lee Ann Clements)

Short-Term Effects of UV-B Radiation on Salt Marsh Vegetation 1412
Christopher D. Raleigh (Eva Koch & Laura Murry)

The Study of the Oxidation of CZT with H_2O_2 Using XPS 1417
Brandy Granderson (De Tang Shi, W. Eugene Collins and Muthukumaran Gunasekaran)

The Effects of Precocene 2 on The Predatory Insect Tenodera aridifolia sinensis Saussure 1422
Emily C. Whiteley (Diane Melroy)

Interspecific Interference and Resource Partitioning Among Males of Three Dragonfly Species (Odonata: Libellulidae) 1427
Michael Wolyniak (Vicky McMillan)

Habitat Selection by American Kestrels (Falco sparverius) Wintering in Northwestern Ohio 1432
Tami L. Parker (J. Eric Juterbock)

The Role of Calcium in Wound-Induced Cell Proliferation 1437
Quoc-Huong Tran (Paul J. Sammak)

Isochore Related Amino Acid Substitutional Biases 1442
Allen J. York (Dan E. Krane)

Effects of Thallium on Inositol Polyphosphate Receptors and Nitric Oxide Synthase in Rat Cerebellum 1447
Chadrick Anderson and Tanya Wright (Chellu S. Chetty and Muthukumaran Gunasekaran)

Initiation of Expression and Cell-Specific Localization of Nitric Oxide Synthase (NOS) in Pre-Implantation Mouse Uterus 1452
Preeti Gupta (Yvette M. Huet-Hudson)

Characterization of Urethral Blockage in a New Mutant Diabetic/Obese Mouse 1456
Michael Villarroel (John G. Vandenbergh)

One-Dimensional and Two-Dimensional SDS-PAGE of Total Protein in the fungus Ustilago maydis 1459
John G. Devlin (Karen Snetselaar and Michael McCann)

Regulation of Superoxide Dismutase Synthesis in Candida albicans 1464
Uma Gunasekaran, Anita Austin and Louis McDonald
(Muthukumaran Gunasekaran, Elias Manavathu and C.S. Chetty)

Antifungal Resistance in Opportunistic Fungi: Isolation and Characterization of Amphotericin B-Resistant Mutants 1469
Uma Gunasekaran, Anjana Challa, Dinita Scurry and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

In Vitro Susceptibility of Clinical Isolates of Opportunistic Fungi to Antifungal Agents 1474
Uma Gunasekaran, Tanya Wright and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

Aye-Aye Gruel Presentation Preference 1479
Heather Ann Lynch (Joan H. Eisemann)

Modification of the Binary TBP-DNA Complex by Pluramycins 1483
Sameer Ambady (Lawrence Hurley)

Characterization of a Mutant dnaA-dnaN Gene Region that Suppresses a Temperature Sensitive Defect in the dnaX Gene of Salmonella typhimurium 1487
Farhang Amini (James R. Walker)

Conservation of Proto-Oncogenes, Tumor Suppressor Genes, and V (D) J Recombinase Genes Across Species 1492
Lucy A. Aplan (Rob Young)

An Analysis of Lipid Bilayer Studies of Single Ion Channels using M2 as an Example 1496
Erin E. Grimm (Carl Helrich)

Metal Regulated Gene Expression in Pseudomonas fluorescens 1501
Marsha L. Kukuk (Silvia Rossbach)

The Development of a PCR-Based Test to Identify the Red Factor Coat Color Genotype in Horses by RFLP Analysis 1506
Staci Murguia (Ann T. Bowling)

Differentiation and Classification of Bdellovibrio bacteriovorus using Random Amplified Polymorphic DNA (RAPD) Analysis 1509
Bao-Dan T. Nguyen (John T. Tudor)

QTL Mapping of a Genetic Marker for Longevity in Drosophila melanogaster 1513
Amy Resler (Jim Curtsinger)

Stability of Heterochromatin in Voles from Chernobyl 1518
Lara Wiggins (Robert J. Baker)

Isolation and Functional Analysis of three Non-Human Primate CXCR4 Genes 1521
Brigitta Zoltay, Jay Vasudevan and Greg Shaeffer (David Camerini)

Proceedings — NCUR XI (1997)

Volume V

PHYSICAL SCIENCES

Modification of an Interference Pattern Through Particle Statistics: Experimental Study 1526
Niranjan Sharma (Willard Fadner)

Nuclear Structure of the Stable Tellurium Nuclei 1531
Brian Champine, Peter Burkett, Christopher Davoren, Stephen Etzkorn, William Faulkner, Bernard Meehan, and Mark Skubis (Jeffrey R. Vanhoy and Sally F. Hicks)

Pulse Propagation in a 1-D Physical Lattice 1536
Jonathan Tuminaro and Joseph Winkler (H. David Sheets)

An Investigation to Measure Mechanical Strain in Structures using Optical Fiber Interferometry 1540
Satyender Mahajan (Zolili Ndlela)

CO Adsorption on Cobalt Particles Supported on Chromia - An FTIR Study 1544
Caribee Collier and Agegnehu Tsega (Murty A. Akundi and A.N. Murty)

Solar Cells Using Organic Pigment Nanoparticles 1549
D.J. Hilton and E.W. Forsythe (B.R. Hsieh and Y.Gao)

Calculating O_3 9.6 µm Absorption as a Function of Atmospheric O_2 1553
Hilary L. Justh (James F. Kasting)

Electromagnetic Field Profiles Inside Biomaterials 1558
Pedro L. Melendez, Dimaries Nieves, Ramon A. Rivera (Idalia Ramos and Fredy Zypman)

Thermal Modeling of the Marcy Anorthosite Massif, Adirondack Highlands, New York: Implications for Depth of Emplacement 1563
Kevin M. Myer (J. Alcock)

Ultra Sensitive Diode Laser Based Monitors for Toxic Environmental Gas NO_2 1568
Jessica Owens (G.N. Rao and M.N. Reddy)

Sample Heating and its Effects on Diffusion Depth 1573
J. Reed Patterson (Peter A. Barnes)

The Hyperpolarizabilities of Phthalocyanines 1578
Tiffiani R. Williams (Beatriz H. Cardelino)

Simulated Super Resolved Imaging of Compact Radio Sources 1583
Erika Barth (David Hough)

A Study of the Lobe-Dominated Superluminal Quasar 3C263 1588
Philip J. Beyer (David Hough)

Global Imaging of the Cusp Region of the Earth's Magnetosphere 1593
John W. Colson (J.D. Perez)

3D Circuit Networks Simulate Biomaterials 1596
Edsel Ruiz, Pedro Melendez (Idalia Ramos and Fredy Zypman)

A Two-Year Climatology of Radiation Budget and Cloud Properties for the ARM SGP Site 1601
Stephen G. Strum (Thomas P. Ackerman)

Nonlinear Optical Properties of Halogenated Porphyrin 1606
Angela Benloss (Beatriz H. Cardelino, Craig E. Moore)

A Novel Method for Investigating Phase Disturbances 1611
Rex L. Blair Jr. (Thomas R. Moore)

An X-ray and Optical Study of Galaxies in Pairs 1616
Sarah Cousineau (Mark Henriksen)

Optically Driven Pendulum 1621
David Coy and Michael Molnar (Randall Peters and LTC Thomas Moore)

Surface Morphology of CdZn Te Crystals Grown by Physical Vapor Transport 1626
Montiquilla Davis (Arnold Burger, Henry Chen, Kuo-Tong Chen and Muthukumaran Gunasekaran)

Avalanche Segregation of Granular Media 1631
James Koeppe and Michael Enz (James Kakalios)

Magnetic Susceptibility (MS) and Visual Spectral Reflectance (VIS) Measurements: Paleoclimate Estimates for Pleistocene Europe 1636
James R. Marlatt (Brooks B. Ellwood)

Diamond Film Coatings on Titanium Alloy Using Chemical Vapor Deposition 1641
Andrea Nelson (John T. Tarvin and Yogesh K. Vohra)

Purification and Crystal Growth of Lead Iodide 1646
Danielle Robinson (Kuo-Tong Chen, Arnold Burger, Henry Chen and Muthukumaran Gunasekaran)

Recalibration of the Wilson-Bappu Effect Using the Singlely Ionized Magnesium k and h Lines 1651
Frederick Scoville (Jose Mena-Werth)

Analysis of X-ray Sources in Galaxy Clusters 1656
Dean Smith (Mark Henriksen)

Using FTIR-Reflection Absorbance Spectroscopy to Study the Structure of Thin Ice Films 1659
Jennifer L. Spillman, Govind Mallick and Robert M. deGroot (Marin S. Robinson)

100

CHEMISTRY

Large DNA Fragment Sizing by Flow Cytometry 1664
Angela R. Cameron (Jeffrey T. Petty)

Enchancement of Asymmetric Induction in the Aqueous Diels-Alder Reaction of (L)-Menthyl Acrylate with Cyclopentadiene by β-Cyclodextrin 1669
Kristen Daniell, Terry E. McInytre, Poh Ai Ling (Moses Lee)

Effect of Lipid Peroxidation Products, 4-hydroxy-2-trans-Nonenal and Malondialdehyde, on Erythrocyte Membranes 1674
Michael Green, Ram Subramaniam (Allan Butterfield)

The Synthesis and Decomposition of Single Source CVD Precursors 1679
Tadd Kippeny (D.S. Amenta, J.W. Gilje, and T.C. DeVore)

Thermal Remediation of Model Chloropesticides Utilizing Reactions with Sodium Salts 1684
James W. Parrett, Jr. (Thomas C. DeVore)

Determining the Effect of Substitutions on the Hyperpolarizabilities of Tricyanoquinoline-Dimethanes 1689
Jamarcy L. McDaniel (Beatriz Cardelino)

Better Magnetic Resonance Imaging Contrast Agents for Tumor Detection 1694
Leah C. Saunders (Thomas R. Cundari)

Computational Analysis of the Electronics of Substituents on Aromatic Systems 1699
Lunelle A. Schmiedekamp (Judy L. Ozment)

Isolation of a Compound Responsible for the Biochemical Control of Dimorphism in Candida Albicans 1704
Joseph J. Tasto (Kate J. Graham)

Adsorption Behavior of NO and CO on Pd/Al_2O_3: An FT-IR and Mass Spectrometric Study 1707
Chad D. Marten and Barry W. Smith (Dilip K. Paul)

Structural Studies of a Modified Oligonucleotide using 2-D NMR Techniques 1712
Thanh Ta, Shannon Teeters and Brigette Semler (Dale G. Ray III, Mark McDougall, Jim Holecek, Lorraine Rellick)

Effects of Additives, pH, and Buffers on the Chemiluminescence of Phenyl Acridinium Ester 1717
Carolyn Snider, John Rollag (D.S. Hage)

Dynamic Surface Tension and Surface Adhesion Detection for the Rapid Analysis of Surfactants 1722
Dana Alloway (Robert Synovec and Kristen Skogerboe)

Interactions of the Domains of Myosin's Regulatory Light Chain with the Heavy Chain: A Photocross-linking Study 1727
Lisa Nguyen (Jennifer J. Olney and Christine R. Cremo)

Thermodynamic Melting Point Studies of a Native and Modified Thirteen Base Pair Oligonucleotide containing 5-Nitroindole using UV Spectrometry 1732
Jamie Doone and Chad Willis (Lorraine Rellick, Dale G. Ray, Jim Holecek, and Mark G. McDougall)

Chitosan-Porphyrin Films for NLO Applications and Optical Devices 1736
Celeste A. Roney (Rosalie A. Richards, Subhash C. Bhatia, Albert N. Thompson, Jr., and Beatriz H. Cardelino)

Biochemical Characterization of Amino Acid Uptake in Potential Vacuolar Mutants of Neurospora crassa 1741
Zeljka Basic and Jonathan Z. Tayco (Kelly Kennan)

BEST COPY AVAILABLE

Preparation of Co(PYAN)$^{+3}$ and Progress Toward the Separation of its Optical Isomers 1745
Lori Bigler (Susan C. Jackels)

Attempted Synthesis of a Precursor of an Anti-tumor Marine Alkaloid: Shermilamine B 1750
William Buitrago (Yvette Jackson and Michael Lyon)

Determination of the Vanadate-Mediated NAD(P)H or NADH Oxidation Mechanism in Biological Systems 1755
Carlos J. Olivo-Delgado (Ileana Nieves-Martinez and Ronald P. Mason)

Mobius Kekulenes: Semiempirical and ab initio Hartree-Fock Calculations of Their Structures and Properties 1760
Patricia L. Frisch (Robert W. Zoellner)

Synthesis of (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d Diisopropyl 4b,8b,8c,8d -tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate: A Project on Absolute Asymmetric Induction 1765
Kimberly Johnson and Jacob E. Simpson, Jr. (Moses Lee)

The Polymerization of Dicyclopentadiene for use in the Undergraduate Organic Laboratory Utilizing Computational Methods 1769
Jason Logan (James W. Hershberger)

Examination of the Decarboxylation of Ketoisovalerate Using Pyruvate Decarboxylase from Saccharomyces cerevisiae 1773
Michael B. Meek (Betty H. Stewart)

Synthesis, Purification, and Activity of Glutaryl-CoA Analogs 1777
Shannon L. McKinney, Carrie L. Donley, Gregory K. Sewall, Patricia L. Kultgen (Colleen M. Byron)

The Synthesis of Rigidin -- A Tetrasubstituted Pyrrole 1782
R. Jordan Shuford (Keith Krumpe and John Gupton)

Molecular Modeling of Vanadium-Oxo Complexes 1787
Laura L. Sisterhen (Thomas R. Cundari)

Characterization of Liquid Crystalline Thermoset Networks 1792
Jeffrey M. Valentine (Christopher K. Ober)

Faraday Rotation of a Photogenerated Organic Triplet Molecule in Polyvinyl Alcohol Films 1797
Paul Trotto (David Hall and David Dwyer)

HPLC Analysis of Eicosanoids in Response to Valproic Acid (VPA), Endotoxins (LPS) and Tumor Necrosis Factor (TNF) 1802
Matthew Thomas McKevitt (J.R. Stephens)

Preparation of an Iron Complex of Pyo$_2$[18]dieneN$_6$ 1807
Shane O'Mahony (Susan C. Jackels)

The Plasma Etching of Metals and Metal Compounds 1811
Gordon Shaw (Judity Halstead)

ENVIRONMENTAL SCIENCES

Pipelines and Potential Disaster: An Introduction to Cathodic Protection 1816
Joy J. Burwell (Brian Hale and Verne Lehmberg)

Twin City Water Quality Initiative Program 1821
Valerie Kuntz (Kenneth Brooks)

Lead Contamination of Canned Food Products from Argentina 1825
Margaret M. Ryan (Richard P. Maas)

Don't Die with TDI: Dynamic Calibration of MDA Isologgers for Toluene Diisocyanate 1830
Clare E. Smith (Herschel A. Elliott and V. Dharmarajan)

The Effect of Carbon Content on the Redox Potential and Fermentation Products of Wetland Soils 1835
Wendy Rash and David Cahan (Kevin K. Moorhead and Keith E. Krumpe)

The Invasion of Carrotwood (Cupaniopsis anacardioides): A Study Comparing the Impact of an Exotic Species on two Islands in Sarasota, Florida 1840
Lisa Downey (Sandra Gilchrist, John B. Morrill and Terry Palls)

Urban Forests and Wildlife: A Web Document 1845
Katrina M. Simon (John Bishop)

Effects of Stratification on Germination of Two Oak Species in Southeastern Arizona 1849
Kimberly Suedkamp (Guy R. McPherson)

Seasonal Fluctuations in Central Greenland Ice Sheet Radar Altimeter Return Characteristics 1853
Philip Dennison (Richard Alley)

Results of a Microseismic Survey of the Front Range of Colorado 1857
Noah Daniel Hughes (Anne Sheehan)

Atmospheric Teleconnections and United States Regional Climates 1862
Dana M. McCracken (Anthony J. Vega)

Extracellular Acid Phosphatase(s) Activity of the Protozoan Parasite Perkinsus Marinus 1866
Christine M. Forsythe (Aswini K. Volety, and Fu-Lin E. Chu)

Microhabitat use by Fish Populations within the Little Miami River 1871
Daniel J. McGarvey (Horton H. Hobbs III and John B. Ritter)

Water Chemistry Habitat Assessment in Eastern Tiger Salamander Ponds 1876
Sara E. Wirtz (Daniel M. Downey)

The Derivation of United States Temperature and Precipitation Regions 1881
Donna M. Fiscus (Anthony J. Vega)

Cloud Masing of Normalized Difference Vegetation Index (NDVI) Images 1885
Heidi Zeleznik (Barry Lesht)

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Groundwater Nitrate Removal for the Main San Gabriel Basin, California

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The Main San Gabriel Basin Watermaster is sponsoring a research project at California State Polytechnic University, Pomona. Watermaster is faced with the challenge that a significant portion of its groundwater contains high nitrate concentration. An alternative water resources management strategy and nitrate removal treatment processes were evaluated. The alternative management strategy of using high nitrate water for non-potable uses proved to be economically infeasible. The team evaluated alternative treatment processes including the established processes (Ion Exchange and Reverse Osmosis) and state-of-the-art biological processes (BioDen™, Daisy Wheel In-Situ, Methylotrophic Fluidized Bed, and Autotrophic Sulfur Reactor). The preliminary cost analysis indicated that some of the state-of-the-art processes are very cost effective and promising. It is recommended that a demonstration scale facility be built and tested before a state-of-the-art process is adopted.

BACKGROUND

Nitrate is a significant groundwater contaminant. The sources of nitrate include animal waste, fertilizer and septic tank leachate. The health hazard of ingesting excessive nitrate has caused Methemoglobinemia (Blue Baby Syndrome) in some infants due to oxygen deficiency and possible suffocation. Healthy adults can tolerate higher nitrate intake. Some have suggested that nitrate may be converted to N-nitroso compounds. This can be associated with cancers of the stomach, esophagus, nasopharynx, and urinary bladder. The National Primary Drinking Water Standards set the MCL (Maximum Contaminant Level) for nitrate at 45 mg/l.

Water from the Main San Gabriel Groundwater Basin serves over a million residents. Water demand is mostly met by delivering about 245,000 acre-feet of groundwater annually. Throughout the years, a number of wells have been either inactive or abandoned due to high nitrate concentration found in the well water. The deficit in water supply of about 15,000 acre-feet has been supplemented with imported water. As the demand for water increases, new wells have to be drilled and inactive wells need to be reactivated. There is a financial incentive as well as necessity to use groundwater instead of imported water. The options of solving the nitrate problem through water resources management as well as pump-and-treat technologies in removing nitrate need to be investigated.

Existing records to identify potential users of high nitrate water were researched. There are a number of parks and large industrial users in the Basin that can utilize high nitrate water. Unfortunately, potential users are scattered throughout the Basin and mostly are a considerable distance from the high nitrate aquifer. Because a separate distribution system is cost prohibitive, solving the nitrate problem through water resources management is economically infeasible.

TREATMENT OPTIONS

The most common processes of removing nitrate from water supply are Ion Exchange and Reverse Osmosis. However, each has its advantages and drawbacks. Both generate concentrated wastes that pose waste disposal problems.

In certain cases, waste must be discharged to a designated brine line that may not be in reasonable reach of the water well. Even if a brine line is accessible, the costs to connect and to discharge can be high. Both processes are relatively expensive.

The new trend is to develop a biological process in removing nitrate. Heterotrophic bio-denitrification has been used in wastewater treatment for years. Heterotrophic bacteria require organic carbon as an energy source for respiration. Its use in water treatment has been restricted because water supply does not contain high organic carbon. Supplemental organic carbon must be added to the influent in order for significant denitrification to occur. The major concern for this type of process is the end products. The unused organic carbon has a potential to form DBP (disinfection by products) such as THMs and some other unknown halo-products that are health hazards. BioDen™, Daisy Wheel In-Situ, and Methylotrophic Fluidized-Bed are in the category of heterotrophic bio-denitrification.

Alternatively, autotrophic denitrification process is currently being developed. Autotrophic bacteria use carbon dioxide as a carbon source and oxidize inorganic matter for energy. The Autotrophic Sulfur Reactor is based on autotrophic bio-denitrification principle. The theory, advantages and disadvantages of each of the above mentioned processes are briefly discussed below.

Ion Exchange

Raw water is passed through a bed of resin. The resin has loosely attached anions such as chloride. In the ion exchange process the nitrate ion is exchanged for chloride. Eventually, the resin is "exhausted" because most or all of the resin are loaded with nitrate ions. Resin is then regenerated with concentrated NaCl solution to replace nitrate with chloride. The regeneration waste is high in TDS (total dissolved solids) and needs to be properly disposed.

Ion Exchange is a proven technology. The process is stable and the operation is simple. However, it does have the following disadvantages: 1) Brine disposal may be a problem, and 2) the product water contains high chloride.

Reverse Osmosis Process

Reverse Osmosis is a membrane process. Raw water is pressured through a membrane that does not allow the passage of molecules larger than water molecule. Nitrate along with other inorganic and organic molecules are removed from water. The waste contains concentrated contaminants and needs to be properly disposed. The process requires sufficiently high pressure to overcome the osmosis pressure and other pressure losses. The facilities include container, membrane, and pumps and control system.

Reverse Osmosis is also a proven technology. The process is stable and the operation is relatively simple. It also removes TDS. The major problem with Reverse Osmosis is membrane fouling. Pretreatment and membrane cleaning/replacement add complexity and cost to the process. It is also very noisy due to the constantly running high pressure pumps.

The BioDen™ Process

Raw water enters the *BioDen™* reactor towers, which contains naturally occurring, non-pathogenic bacteria. These bacteria are stimulated by the automatic addition of small amounts of nutrient (high fructose corn syrup) which causes the bacteria to respirate the nitrates into harmless nitrogen and carbon dioxide gases, which are vented into the air. The treated water then flows through slow sand filter which removes residual bacteria, organic matters and turbidity in the water. The vendor is currently investigating the effectiveness of replacing slow sand filter with rapid sand filter that is less costly.

Denitrification is carried out by numerous bacterial species found in soil and aquatic environments. The carbon source chosen for the BioDen™ process is High Fructose Corn Syrup (HFCS). It was chosen because of its low price, availability, non-toxicity, solubility in water and the ease with which it is degraded by a broad range of bacterial species. Furthermore, unlike some other carbon sources such as ethanol and methanol, HFCS is not flammable and can easily be stored.

Daisy Wheel In-Situ

In-situ bio-denitrification is an emerging technology to restore aquifers contaminated with nitrates. The research hypothesis is that naturally occurring denitrifying microbes can be stimulated by adding a stoichiometric amount of ethanol. Ethanol is used as the energy and carbon source. The end products are less toxic than that of methanol. Additionally, the nitrate removal rates should be fast enough to make this a practical remediation strategy in the contaminated aquifers. In order to denitrify deeper portions of the aquifer, a system called "Daisy injection system" will be utilized. The basic design consists of an extraction well (production well) surrounded by twenty injection wells arranged in a circular fashion. The injection wells will inject ethanol. Biological treatment takes place within the aquifer and vadose zone. It does not require a contactor structure. However, the in-situ process is difficult to control due to numerous variables involved such as physical and chemical soil characteristics. This is a technology still in the experimental phase but should be followed for further results.

Methylotrophic Fluidized-Bed Reactor

Methanol is used as the carbon and energy sources for heterotrophic bacteria. The fluidized beds are filled with graded sand with a uniformity coefficient of 1.46. Experiments show that excess methanol in the effluent is inevitable, and thus prompt to toxic by-product (mainly THM) during the chlorinating process. Therefore a GAC unit would be required to remove the excess methanol and VSS or VOC in the effluent before the water is disinfected with chlorine. The Methylotrophic Fluidized-Bed Reactor technology is quite complex, and thus requires intensive supervision. There is a small pilot scale plant currently operating in Europe, but this denitrification process is mostly in the research stage, so unexpected problems for a large-scale treatment plant can be potentially significant.

Autotrophic Sulfur Reactor

An autotrophic denitrification process is being developed at the Orange County Water District utilizing elemental sulfur as the energy source. The organism, Thiobacillus Denitrificans, oxidizes elemental sulfur using nitrate as the terminal electron acceptor. Carbon requirements are met by the assimilation of carbon dioxide, bicarbonate, and carbonate present in the groundwater. The end products of the reaction are nitrogen gas and sulfate anion. A variety of bio-reactor designs were tested successfully. Of these, a cone shaped reactor containing a partially fluidized bed of elemental sulfur granules (around a size 10 sieve) seemed to offer a significant advantage.

The advantages of this process include low TOC (total organic carbon) in the product water and a relatively simple system. However, the autotrophic process is slow compared to the heterotrophic process, thus, requiring a larger contactor. The process is new and its design criteria are still being developed.

PRELIMINARY COST ESTIMATE

The preliminary cost estimate is based on an 800 gpm demonstration plant. These cost comparisons are preliminary because some of the processes are still in the developing stages. The costs for Ion Exchange and Reverse Osmosis are based on previous project costs adjusted for 1997. The cost for BioDen is provided by vendor. The costs for the state-of-the-art biological processes are the team's best estimate with limited information.

The costs include construction cost, O & M (Operation and Maintenance) costs, and annualized total cost for nitrate removal facilities only. The construction cost has been annualized for 15 years at an interest rate of 7%. The processes are ranked from 1 to 6 for cost competitiveness with 1 being most cost effective.

Table1: Preliminary Cost Analysis

PRELIMINARY COST ESTIMATE

Processes	Ion Exchange	Reverse Osmosis	Auto-trophic Sulfur	BioDen™	Daisy wheel In-Situ	Fluidized Methanol Bed
Construction Costs ($)	$824,200	$1.7 Million	$1.05 Million	$1.5 Million	$761,000	$901,000
Annualized Constr. Costs ($/ yr)	$90,500	$189,725	$115,160	$171,720	$83,600	$99,000
O & M Costs ($/yr)	$57,500	$263,000	$102,000	$66,030	$143,460	$203,000
Total Annual Cost ($/yr)	$148,000	$452,725	$217,160	$237,750	$227,020	$303,000
Cost Competitiveness	4	6	1	3	2	5

CONCLUSION

Reverse Osmosis and Ion Exchange were determined as viable and proven treatment options. Three (Autotrophic Sulfur Reactor, BioDen and Daisy Wheel In-Situ) out of the four biological processes that were evaluated are very promising. All are state-of-art processes in various stages of development. BioDen™ is in a more advanced stage of development and Daisy Wheel has the potential to clean up a large area of aquifer economically. However, Autotrophic Sulfur Reactor may be the best. The process is simple, stable and does not appear to have the potential of producing harmful DBP. We recommend that the Main San Gabriel Watermaster monitor Orange County Water District's demonstration plant using Autotrophic Sulfur Reactor and to consider the development of a small demonstration plant using the BioDen™ Process in order to develop more reliable data.

REFERENCES

Bell, Kartinen, Martin,. Boyle Engineering Corporation, Ground Water Reclamation Project Engineering and Economic Feasibility Study, April 1994

Brown, Doug. Camp Dresser & McKee, Inc., City of Tustin Desalter Preliminary Design, May 1992.

Brown, Thomas, American City and County, Solving Nitrate Contamination, Vol. 110, October 1995. pg. 46

Copeland, J. and Mann, G., Nitrate Removal Technology, LLC.

Liessens, Germonpre, Beernaert, and Verstraete, Journal of the American Water Works Association JAWWA5, Removing Nitrate with a Methylotrophic Fluidized Bed, Vol. 85, No. 4, April 1993. pp. 144-154

Reilly, James F., Engineers Report for the Tustin Desalter Project, March 1991.

Richardson Engineering Services, Inc., Process Plant Construction Estimating Standards, Vol. 1, Sitework Piping Concrete, 1997 edition.

Richardson Engineering Services, Inc., Process Plant Construction Estimating Standards, Vol. 3, Mechanical and Electrical, 1997 edition.

Richardson Engineering Services, Inc., Process Plant Construction Estimating Standards, Vol. 4, Process Equipment, 1997 edition.

Ridgeway, Harry, Orange County Water District. 1997.

Sincero, A. and Sincero, G., 1996, Environmental Engineering: A design approach, Prentice Hall, Inc., Upper Saddle River, NJ. 1996

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OCCUPANT DYNAMICS IN STATIONARY AND MOVING VEHICLES SUBJECTED TO VERTICAL IMPACTS: AN EXPERIMENTAL STUDY

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While many studies have involved vehicle occupant dynamics and injury in lateral and line impacts, little research has been conducted to evaluate the effects of vertical impact and assess the potential for head and spinal injuries. This project deals with vertical impacts and provides data which should help develop severity-prediction models for furthering occupant safety. The impact is simulated by vertical stationary and moving vehicle drops of a single vehicle tire. Sensors placed at various points of interest in the vehicle and at the head region of the occupant monitored tri-axial accelerations of which profiles were collected via an onboard computer. The data was then analyzed based on the duration of impact and proximity to the point of impact, and was compared to data collected regarding vertical accelerations in common daily activities. The dampening ratios of a vehicle's chassis, seat, and of the human body are sought.

BACKGROUND

With the large number of transportation vehicles in use worldwide, one area of great concern is that of occupant safety. Over the last few years, this area has received considerable attention in the development of dynamic simulation models of vehicles' occupants. Automobile accidents alone caused 40,676 fatalities and over 3.2 million injuries in the United States in 1994. Medical costs relating to the direct care and rehabilitation of these fatalities and injuries exceeds $120 billion dollars per year. With automobile accidents being the leading cause of death for those between the ages of 1 and 34, the costs associated with production losses due to mortality is estimated to exceed $50 billion per year(Macinnis,1996).

Until recently, little research has been done to study the field of vertical accelerations sustained by humans; the majority of research has centered around lateral and line acceleration. The research in this study was prompted by the need for information concerning vertical impacts. The severity of such accidents had not been determined nor had models been developed to help give an understanding of the effects of various speed changes in vehicular accidents. In this project a series of low speed vertical stationary and dynamic impact tests were performed. It is expected that these tests will yield vital data to give a better understanding of the dampening effect in the specified areas of the vehicle and also in the human body. This data would also be useful in developing severity-prediction models of occupant injury (Macinnis,1996).

EXPERIMENT SETUP AND PROTOCOL

APPARATUS

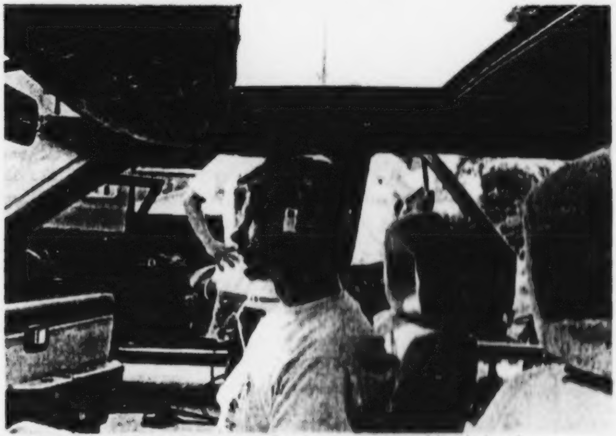
The apparatus used in the experiment included:

- An onboard computer data acquisition system.
- National Instruments VirtualBench Logger™ software (National Instruments, 1996)
- Two tri-axial piezoelectric accelerometers
- Peak accelerometers (2 arrays of 8) 2, 4, 6, 8, 10, 15, 25 and 30 g's
- Two video cameras, one still camera and video camera stanchion
- Accelerometer harness for the head (custom made in house)
- Lever system for drop test (custom made in house)

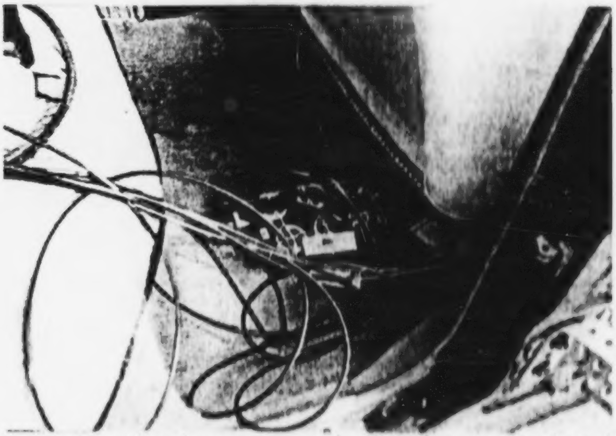
A detailed protocol was followed to guide the research and also to ensure the safety of the researchers and test subjects.

ACCELEROMETER PLACEMENT

There were two tri-axial piezoelectric accelerometer arrays; one was located under the passenger seat back and the other was located on the occupant's head harness (See Photographs 1, and 2). The two peak accelerometer arrays were located under the passenger seat back and in the trunk above the left rear tire (drivers side rear tire).



Photograph 1: Tri-axial accelerometer placement on test subject's head



Photograph 2: Tri-axial accelerometer array and peak accelerometer array located below the seat back

STATIONARY SIMULATION

The stationary crash tests were set up to simulate the effects of an actual vertical impact on an occupant. The vehicle was raised from the left rear wheel (drivers side rear wheel) using a lever system (see Photograph 3.). It was then released from the heights 12", 18", and 24" to the bottom of the rear quarter panel allowing the vehicle to fall freely to the ground. The accelerations were measured on the three Cartesian axis at a number

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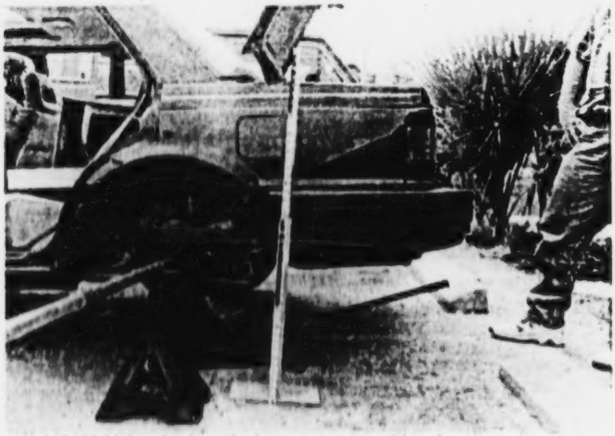
of key points in the vehicle and on the head of the occupant for the duration of impact. A sample of the stationary data appears in figure 1.



Photograph 3. Vehicle raised on the lever system awaiting drop.

DYNAMIC SIMULATION

For the two dynamic simulations, the vehicle was prepared by removing all but two of the left rear wheel's lug nuts which were engaged approximately two threads. The vehicle was accelerated up to approximately 15 mph and was then turned right causing the wheel to be ejected off. The subsequent engagement between the tire and the vehicle resulted in the rear of the vehicle being first raised as the tire rolled partially underneath and then being dropped and slid to a rest position.

Data acquired from the onboard computer for both the stationary and the dynamic runs were used to read the accelerations at the point chosen. The dampening ratios of the separate components of the system were calculated using the geometry of the vehicle and the observed accelerations over the rear tire. Accelerations were then calculated at the seat position and compared to the actual observed values. The comparison allowed for the study of the effects of the chassis, seat and body on the absorption of impact.

RESULTS

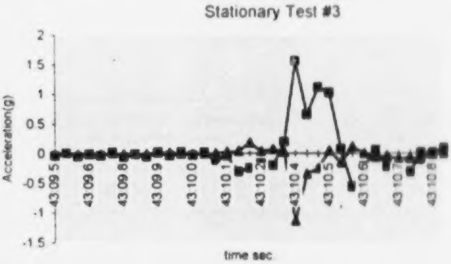


Figure 1. The vertical component of the two tri-axial accelerometers during the third stationary impact simulation (▲ at head and, ■ at chassis)

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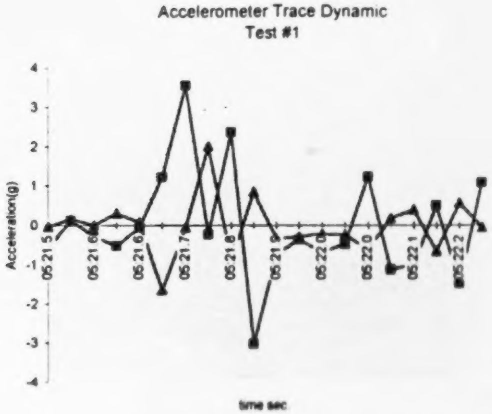

Figure 2. The vertical component of the two tri-axial accelerometers during the first dynamic impact simulation (▲ at head and, ■ at chassis)

ACCELERATIONS AND DAMPENING PERCENTAGES

Stationary Run	Peak a_{wheel}	Peak $a_{chassis}$	Peak a_{head}	Peak a_{person} Assuming no suspension
#1	2.1g	0.3g $damp_c$=71%	0.23g $damp_{c+s+b}$=78% $damp_{s+b}$=23%	1.05g
#2	3.9g	0.52g $damp_c$=73%	0.45g $damp_{c+s+b}$=77% $damp_{s+b}$=14%	1.95g
Dynamic Run				
#1	3.9g	1.40g $damp_c$=28%	0.6g $damp_{c+s+b}$=69% $damp_{s+b}$=57%	1.95g
#2	3.9g	1.33g $damp_c$=32%	0.53 $damp_{c+s+b}$=73% $damp_{s+b}$=60%	1.95g
Time Duration		$0.11 < \Delta t < 0.19$	$0.15 < \Delta t < 0.25$	

Table 1: Tolerance ≈ 11% on acceleration
c + s + b = chassis + seat + body

It was observed in both the stationary simulations and the dynamic simulations that the dampening effect in the seat and body was approximately 20%; that of the chassis was approximately 70%. The combined effect of the seat and body and chassis was approximately 75%. These numbers were within the ± 11% error calculated.

The peak acceleration experienced by the wheel well varied from 2.1g to 3.9g in the stationary simulation, but remained the same in both dynamic simulations. The suspension system of the vehicle is responsible for a_{wheel} exceeding 1g, but the research did not focus on the absolute value of the acceleration at the wheel, rather it focused on (a) the acceleration between the various points in the vehicle, and (b) the acceleration and duration experienced by the occupant.

The peak acceleration decreased considerably from the points of the wheel well, to the chassis and head. No accelerometers were positioned at the seat level to evaluate the dampening between the seat and head (this is currently being researched).

The duration of impact in all runs was less than 0.25 sec., with the head experiencing the longest duration at no more than 0.6g. Also, it is clear from the graphs that the shape of the acceleration curve at the head is much smoother and more spread out than its counterpart at the chassis and the seat. To put these forces into perspective, studies have measured the peak acceleration forces in whiplash motion from a simulated typical non-exaggerated cough at approximately 3.5g, a simple hop off a 8 inch step landing on both feet at approximately 8.1 g, and plopping passively backwards into an office type chair with a low back at approximately 10.4 g (AFSC, 1977). It was expressed by the test subjects that the forces experienced by the simulation could be compared to hitting a medium sized speed bump at approximately 15 mph (NASA, 1973).

By looking at the vertical accelerations from the simulations, a pattern of dampening was found for the system. These ratios given in percentages can be used to help approximate the amount of force experienced by an occupant. Further research is currently being conducted to separate the amount of dampening by the body. This information would prove beneficial in areas other than the study of vertical impacts.

ONGOING RESEARCH

An in-depth study to explore the dampening effect of the human body remains ongoing. A series of test composed of an exaggerated step and sit test will be used to examine the forces experienced by the human body. The test subject will be instrumented in four key points, these being the ankle, tail bone, base of the neck and head. This research will be used along with the previous data to help understand the effects of vertical acceleration and time duration on the human body.

ACKNOWLEDGMENTS

The author would like to express his appreciation to everyone at Applications Engineering Group, Inc., Jacksonville, FL, for making this research possible through funding and support.

REFERENCES

Effectiveness of Occupant Protection Systems and Their Use, National Highway Traffic Safety Administration, 3rd Report to Congress, Washington, D. C., 1996

Bailey, Mark N. Wong, Bing C., and Lawrence, Jonathan M., Data and Methods for Estimating the Severity of Minor Impacts, Macinnis Engineering Associates Ltd., Vancouver, BC, Canada, 1995.

VirtualBench-Logger software, National Instruments Corporation, 1996.

Swearingen, John J., McFadden, E. B., Garner, J. D. and Blethrow J. G., Aerospace Medicine, Human Voluntary Tolerance to Vertical Impact, Vol. 31, Dec. 960 pg. 989-998

Woodson, Wesley E., Tillman, Barry and Tillman, Peggy, Human Factors Design Handbook, 1992, McGraw Hill, Inc., New York.

Fraser, T. M., in J. F. Parker and V. R. West (eds.), Bioastronautics Data Book, 2nd ed., National Aeronautics and Space Administration, 1973, pg. 191-219

Human Factors Engineering, AFSC DH 1-3, ser. 1-0, General Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, 1977.

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SubzeroCam: Design of a World Wide Web-Based Digital Camera for Sunrayce 97

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The purpose of this paper is to demonstrate a unique merging of solar-powered vehicle design and the Internet. Sunrayce 97 is a solar-powered vehicle competition in which undergraduate students from universities across the United States and Canada design and construct cars powered only by sunlight. These vehicles then race from Indianapolis, Indiana, to Colorado Springs, Colorado, over a ten day period in June. SubzeroCam is a World Wide Web-based digital camera that displays color images of North Dakota's first solar-powered vehicle, appropriately named "Subzero" for our renowned winters. Through an inexpensive digital camera connected to the Internet via a personal computer, SubzeroCam sends updated images of the UND Sunrayce laboratory to a web page in real-time.

Ultimately, the camera was developed to allow sponsors and other Sunrayce teams observe student members of the Society for Energy Alternatives (SEA) construct Subzero over the Internet at the World Wide Web address http://www.und.nodak.edu/sea/SubzeroCam/. Time-lapse movies, known as animated GIF's, were created from key days of construction, and they are also available on the SubzeroCam home page to download and view.

BACKGROUND ABOUT SUNRAYCE 97

Sunrayce is a biannual solar vehicle race that is open to all colleges, universities, and other post-secondary institutions across the United States and Canada. Organized by the National Renewable Energy Laboratory (NREL), Sunrayce is sponsored cooperatively by the Department of Energy, General Motors, and Electronic Data Systems (Sunrayce Headquarters Web Page).

Figure 1: Aurora II – University of Minnesota's Entry in Sunrayce 95

Solar vehicle racing is on the cutting edge of alternative energy development. These vehicles utilize composite structures, high efficiency solar cells, the latest in battery technology, high efficiency electric motors, as well as computer hardware and software to push these technologies to new limits. Students face the challenge of designing a safe vehicle to operate at highway driving conditions, powered by the same amount of electricity as that used by a hair dryer.

Vehicles must pass a strict scrutineering session two months before qualifying to be eligible for the competition. The qualifying session, held in either Michigan or Arizona, determines the fastest 40 vehicles which will participate in the actual competition.

Sunrayce 97 follows a 1,150 mile race route from Indianapolis, Indiana, to Colorado Springs, Colorado, and will be held from June 19, 1997, through June 29, 1997. Each day, participants race between 75 and 150 miles on a predetermined course using state highways. The cumulative racing time over the ten day event determines the final team standings.

On a broader scale, the objectives of Sunrayce are to stimulate interest in technical education and careers among students, promote energy efficiency and the use of renewable sources of energy, and raise confidence in alternative energy methods that make fewer demands on the environment.

BACKGROUND ABOUT THE SOCIETY FOR ENERGY ALTERNATIVES (SEA)

The Society for Energy Alternatives (SEA) is the newest student engineering organization at the University of North Dakota (UND) (Society for Energy Alternatives Web Page). SEA's mission is to promote energy conservation and environmental awareness through its efforts in Sunrayce. The team consists of approximately 40 members, primarily in the mechanical and electrical engineering disciplines. The different backgrounds and experiences of the members contribute to the potential success of the team.

As a first year team, several obstacles inhibited the progress of SEA's solar vehicle. The most outstanding of these was the cost incurred for design and construction. Corporate and individual sponsorship was the answer to this dilemma. To date, SEA has managed to capture the attention of many corporations, UND alumni, and professors, and the Society has raised over $100,000 in monetary, expertise, and material donations.

Currently, the solar car is in the midst of construction. Each of the design teams (power systems, body, suspension, and chassis) set up for the project have spent incredible amounts of time designing their aspect of the car. A graphical rendering of "Subzero," appropriately named for our renowned North Dakota winters, is shown in Figure 2.

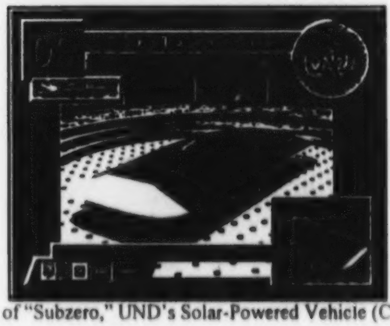

Figure 2: Rendering of "Subzero," UND's Solar-Powered Vehicle (Courtesy of VSAERO)

DESIGN AND IMPLEMENTATION OF SUBZEROCAM

An open philosophy was adapted early on by SEA team members in the development of Subzero. Being a first year team, many seemingly unanswerable questions arose which could be addressed only by teams with prior experience. Most teams were hesitant in doling out help, for they viewed Sunrayce as a serious competition between the colleges and universities involved.

To hopefully open the doors of communication among the teams, SubzeroCam was developed for the University of North Dakota's solar-powered vehicle project at the World Wide

Web address http://www.und.nodak.edu/sea/SubzeroCam/. This allows our corporate and individual sponsors and other Sunrayce teams to observe the construction of Subzero over the Internet. Through an inexpensive color digital camera, the Connectix Color QuickCam™ (Connectix Corporation Web Page), scenes of the solar-powered vehicle laboratory were collected as still digital images and image sequences during days of high activity in the work space.

Digital Camera Hardware and Software Interface

A unique aspect of SubzeroCam is that it bridges the gap between a personal computer and a UNIX station. The Connectix QuickCam™ is used on the personal computer for image and video acquisition, and a separate UNIX machine is used to support the SEA web pages.

The Connectix Color QuickCam™, shown in Figure 3, offers a quick and easy installation. The camera User Guide (Connectix Corporation, 1996) leads the user through a simple Windows 95 Plug and Play installation of the hardware (including only the digital camera with no internal computer cards) and software.

Figure 3: Connectix Color QuickCam™

The camera's software allows for easy adjustment of image size and quality. Although the fluorescent lighting conditions within the laboratory shown in Figure 4 were poor, adjustment of the brightness, hue, white and black levels, and saturation help produce an excellent image. Image size was set to "Half" (320x240 pixels) to maximize overall image size and minimize the file size on the computer hard drive. The Color and Sharpness features were maximized to attain the best possible image. With these above settings, the average JPEG-format file was 12 kilobytes in size. Focusing was performed by the adjustable ring on the outside of the lens.

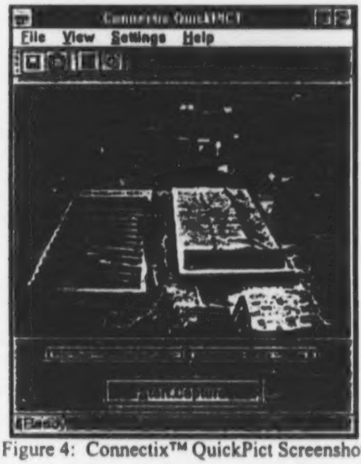

Figure 4: Connectix™ QuickPict Screenshot

Other features include the capability to take pictures automatically and at varying time intervals with the auto capture options. This allows the camera to be set up in basically two modes: single or multiple image capture. Normally, the single capture mode is desired, essentially to conserve space on the hard drive of the computer. After choosing a time interval between every picture, a file name must be chosen. In Figure 5, the interval time was set to 5 minutes, and the software was set to save the single image each time as "subzero.jpg." On key days of vehicle construction, digital video sequences were created by changing the camera set up so that an image was captured every 5 minutes and then saved as a unique file name. For the multiple image capture mode, the file series must be indicated; e.g., the sequence "subzero.jpg" automatically saves the images as subzero1.jpg, subzero2.jpg, etc.

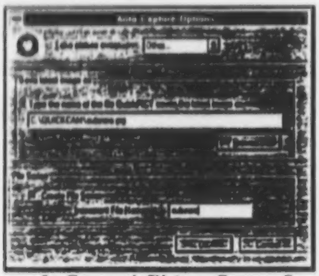

Figure 5: Connectix™ Auto Capture Screen

This digital camera was connected, via the parallel port, to a personal computer (486/33 MHz) running the Windows 95 operating system. With the use of a program called Microsoft Front Page, downloadable at http://www.microsoft.com, the personal computer was set up as a web server (FrontPage 97 Web Page). This allows the computer to be connected to the campus network via an Ethernet connection. This configuration has its own allocated Internet Protocol (IP) address and web site name.

The most difficult problem dealt with getting the "subzero.jpg" image from the personal computer used for image acquisition to the UNIX server where the Society for Energy Alternatives web pages reside. With the described set up, a link can be set within the HTML code of the SEA web page to the images saved by the digital camera software.

The final result of the SubzeroCam web page containing the image "subzero.jpg" is shown in Figure 6 as viewed by the Netscape Navigator© web browser. To date, the visitor count is over 8,000, with a goal of 10,000 hits by May 1997.

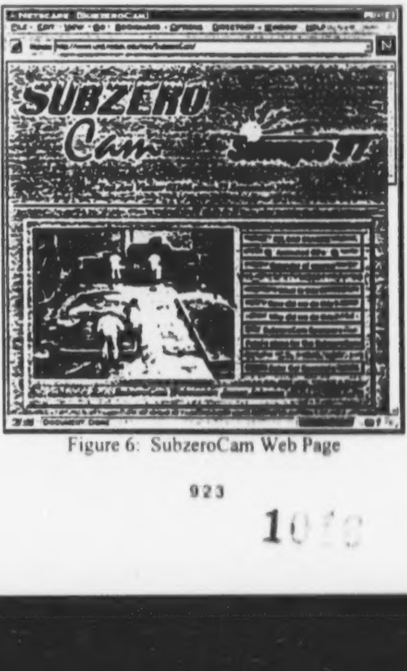

Figure 6: SubzeroCam Web Page

Animated GIF's: Generation of Digital Video Sequences

SubzeroCam was originally inspired by another Internet camera at the University of Notre Dame known as the DomeCam (DomeCam Web Page). Although similar in nature to SubzeroCam, it is a completely UNIX-based camera that views the golden dome of the administration building on the Notre Dame campus. Images are captured every five minutes, and at midnight the images are compiled to create a 24-hour time-lapse movie in the MPEG-format. The advantage of the DomeCam configuration is that the UNIX script was developed to automatically create time-lapse movies in the commonly accepted MPEG digital video format.

For SubzeroCam, a similar approach was taken to generate digitized video sequences. Time-lapse movies, known as animated GIF's, were created from key days of construction. With the use of a shareware program called the GIF Construction Set for Windows, downloadable at http://www.mindworkshop.com/alchemy/alchemy.com, a series of images can be concatenated to create a digital video sequence (GIF Construction Set for Windows Web Page). A built-in wizard guides the user through this process with relative ease. Essentially, it lets you choose the images to be used in the sequence and then prompts for the desired time interval between each image. Animated GIF's are viewable in many web browsers, including Netscape® and Microsoft Explorer®. Several movies are available on the SubzeroCam home page to download and view.

The challenge of using this shareware program was making sure that the individual still images were in the correct sequence. Since the file series ends with numbers, the file subzero1.jpg will immediately be followed by subzero10.jpg, placing images 2-9 out of sequence. The result of placing many images in order quickly becomes a tedious process. Attempts are still being made to automate this process, preferably on the personal computer side.

CONCLUSION

An inexpensive World Wide Web-based digital camera was successfully created to allow sponsors and other competing Sunrayce teams watch the construction of the University of North Dakota's first solar-powered vehicle. With the use of the Connectix QuickCam™ and its software, SubzeroCam was designed and implemented. This camera captures digital images of the laboratory work space where Subzero is being constructed, and those images are continually updated to a specially designed web page located at the address http://www.und.nodak.edu/sea/SubzeroCam/. Animated GIF's were also created from key days of construction and are available to download and view.

ACKNOWLEDGMENTS

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REFERENCES

Connectix Corporation, 1996, ColorCam User Guide™, (San Mateo, CA), May 1996.
Connectix Corporation Web Page. Information on the Connectix Color QuickCam.
    Available http://www.connectix.com/.
DomeCam Web Page. University of Notre Dame Internet Web Camera.
    Available http://lisa.ee.nd.edu/DomeCam/.
GIF Construction Set for Windows Web Page. Alchemy Mindworks Inc.
    Available http://www.mindworkshop.com/alchemy/alchemy.html.
FrontPage 97 Web Page. Microsoft Web Page. Available http://www.microsoft.com/frontpage/.
Society for Energy Alternatives Web Page. Available http://www.und.nodak.edu/sea/.
Sunrayce Headquarters Web Page. Available http://www.sunrayce.com/sunrayce/sunrayce.html.

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Using Java for Computational Electromagnetic Scattering

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ABSTRACT

Java is a new and progressive language, which, to this point, has been used mostly for simple purposes, such as providing interactive graphical user interface (GUI) components on web pages (Lemay, Perkins, 1996). However, the potential of the Java language has yet to be realized. Its platform independence and ability to utilize the largest network in the world, the world wide web, will one day allow a standard personal computer to have the same power as a super computer, such as a Cray. This project explored that potential, examining the ability of the Java language to perform a large number of floating point operations by computing a computational electromagnetics code. This code, employing the Finite Difference Time Domain method for electromagnetics, was modeled after a Fortran version written by Dr. Raymond Luebbers, Dr. Karl Kunz, and John Beggs, of the Pennsylvania State University (Kunz, Luebbers, 1993). Output from both codes was compared and proved identical. Run-time performance was also examined, and the Java code was slower. However, beta versions of Java compilers were sampled (but cannot be published due to a non-disclosure agreement) and proved much faster than their predecessors, only slightly lagging behind Fortran run-times. Additionally, since computational science relies on enhanced visualization techniques, Java's graphics capabilities were explored in the project. This feature, not provided by the Fortran language, was examined by animating the scattered electromagnetic field. While the animation is very coarse, it is expected that Java's graphics capabilities will follow an evolution similar to current video game systems. This complete code can be found at http://www.personal.psu.edu/lnl/fdtd.

BACKGROUND

Fueled by its application to multiple scientific disciplines and numerous industrial applications, computational electromagnetics (CEM) is a growing field. For example, oceanographers rely on CEM methods to analyze electromagnetic backscattering from the ocean bottom. Organizations such as NASA rely on CEM methods to inspect electromagnetic wave transmissions from space and from antennas. While there are several computational electromagnetic methods in existence, one of the most widely used and increasingly popular is the Finite Difference Time Domain (FDTD) method. Besides being much simpler than other computational methods to grasp and implement as code, the FDTD method is able to effectively model complex geometries and most material types. This allows for a broad range of capabilities: the ability to analyze scattering and radiation problems involving wires and plates, to model microwave propagation through inhomogenous biological materials, and to analyze electromagnetic backscattering from aircraft, such as in stealth technology (Kunz, Luebbers, 1993). The question, then, is given the increasing need for effective computational electromagnetics, and the growing popularity of the FDTD method, what is the most advantageous way to implement this method? This project explores that question by examining the advantages of the Java language applied to computational electromagnetic scattering.

INTRODUCTION

Java is extremely attractive for computational science (not just electromagnetics but fluid dynamics as well) for three main reasons. First, Java has several inherent characteristics, such as threads, which are well supported by many of today's powerful processors, such as the SMP. Second, Java naturally understands networks, and can transmit through the largest network in the world, the world wide web. And, because Java is object oriented, this feature allows Java to distribute object models to multiple machines connected to the network, and for those processes to run in parallel. Currently, Java does not allow message passing between parallel processes, but it will in the near future. Third, Java's graphics capabilities, while primitive at this point, allow for enhanced visualization of electromagnetic (or fluid dynamic) fields. Visualization of such fields in the past has relied on static images viewed in discrete time intervals-- much like tracking a moving ball with multiple pictures from a still camera. However, the Java language allows for visualization of these fields over a continuous time interval-- like tracking the same moving ball with a video camera instead of a still camera. This ability to animate and display physical processes in nature has further implications for educational institutions, providing excellent visual aids for professors and students of engineering and science disciplines.

Furthermore, a significant attraction of Java is its ability to implement very appealing GUIs, or graphical user interfaces (Lemay, Perkins, 1996). Whereas most programming languages require the user to "hardwire" code parameters, the Java language allows the user to manipulate the same parameters with buttons, scrollbars, menus, etc. This dramatically increases the usability of the code.

METHOD

Approach

The FDTD method has multiple capabilities (analysis of currents, power density, interior coupling, scattered fields, etc.) for a variety of electromagnetic devices (such as lasers, microwave, radar) and for a variety of systems responding to that stimuli (aerosols, humans, aircraft, etc.). This project will analyze the FDTD capability to model the scattered field and radar cross section from an airplane wing responding to a radar wave.

These factors were chosen based on a unique problem posed to current stealth technology research, stealth helicopters. The design of most stealth aircraft involve optimizing both the geometry of the aircraft and its material. However, the airfoil geometry of the helicopter blade can not be altered much, since it is the characteristic airfoil shape which produces the required lift. Therefore, the design of stealth helicopters must rely on the optimization of the material properties of the helicopter blade. Because the FDTD method can analyze complex geometries and most penetrable dielectric and magnetic materials, the FDTD approach is a good candidate for examining these material properties.

Algorithm

Implementation of the FDTD method for electromagnetic backscattering requires six main steps:

1. Define the problem space cell size
2. Construct the target object
3. Define the size of the time step
4. Analytically specify the incident field
5. Perform the computation on the scattered field
6. Apply the boundary conditions.

The problem space, including the geometry of the target object, is defined in rectangular cells with dimensions of no more than 1/10 the wavelength of the incident field. Secondly, the target object is constructed in Yee cells (Yee, 1966). Although building the object in rectangular cells does produce some staircasing of the geometry, accurate modeling can still be made by minimizing the dimensions of the Yee cells. The time step for iterating the computation must be chosen such that the electromagnetic waves do not propagate through more than one cell per iteration. This is known as the Courant stability condition, and the time step is usually chosen as the smallest cell dimension divided by the speed of light. Fourth, the incident field must be defined. This is an analytical specification, a key advantage of the FDTD method, and the incident field is chosen as a Gaussian pulse. The parameters for this step consist of the pulse amplitude, frequency, and width in time steps. The fifth step involves the advancement of the x, y, z component of the scattered electric and magnetic fields. Lastly, some outer radiation boundary condition must be applied to account for the usual boundary effects in computational modeling. This project used a second order Liao boundary condition method, which is a standard method in computational electromagnetics.

The run time of the algorithm is dependent on the dimensions of the 3-D problem space and the maximum number of floating point operations per second (FLOPS) supported by the computer on which the code runs. For N number of cells in the problem space, 6 components per cell (Ex, Ey, Ez, Hx, Hy, Hz), 10 operations per component, and T time steps, the run time is approximately 60 x N x T divided by the maximum number of FLOPS on the machine.

Implementation of Java

Because of the large number of computations required for this method, and for other computational methods, parallel processing computers are often used to allow for larger problem spaces (Ahuja, 1995). Most parallel processors will only accept non-object oriented languages such as Fortran and C. However, to view computational fields, it is preferable to incorporate the most modern graphics capabilities. More and more, modern graphics technology is using object oriented software, for example the Virtual Reality Modeling Language (VRML). It becomes useful, then, for computational science to follow a similar path, such that modern implementations of computational methods are compatible with modern graphics technology. The disadvantage of object oriented computational methods, currently, is that they are often not supported on parallel processors, and thus are restricted to the size of the problem space they can generate. However, object oriented coding does possess a multi-threading feature, which allows for simultaneous execution of separate tasks. So, for example, six separate threads could simultaneously compute the scattered electric and magnetic fields in the x, y, and z directions. The current restriction on this feature is that message passing between threads is not supported, so the processes must be independent of each other. Methods for message passing, though, are quickly being developed, and will make Java even more efficient-- perhaps allowing clusters of standard PCs to mimic a supercomputer.

It is for this reason that the Java language was chosen for this project. Java has a networked based architecture and is platform independent. Therefore, individual threads can run on separate processors. Also, Java can be transmitted across the internet, so the processing power is massive. Furthermore, Java is directly compatible with VRML, so it provides enhanced visualization. Multi-threading and VRML, however, were not investigated at this time. Instead, the project examined Java's run time speed in performing the computation, accuracy of the results, and Java's ability to animate those results. The Java code for this FDTD method was modeled after a Fortran version designed by Dr. Raymond Luebbers and Dr. Karl Kunz of the Pennsylvania State University (Kunz, Luebbers, 1993). Run time speed and results were compared between the Fortran and Java code on multiple platforms.

Design

The URL for this applet is http://www.personal.psu.edu/lnl/fdtd , and the design of the code is illustrated by the flowchart in figure 1. The modules called within Fdtd class are inter-meshed, passing static variables or instance variables between each other. ImageFoil, Fdtd, Animate, and Graph are all pop- up windows within which the computations are performed and/or the displays generated. Because the computation is performed within a pop- up window, multiple computations can be performed simultaneously, assuming the user machine has sufficient memory to handle the data storage.

RESULTS

Figure 2 depicts the results of the run-time comparison between Java and Fortran for the FDTD code. This graph is for a 20x20x20 cell problem space with 200 time steps, approximately 96x10^6 FLOPS. A more comprehensive comparison of run times for various MFLOPS between Java and Fortran can be found at the Java Linpack web site, http://www.netlib.org/ benchmark/ linpack.java. While Java does lag behind Fortran, the Java compilers are rapidly becoming more effective (unfortunately, the beta compiler can not be named because of a non-disclosure agreement). Whereas Fortran has been optimized over the past 20-30 years, Java is only a few years old, yet is developing and evolving at a much faster rate. Based on the Java Linpack data and the results obtained in

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- SetParameters.class (GUI for setting code parameters and a nest for pop-up windows)
  - →ImageFoil.class (displays the user selected airfoil)
    - →nacaFoil.class (computes the coordinates for the airfoil)
  - →Fdtd.class (initializes variables and class instances based on the parameters selected in SetParameters.class)
    - →Func.class (performs various EM functions)
    - →Build.class (determines material properties for idone, idtwo, etc. arrays)
      - →nacaFoil .class
    - →ElecMagFld.class (stores and performs methods on E and H variables)
    - →FarZone.class (responsible for near to far zone transformations)
    - →LiaoBC.class (applies 2nd order Liao boundary condition to E field)
    - →rcs.class (computes radar cross section)
      - →Complex.class (handles complex numbers and operations)
    - →animate.class (computes magnitude of E and H field)
  - →animate.class (animates E or H field in user selected 2-D plane)
  - →Graph.class (plots rcs vs. azimuthal angle phi)
    - →rcs.class

Figure 1. FDTD Flowchart

this project, it is evident that Java is quickly becoming comparable in run-time to an established language such as Fortran. This provides supporting evidence for the effectiveness of Java applied to computational electromagnetic scattering.

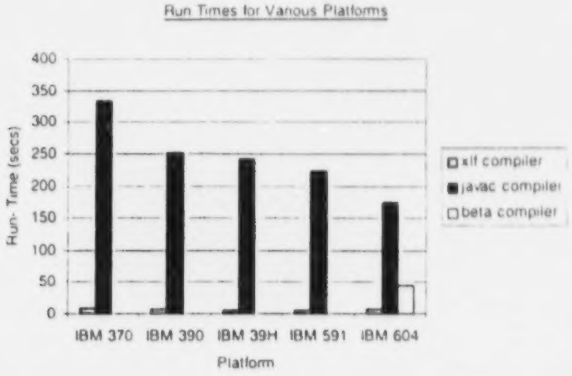

Figure 2. Run-time comparison between Fortran and Java on various platforms

Figure 3 displays the I-J plane cross section of the scattered electric field in the x direction at time step 30 for the same conditions as figure 2. The Fortran output is depicted by diamonds (from the Fortan "xyzIJ.dat" data file) while the Java output is depicted by dashed lines (from the Java "exsIJ.dat" data file). The similarity of results is very promising. Because different compilers handle floating point operations differently, and because Java is significantly less developed than Fortran, this level of accuracy was not expected.

CONCLUSIONS

The results of this project provide supporting evidence for the use of Java for complex tasks such as computational electromagnetic scattering. Java has demonstrated 1) an ability to produce accurate results at a high level of precision, 2) potential for run-time performance comparable to an established computer language, 3) because of its multi- threading capabilities, a potential for parallel performance-- perhaps in the future, comparable to parallel supercomputers (Ahuja, 1995).

There are a few suggestions for improvements on this code. For example, the

ElecMagFld.class module currently contains the six methods which need to be performed

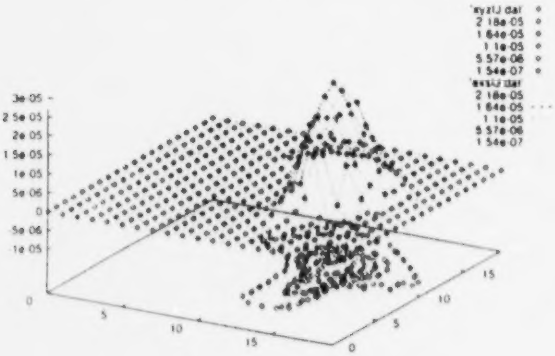

Figure 3. Scattered Ex field for a single time step

on the electric and magnetic fields. Because these methods can be run independently, without communicating between each other, this class could be divided into 6 separate classes implementing threads. The threads perform the six methods in parallel, and each class containing the thread would extend a parent class containing the field values. This would decrease the run time by an order of magnitude. Caution must be taken, however, that other methods or threads within the computation do not perform their operations prematurely. For example, the LiaoBC.class must not perform operations before the E field methods have been performed. Additionally, since the operations are performed within a time step loop, the loop must not be able to advance until all operations for that iteration have completed.

Further, improvements in graphics can be made in the animate.class module. Hopefully, with advances in such languages as VRML, the ability to display an animated 3D electromagnetic field will become a reality. Also, Java needs to incorporate an animation routine which does not simply call a repaint method within a loop. For a large number of small pixel cells (e.g. 40x40 grid of cells with dimensions of 10 pixels), a "curtain" effect develops.

The future of Java looks very promising. With improvements in data parallel and message passing features, and graphics capabilities, Java may become the dominating computer languages. A worthwhile URL to visit is http://www.javaworld.com/javaworld/jw-01-1997/jw-01-dampp.html, which discusses a Distributed Applet Massively Parallel Process (DAMPP). This DAMPP system performs a ray tracing computation by using Java's network feature to allow the computations to run in parallel on multiple machines connected to the world wide web. However, this computation does not involve any message passing between the threads, which many computational methods require. This method is tribute, though, to the potential of the Java language.

REFERENCES

Ahuja, V. "A Finite Volume Time Domain Method for Maxwell's Equations on Parallel Computers". Ph.D. Thesis, Pennsylvania State University. 1995.

Kunz, K.S., and Luebbers, R.J. The Finite Difference Time Domain Method for Electromagnetics. CRC Press, Inc., Boca Raton 1993.

Lemay, L. and Perkins, C.L. Teach Yourself Java in 21 Days. Sams.net, Indianapolis, 1996.

Yee, K.S. "Numerical Solution of Initial Value Boundary Problem Involving Maxwell's Equations in Isotropic Media", IEEE Trans. Ant. Prop., 14(3), 302, 1966.

Flat Oceans and Satellite Radar Anomalies

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Radar backscatter coefficient records for the TOPEX/Poseidon radar altimeter were found to possess abnormal spikes in amplitude. It was postulated that these high returns were somehow related to a lack of surface roughness providing a high pulse energy return. Global occurrence of the spikes was examined and ocean surface characteristics at the geographical location of the spikes were investigated. A correlation study was made of ECMWF wind forecasts with backscatter and other data products. Negative correlation was found, implying low wind conditions cause a large majority of the phenomena. Surface slicks, both biogenic and man-made, were also implicated. Abnormal backscatter readings add noise to the sea surface height product, important to global change calculations. Current editing guidelines seem to compensate for the anomaly, which should be considered in the next generation of altimeter algorithms.

INTRODUCTION

Radar altimetry has become a major tool for measuring global ocean circulation with its development from GEOS-3, Seasat, Geosat, ERS-1, TOPEX/Poseidon, to ERS-2. The radar altimeter yields an accurate measurement of the height from the instrument in orbit to the ocean's surface. This is done by timing the two-way travel of a microwave radiation radar pulse from altimeter to nadir (the spot directly below the satellite on the ocean's surface) and back. The fundamental measurements are significant wave height (swh), sea surface height (ssh), and backscatter coefficient (σ^0), which is derived from the radiation scattered back to the satellite. SSH is found by applying precision orbit data, earth's geoid, tidal and atmospheric corrections to the pulse's travel time.[1] SWH is calculated from the slope of a pulse's waveform. The method of pulse altimetry is documented by Chelton, Walsh, and MacArthur.[2]

The need for calibration is obvious and a detailed strategy for the calibration of radar altimetry missions is outlined by Koblinsky et. al.[3] As mentor, Koblinsky assigned the author the task of investigating apparent 'spikes' in the TOPEX σ^0 data. Before detailing previous work on the spikes, we will look at σ^0 itself.

The radar backscatter, σ^0, is derived from the instrument specific automatic gain compensation, AGC. The AGC determines the attenuation that is applied to the returned signal to keep a constant output power. This is described in better detail by Rapley[4] and Chelton et al.[2] Each particular instrument has its own AGC. After several instrument specific constants are subtracted, a measure of the σ^0 is derived. This backscattered power depends on the sea surface roughness, which is dependent mostly upon wind speed.[5]

George Hayne and Dave Hancock did the initial work on σ^0 spikes which is documented in part in the Observational Sciences Branch WWW site.[6] They refer to the data anomaly as σ^0 blooms. As suggested by Dr. Kevin Arrigo, they will be referred to here as σ^0 spikes. Blooms can refer to plankton blooms, which are themselves a possible cause of σ^0 spikes. Hopefully this will circumvent any confusion from mixing biology and engineering.

Originally, scientists from Johns Hopkins Applied Physics Lab queried Hayne and Hancock about fluctuations in TOPEX Vatt, which is a measure of satellite attitude. If Vatt is zero the satellite is pointed straight at nadir. A subsequent investigation led them to notice regions of the AGC where the response rose by 6 dB or more, i.e. the spikes. They found it was not an instrument problem, and thus concentrated on the σ^0.

The spikes are marked by local increases in σ^0 to above 12 dB in the Ku band, and above 16 dB in the C band. They are found in all cycles and persist for up to tens of seconds. The TOPEX dual band altimeter allows scientists to calculate the ionospheric correction from the difference between the two bands. The waveform based attitude estimate (Vatt) increases during a spike to a limit of 2.55 degrees, signaling Vatt out of normal bounds. The spacecraft's actual attitude changes very slowly. These attitude out-of-bounds markers are caused by the σ^0 altering the waveform amplitude. This causes the trailing edge to fall off faster than the algorithm is programmed to accept. Refer to Chelton, Walsh, and MacArthur[2] for how the waveform is derived and for a look at a sample waveform. It is emphasized that the satellite is not actually aimed away from nadir during a spike. The spikes generally occur at low SWH, but can be found at values up to 4m. Such σ^0 spikes have been seen in Geosat[6] and ERS-1[7] data. Guymer and Quartley also cite the importance of σ^0 in deriving correct sea surface topography.[7]

In an initial investigation of one full cycle (10 days), Hayne found the spikes to affect 5% of the overall data.[8] Spikes could affect SSH measurements in two ways. An anomaly in the ionospheric correction (tied to a spike) would cause an error in the range, since ionospheric correction is a constant used in finding the range. If the σ^0 spike is linked to an increase in sigma height (sigh: the 10/sec rms of SSH), this would indicate the range value is not as reliable during a spike. A spike could also tell us something about the ocean's surface, perhaps indicating a slick or calm area.

METHODS

We desired to make a correlation analysis of the σ^0 spikes and actual ocean surface conditions. After discussion with Hancock, Hayne, and Koblinsky, it was opted to use a conservative value of 16 dB K-band to demarcate a spike in my investigation. In retrospect, 13.5 dB would have been a more thorough value. However, the one used saved computing time and still provided plenty of data.

We know ocean surface roughness, which is due to wind energy, is the main cause of radar backscatter. Capillary waves are believed to begin at wind speeds above 4 m/s. It isn't until wind speed reaches 5 to 7 m/s that the ocean's surface begins to experience wind loading and the consequent increase in roughness.[9] Surface slicks, whether biogenic (caused by plankton blooms or some biological process) or manmade (such as oil), tend to decrease surface roughness. Thus we expect σ^0 spikes will occur under low wind conditions or when the altimeter tracks a slick, since that is when the ocean's surface is calmest and smoothest.

The first step was to analyze all the material available on the OSB Web site.[6] which includes histograms and a movie of bloom occurrence. With Kenny Rachlin, occurrence maps were generated using TOPEX tracks 11 to 100. We saw a higher rate of occurrence in the tropical latitudes and the doldrums. Spikes that were possibly caused by formation of sea ice in higher latitudes have been edited out of the GDR. We also generated AGC maps for both bands and K-band σ^0 maps for the individual cycles 11-100. These were examined for temporal and spatial patterns.

Prevailing winds and climate maps were analyzed. Monthly maps of SSMR (side scanning microwave radiometer), ECMWF (European Center for Medium range Weather Forecasts), and COAPS were available.[10,11] These various wind products all showed low winds in the tropics and high winds (>7m/s) in areas where spikes were less frequent.

All summer I searched for a synthetic aperture radar (SAR) image of a surface slick that had also caused a spike when TOPEX passed over. A surface slick shows up as a black patch when viewed by SAR. This was not an easy thing to find. However, one did turn up in the JPL home pages.[12] This will be discussed further in the results section. The difficulty of finding a match between a satellite overpass and a shipboard observation, which was also tried, is discussed by Srokosz and Guymer.[13] In order to match TOPEX σ^0 spikes with biological slicks one could use coastal zone color scanner (CZCS) data, but none was available for the relevant time period.

It was decided to concentrate on one section of ocean that held a high number of σ^0 spikes. The test area covered -20 to 20 N latitude and 100 to 180 E longitude, in the western tropical Pacific, shown as an occurrence map in Figure 4. I downloaded all the σ^0 data for every TOPEX track in this area from cycles 11-100. This corresponds to late 1992 through the end of 1994.

The only wind data which was readily available was ECMWF gridded u and v wind component forecasts. This is from a 2.5 by 2.5 degree grid and calculated every twelve hours at midnight and noon. With the help of Christine Boone I downloaded the data in the test area and interpolated the wind component onto the TOPEX tracks, thus getting wind speed. The ECMWF claims an accuracy of just over 90% on their forecasts.[14]

I also downloaded the TOPEX C-band σ^0, ionospheric correction (ionocor), swh, Vatt, and sigh values for the test area. Statistical analysis in the form of autocorrelation, crosscorellation, correlation coefficients, and best fit lines to scatter plots were performed and calculated for the data. Correlation was calculated following Bendat and Pierot.[15] Correlation coefficient was calculated by a MATLAB routine. Specifically, we looked at σ^0 versus SWH, ionocor, sigh, Vatt, and wind speed.

Doug Vandemark supplied a graph of TOGA-TAO buoy[16] wind speed data that was taken when TOPEX passed within one mile nadir from the buoy within one hour of the time the data was uploaded from the buoy and a σ^0 over 16 dB was recorded.[17] This provided a nearly in situ measurement of wind speed. However, only 69 times since the buoy array was deployed have these conditions been met.

RESULTS

One SAR image correlated to a bloom was found (see the Web address listed in reference 12). This is an image of oil production off the coast of India, centered at 19.25 N and 71.35 E. TOPEX headed southbound over the region, crossing the top half of the picture from top left to middle right. The σ^0 is 14 dB at the top of the image and increases to 16 dB at the bottom.

A maximum in the autocorrelation function appearing to the right of the origin would indicate some periodic response in the spikes, whether temporal or spatial. All the autocorrelations generated showed no maximum.

Crosscorrelation between wind speed and σ^0 was plotted. A negative correlation was seen, which means high values of σ^0 occur at low wind speeds. This type of analysis for C band compared with K band showed the same spikes at the same times and places for the two bands. The only difference was the expected one of amplitude.

Several factors limited the amount of data analyzed. A few of the tracks started at the equator, headed north to 20 degrees, then wrapped around again from the south and finished at the equator. This created discontinuities in σ^0 and wind speed. About one tenth of the data tracks analyzed were for times where the ECMWF forecast changed days. This also led to discontinuity. An error in the program which downloaded wind vectors limited us to five good cycles of data, or five groups of ten days, each spread four to five months apart. Five cycles of ten tracks over the open ocean (north to south) were used, giving a data set of fifty records of wind vs σ^0. The same tracks were used for σ^0 vs the other types of data with all cycles available. Crosscorrelation was variable over the data set analyzed. Four examples of positive correlation (out of 50) were also found.

Scatterplots of wind vs σ^0 were made for each track. Correlation coefficient and a best fit line was also calculated for each track and the entire data set. Seventy-five percent of all spikes occurred at wind speeds below 5 m/s. The average values were calculated from the average of each track over the 5 useful cycles, where each average value was the mean at a certain geographical location. The significance (using the -0.356 correlation coefficient of average values) is 67.3%.[15] The significance of the slightly lower value of correlation coefficient ($\rho = -0.2421$) calculated from the overall data set is 91.9%. Out of 30,717 individual 1-sec averaged values analyzed, 2,229 had $\sigma^0 > 16$ dB, or 7.26%.

Scatterplots of swh vs σ^0 showed the expected inverse relationship. High values of σ^0 seemed to occur at low swh. Above about 4 m, spikes aren't present. Plotting the ionospheric correction (which varies from night to day) vs σ^0 showed no evidence of a correlation. Spikes did not produce corresponding anomalies in ionocor. The best fit line to σ^0 vs sigh shows an increasing value and thus higher standard deviation of height values as σ^0 increases.

Doug Vandemark at Wallops found 69 instances where TOPEX passed over a TAO buoy[17] within an hour of recording a σ^0 greater than 16 dB. The starting geographical distribution of the TAO buoy array can be found at the WWW address cited in reference 16. The wind speed for each TOPEX passover that included a σ^0 spike was never above 5 m/s.

CONCLUSIONS

From these results we can draw certain conclusions. We have a good match between a SAR image of man-made oil slicks and a spike in σ^0. This confirms the initial suspicions that spikes are caused by lack of surface roughness. More effort could be made to develop SAR images of surface slicks and match a shipboard study to the altimeter's over flight. An investigation of the ocean's air-water boundary layer could also shed more light on this phenomenon.

The autocorrelation showed no periodic characteristics either temporally or spatially. Spikes present during one pass have no effect on the following pass over the same area. This implies spikes are on a temporal scale that is shorter than one cycle, which is ten days.

Spikes look the same in both C-band and K-band. Both radar bands react to the phenomenon in virtually the same way. This is supported by the fact that the ionospheric correction values studied were unaffected by spikes.

The crosscorrelation between wind speed and σ^0 showed a net negative correlation as expected. However, a few tracks also exhibited positive correlation. The correlation coefficient between predicted wind speed and σ^0 was not very high. However, the correlation was shown to be statistically significant. We can be reasonably certain of the correlation between spikes and low winds. We must also keep in mind ECMWF winds are 12 hour averages interpolated onto the tracks from a 2.5 by 2.5 degree grid. This means we do not have the exact wind speed at the time and place Topex took the data. This level of accuracy is still meaningful. Over 75% of the spikes occurred at wind speeds of less than 5 m/s. It is likely that most of the other fourth can be chalked up to the error due to not having in situ measurements of wind speed. The best fit curve to the data was similar to the algorithm shown in Chelton & McCabe.[5]

The TAO buoy data shows spikes occur in winds under 5m/s. This method of in situ measurement showed no spikes over 5m/s. Both the predicted wind speed and the actual wind speed from the buoy does not show a link between wind speed and spike strength in dB. Forsooth, the amplitude of the spikes seems to be random. Perhaps amplitude is related to surface area of the slick or calm encountered.

The spikes cause higher than normal values of sigh. A linear relation between σ^0 amplitude and sigma height value was seen. This means that the higher the σ^0 the higher is the noise or error in the value derived for sea surface height. Current editing guidelines issued by the OSB say not to use data points for which the attitude marker is higher than 0.12 degrees. In the study region, this guideline eliminated most of the spikes > 16 dB. Using this guideline, only one percent of spikes over 16 dB remain in the data. However, 6% of spikes over 13.5 dB remain. Due to a counting loop error the actual data for these percentages is not precise. We can safely say editing rids the data of the very high amplitude spikes, yet a small part of the data still has σ^0 values larger than normal. Topex users should decide if this is significant to their research.

REFERENCES

1. AVISO, Aviso User Handbook: Merged Topex/Poseidon Products, AVI-NT-02-101-CN, Edition 2.1, 1992.
2. Chelton, D.B., E.J. Walsh, J.L. MacArthur. 1989. Pulse Compression and Sea Level Tracking in Satillite Altimetry. Journal of Atmospheric and Oceanic Technology Vol. 6, June 1989: 407-438.
3. Koblinsky, C.J., P. Gaspar, G. Lagerloef, editors. The Future of Spaceborne Altimetry: Oceans and Climate Change, Joint Oceanographic Institutions Incorporated, Washington DC, 75 pp, 1992.
4. Rapley C. Satellite Radar Altimetry. from Space Oceanography. Cracknell, A.P. ed. World Scientific Publishing Co. Ptc. Ltd., Singapore, 1992, pp355-370.
5. Chelton, D.B., McCabe, P.J. 1985. A Review of Satellite Altimeter Measurement of Sea Surface Wind Speed: With a Proposed New Algorithm. J. of Geophysical Research, Vol. 90 No. C3 pp 4707-4720.
6. Orbital Sciences Branch Topex Web Site, http://osb3.wff.nasa.gov/topex/blooms/blooms.html
7. Guymer, T.H., G.D. Quartly. The effect of Rain on ERS-1 Altimeter Data. ESA SP-359, Proceedings First ERS-1 Symposium - Space at the Service of our

Environment. Cannes, France, 4-6 November 1992.

8. Hancock, D. & G. Hayne, personal comunication
9. Shepard, class notes from Introduction to Coastal & Oceanographic Engineering University of Florida. Spring 1996.
10. Halpern, Fu, Knauss, Pihos, Brown, Freilich, Wentz. An Atlas of Monthly Mean Distributions During 1993. JPL Pub 95-3.
11. COAPS Web Site; http://www.coaps.fsu/fsuwinds/
12. JPL Radar Imaging Web Site, http://www.jpl.nasa.gov/sircxsar/oilsk.html
13. Srokosz, M.A., Guymer, T.H. 1988. A Study of the Effect of rain on Seasat Radar Altimeter Data. Proc. of IGARSS '88 Symposium. Edinburgh, Scotland, 13-16 Sept. 1988. ESA SP-284: 651-654.
14. ECMWF Web Site
15. Bendat, J., A. Piersol. 1986. Random Data: Analysis and Measurement Procedures, 2nd edition. John Wiley & Sons, Inc. New York. pp 566.
16. TOGA/TAO buoy homepage, http://weir.pmel.noaa.gov/toga-tao/gif/tao-array-huge.gif
17. Doug Vandemark, personal communication

Cyberprint:
Creating Alternative Medical Visualization Tools Using Architectural Metaphors

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The *cyber* PRINT project focuses on the need for medical visualization tools that aid doctors in the quick assessment and accurate monitoring of physiological conditions. Previous attempts at designing effective, real time, visualization devices have been hindered by poor graphic metaphors, and lack of design considerations. This design work helps to show associations of bodily functions by using traditional architectural representation methods and the metaphor of a building. The design ultimately becomes a depiction of an individual's physiological data in real time inside the digital space.

BACKGROUND

Humans are largely visual creatures. Throughout time humans have used pictures to communicate difficult concepts quickly and effectively. These pictures, like the ancient pictographs found in the Lascoux caves, help us make inferences that lead to better and quicker understanding of the message behind the picture. Research connected to thinking, imagination, intelligence, ideation, learning and other complex mental processes, shows that visualization plays a sophisticated and essential role in helping humans manipulate and understand information (Arnheim 1969, Bronowski 1978). In fact, our ability to use imagery has led to some of the most important technological, cultural and conceptual innovations in the history of humankind (Klima 1985). McCormick *et al.* stated in a report to the National Science Foundation ("Visualization in Scientific Computing") that there is so much information being produced today that all the scientists can do is archive it until a future date. This report postulates that interactive graphic displays are the best available solution in managing all this information due to their ability to convey large amounts of information in a simple and understandable way.

It is in the electronically sustained virtual environment of computers where the scientific visualization of complex data can finally take place and grow. Digital space can be seen as a database, that is, an information environment organized in a logical manner so that data is easily depicted, accessed, navigated, modified, stored, and retrieved. However, how this data is organized and modeled is up to the designers imagination. Data visualization needs not follow any particular course (i.e., literal, cultural, etc.) of representation, it may be modeled in an infinite number of ways. The only constraints are located in the bias of the human interface and the hardware/software capabilities. Given these instrumental constraints and the malleability of the digital canvas, decisions about what information should be deleted, highlighted, contextualized, or represented become very important. Medical visualization design should be the qualitative filtering and depiction of information towards achieving a clear end.

Most scientists whom develop these displays do not have the design background that would allow them to easily communicate large amounts of abstract data to different disciplines. Architecture bridges this gap, through it's millennia old design expertise. Architecture is well versed in the design and planning of multidimensional environments supporting human activities, as well as the representation, simulation and communication of diverse types of information. In addition, it deals with the spatial organization and resolution of complex information requirements and it addresses the human body in its multiple dimensions (scale, space, tectonics, etc.). There is a natural relationship between digital space and architecture that can be put to direct use in visualization design. Marcos Novak points out in his article "TransTerraFirma"

> *"To the extent that this development (i.e., the creation of virtual environments) inverts the present relationship of human to information, placing human within the information space, it is an architectural problem: but beyond this, cyberspace has an architecture of its own an, furthermore, can contain architecture.*

BEST COPY AVAILABLE

> *To repeat: cyberspace is architecture; cyberspace has an architecture; and cyberspace contains architecture"*

In other words, there is a natural relationship between digital space and architecture that could be put to use in visualization design.

DESIGN CONSIDERATIONS

Much of the work in the medical visualization field falls into one of two camps: (1) imaging (e.g., X-rays, CAT scans, etc.) and (2) interactive modeling of the body. These technologies are effective at displaying vast amounts of information but they are still confined to purely representational images rather than displaying a much more abstract depiction. This current paradigm stresses that the images are basically mappings of specific data on a computer modeled representation of the human body or head in a static way. Very little work has been done in the investigation of temporal depictions of physiology. The work that has been done has been carried out by the individuals who investigate the data; the scientists. However, scientists have the technical skills for implementation, yet they are trained in quantitative rather than qualitative methods, analytical rather than integrative processes.

The *Cyber* PRINT project goal is to create a coordinated and interactive hyper-representation that articulates physiological data in real time and in a format that is easily and quickly understood. The *Cyber* PRINT name comes from the fact that each individuals physiological data is unique to that individual much like a fingerprint, and that this information is contained within the digital environment. Ultimately, the *Cyber* PRINT would obtain its raw data from existing medical equipment that measures human physiological signs using non-invasive techniques. These include electrodes that measure heart rate, and a respirator device that measures breathing rate, volume and gas content in each breath. Currently, the information that is displayed in the new representation is obtained from a body simulator that mimics physiological responses based on an anesthesiologist's input. The current phase of the project is the development of an effective design that transmits the data in a clear and concise way

One of the first issues to be dealt with in the development of a new, real time, physiological representation, is to see how the integration of previously displayed distinct data can be achieved. Physiological activities within the body are all connected. When air is inhaled into the lungs there is pressure exerted on the heart by the lungs because of its close proximity. Due to this pressure, the volume of blood pumped by the heart changes with each beat. Understanding this type of interrelationship of bodily functions many problems during surgery can be brought about by another problem. For instance, when a patient experiences rapid blood loss the stroke volume of the heart decreases dramatically and the respiratory and heart rate rise as the body try to compensate for hypovolemia. When the interrelationship of physiological states is not adequately displayed, as in the current monitors, the physicians response time in identifying problems is much slower . (Figure 1). While this is the norm in the medical profession, recent studies have suggested that integrated graphic displays can reduce detection times of significant events(i.e. hypertension, rapid blood loss, etc.). Professor Dwayne Westenskow et al. at the University of Utah Department of Anesthesiology showed that using graphic integration with shapes and colors versus traditional wave and number based representations can dramatically reduce detection time.

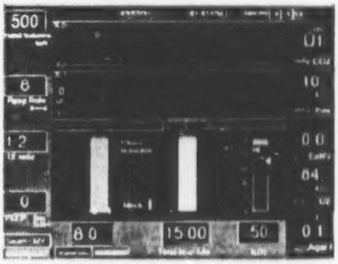

Figure 1: Standard for graphic displays used by anesthesiologists

In addition to its failure to properly show interrelationships between physiological data, it is difficult to view a history of the data in the current displays. While the historical information can be accessed via another screen that is separate from the current state screen it is not an adequate way to monitor trends as they occur. Therefore, a meaningful way to track history must be developed.

By providing auditory cues the current displays provide notification when something has gone wrong with the patient. However they lack pertinent visual cues to communicate problematic situations to the physician. This situation can be corrected by integrating informative colors and meaningful thresholds within the display. For instance, normal ranges can be displayed via a set of regulating lines and monotone colors. When the output transgresses these normal conditions vivid colors can be shown which would aid the physician to make a rapid assessment.

ARCHITECTURE AS METAPHOR

By integrating different variables such as heart rate and stroke volume (cardiac output * heart rate) and incorporating time, a 3-dimensional object can be constructed that displays this information (Figure 2). As time progresses the box is built with the thresholds of the current state rectangle making their mark which produce a 3-dimensional wave form. After the 3 minute mark the information would be collapsed into blocks of time. These blocks would display information from the 5 minute, 10 minute, and 15 minute mark. This 3-dimensional object can be viewed as an architectural construction much like a building. The building begins to have two components; one is the roof and the other is the wall. Both these components of the building protect the inside from the out but more importantly, the walls and roof help create individual spaces yet retain a connection to the whole construction with a tectonic or language of their own. This connection of disparate elements in buildings is intuitive for all people.

This form is conveyed through a series of standard architectural drawings such as plans, sections, oblique and axonometric views and elevations. When the physician wishes to obtain more information, such as a stroke volume wave-form, they can click on the appropriate side and an elevation view is brought up (Figure 3) This dual type of display can help bridge the gap between the new representation and the more traditional wave form that a physician may be more comfortable seeing.

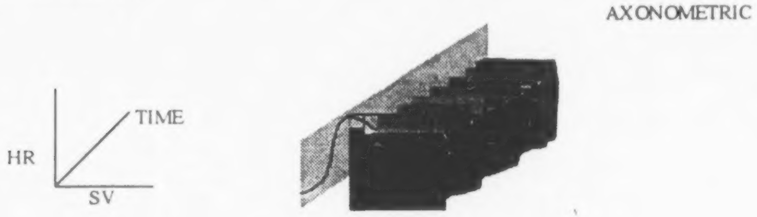

Figure 2: 3-dimensional architectural construction

By understanding simple physical principles it is known that in a gravitational environment, roofs cannot go unsupported. Something such as walls or another device must provide the support. This simple concept can aid in the communication of significant physiological events in our display. If, for instance, the wall becomes significantly detached from the roof a physician can easily tell that there is a problem with the stroke volume of the patient. Whereas with the old wave form representation the doctor must interpret what they are seeing which resulted in much slower recognition times (Westenskow).

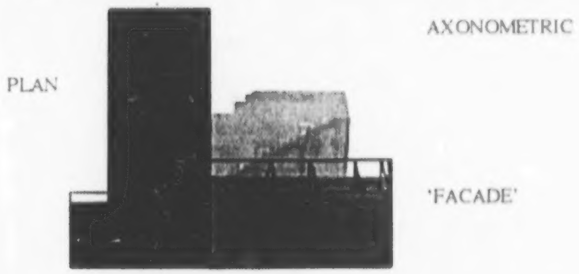

Figure 3: 3-dimensional construction with elevation views

For the physician to gain perspective on what is happening with the patient normal values must be displayed through a series of regulating lines. These lines are applied to the 'facade' of the building which displays the current condition of the patient. When the patient's physiological responses are within the normal values the front rectangle is contained in the regulating lines (see

Figure 2). If, perhaps, the heart rate is too high or low the front facade is either above or below the regulating lines. An additional visual cue can be added to help the physician in quickly monitoring changing conditions. When the current condition rectangle transgresses the boundaries, a brighter hue red can be displayed showing the degree of transgression.

To connect the physiological data even more a wall was placed to the left side of the construction (see Figure 1). On the wall would be displayed current drug content in the body and the time frame in which this would wear off. By directly associating the time frame of the drug content with the time frame of the heart rate and stroke volume a physician can directly see how the administered drugs are effecting physiological responses. These associations can be used as a powerful teaching device in training anesthesiology students.

CONCLUSION AND FUTURE WORK

The models that have been presented were developed as a schematic design on a Macintosh computer without regard to actual physiological data. This design is currently being transferred over to an IBM workstation where actual physiological data is being taken from the Body Simulator and converted into a digital representation. While the findings and investigation of the design have been very promising there is still an ongoing investigation involving different ways of representing the information. Currently a more organic design is being developed using spheres and brighter colors.

We live in a digital era. All areas of our lives have been touched in some way by computers. In this age of computers technology is advancing at a breakneck pace. With this advancement of technology comes increased amounts of information that must be dealt with. It is apparent that the way to deal with this information overload is to represent it in a pictorial way that allows for successful and quick communication. As the digital environment becomes more malleable through software and hardware improvements the way in which we display information becomes more of a question. The future of digital representation does not need to have its roots firmly planted in the past. It is up to individuals with differing backgrounds and talents to add to the knowledge base of information representation.

ACKNOWLEDGMENTS

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REFERENCES

Arnheim, R. (1969). Visual Thinking. Berkeley, CA: University of California Press.

Bronowski, J. (1978). The Origins of Knowledge and Imagination. New Haven: Yale

Klima, G. (1985). Multi-Media and Human Perception. Elnora, NY: Meridian Press

Ellis, S. (1993). Pictorial Communication: pictures and the synthetic universe; in S. Ellis (Ed.): Pictorial Communication in Virtual and Real Environments. Washington, DC: Taylor and Francis, pp. 24-39

(1993). Prologue, in S. Ellis (Ed.): Pictorial Communication in Virtual and Real Environments, Washington, DC: Taylor and Francis, pp. 3-11

Novak, M. (1995b). TransTerraFirma; Sites Vol. 26, pp. 34-53

(1995a). Transmitting Architecture. A.D. Profile #118: Architects in Cyberspace, pp.42-47

(1991). Liquid Architectures in Cyberspace; in M. Benedikt (ed.): Cyberspace. First Steps. Cambridge, MA: The MIT Press; pp.225-254

Mitchell, P., D.Gravenstein, & D Westenskow (in press). An Integrated Graphic Data Display Improves Detection And Identification of Critical Events During Anesthesia (Article has been accepted for journal publication)

Tufte, E. (1990). Envisioning Information. Cherise, Conn: Graphics Press

(1983). The Visual Display of Quantitative Information. Cherise, Conn: Graphics Press

Sustainable Building: Planning and Design of a Family Residence and Education Center Using Local building Materials

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ABSTRACT

This paper will discuss alternatives to typical residential building materials. Materials used in typical residential buildings are often mass-produced and shipped to the construction site. The environmental cost for shipping and producing these materials is enormous, and limits the diversity and design of the buildings. In the past, buildings were constructed from locally available materials and only limited by the availability of those materials. This paper will compare the use of historic building materials and present day materials, including a case study of planning and design of an education center and family residence in Canelo, Arizona. The paper will address the use of alternative architectural materials in this site and how to keep the site as a family residence, while maintaining it as a successful learning center. The site is in southeastern Arizona on a forty-acre plot of land in the basin and range area near the Huachuca Mountains. The owners run a nonprofit organization from this site and present seminars and workshops on the use of alternative buildings materials, such as straw bale, prickly pear cactus, and bamboo. Currently the site has no formal orchestration in locating new buildings, and an overall master plan needs to be developed. Also, there is no formal educational space. This paper introduces a master plan for the property and a design for a formal education space, emphasizing the use of locally available, alternative building materials.

INTRODUCTION

Sim Van Der Ryn and Stuart Cowan in Ecological Design, state " by working with living processes, we respect the need of all species while meeting our own. Engaging in processes that regenerate rather than deplete, we become more alive" (1996, p. 102). This quotation embodies the spirit of a family residence and education center in Canelo, Arizona. Owners of this forty-acre plot of land present workshops on alternative construction materials and their use on the site. Using alternative construction materials is not about creating new revolutionary materials, it is about revisiting the past and applying it to the present. The Canelo Project, a non-profit organization also apply historic construction materials to their site, while creating a sustainable residence for the owners and educating others about the process. This paper will discuss historic building materials and methods and compare the sustainability of their design to that of modern construction materials. Also, there will be discussion of the materials available on site and their applications with these historic methods. The site has no formal orchestration in locating new buildings and the family residence also serves as the educational center. Because of this, an overall master plan needs to be developed. To conclude this paper, this mater plan will be presented, which will include an application of historic construction materials to the outdoor educational center.

HISTORIC CONSTRUCTION MATERIALS

The owners of the site are not breaking new ground with their use of alternative construction materials. The materials and methods taught here have been used for centuries. They teach a method that predominately uses straw bales as the construction material.

Other methods that can be used in construction for this site include adobe brick construction, roof thatching and a system of wattle and daub wall construction. They do, although less frequently offer workshops on these other materials and methods.

Historically, straw has been used as a construction material for nearly forty thousand years (Bryce, no date). Hunting and gathering tribes of Africa used straw to build their homes and adobe bricks mixed with straw have been found in Jericho dating back to 8300 B.C. (Bryce, nd). Straw bale construction became mainstream in the plain states of North America in the late 1800's. Homesteaders in Nebraska started using straw bale for numerous buildings, including homes, farm buildings, churches, schools, offices and grocery stores (U.S.D.O.E. 1995), because a decent supply of wood was not available.

Adobe already existed on the site when the owners purchased this land; the existing residence was made using this construction method. This method can be done in numerous ways, anything from pouring layers of mud (a clay and sand mixture) on top of one another until a wall is formed or sun drying bricks of the same materials to build that wall. It is also used to weatherproof walls made from straw bales and wattle and daub. This method has been discovered in numerous Neolithic sites around the world, including Anatolia and Crete (Garrison, 1979). Adobe is still used widely as a construction method in Mexico and the southwestern United States.

Roofs made of thatch have been used around the world for many centuries (Brunskill, 1971). Thatch has been discovered in many climates and many countries ranging from the West Indies to Africa to England (Brunskill, 1971). Although it has not been widely practiced in the United States, many countries still construct roof structures in this manner. In England it has been elevated to an art form (Yarwood, 1963), it can only be learned by an apprenticeship under a trained craftsman. This is a method that owners of this site have only recently been experimenting with, using bear grass from the site.

Wattle and daub, possibly the most obscure methods mentioned, is a system of interweaving tree branches around posts, called staves and filling the cracks with an adobe mixture (Brunskill, 1971). The history of wattle and daub is comparatively short. This method was mainly practiced in England from the Roman occupation (from about 52 B.C.) to the twelfth century (Brunskill, 1971). As construction methods became more advanced wattle and daub became used less due to the lack of insulation (Brunskill, 1971).

In comparing the sustainability of historic methods and materials, appropriate to the southwest region, to their modern counterparts one must first define sustainable design for this site. For this site, sustainable design means using the locally available materials and creating minimal impact on the site. Included in this is the environmental cost, the theory of computing the costs to the environment, and impacts on the environment (Van Der Ryn and Cowan, 1996).

Currently in Arizona, housing is framed with wood, which is usually shipped a great distance from a wood mill. The tractor-trailers shipping wood to the housing site have a very high environmental cost, because they contribute to air pollution (Pijawka, 1995). After the framing is complete the walls are filled with a polystyrene insulation and finished with a gypsum wallboard, neither of which are contributing to, "processes that regenerate rather than deplete" (Van Der Ryn and Cowan, 1996). For Arizona, block construction is a typical method to finish the exterior of the house. The method used to make these blocks is far from an environmentally friendly action. For example, just the firing of the blocks releases a large amount of pollutants into the air. Other materials in the construction process are just as environmentally unfriendly. For example, outgassing from various materials, including roof tiles, paints and pavement for the driveway contribute to environmental degradation (Van Der Ryn and Cowan, 1996).

In contrast, the historic materials and building methods described above are considerably more sustainable for this site. Straw bales can be made from a variety of different plants, including barley, buffalo grass, native meadow hay, rye and oats (Bryce, nd). Straw bale utilizes the part of the plant stalk that is normally burned or plowed under by the farmer; over 200 million tons are burned in the United Sates every year (Bryce, nd). Although these straw bales are shipped to the site, the environmental cost of shipping and recycling the straw outweighs the environmental cost of milling the wood and shipping to the site. Adobe, whether it is to finish a wall or build a wall, is an extremely durable material and an extremely sustainable material, when compared to stucco finishes, gypsum wallboards, and block construction. The thatching of a roof and wattle and daub wall construction, using the environmental cost theory, greatly outweigh any modern method. Both methods use parts of plants that are normally thrown away, these methods are much less damaging to the environment. Even when considering the insulation of modern buildings, these alternative materials, with exception of wattle and daub, provide more insulation. For example, a modern house has a median R-value (the value given for insulation) of 19, a straw bale house with an adobe finish has an R-value of 50 (Bryce, nd).

CANELO PROJECT NATURAL RESOURCES

Canelo, Arizona is located in southeastern corner of the state near the Huachuca Mountains; sitting in the foothills called appropriately, the Canelo Hills. Specifically, the forty-acre site can be divided into three areas: Plains, Washes and Slopes. Turkey Creek, which is filled with water about eight months of the year, bisects the property. Geologically, the site is made of rock and soils from the Paleozoic Era, approximately 570 million years old. Soils in this site are a mixture of gravely clay loam and sandy clay loam. These very fertile soils are excellent for farming, and according to Roadside Geology of Arizona, "support grass-rich, non desert type of forage, making for ideal ranch country" (1983, p. 118).

Vegetation in this area is diverse, and can be correlated to the three landforms mentioned before, the slopes, washes and plains. The slopes, where the most plant diversity occurs, include various oak trees, agave, juniper, mesquite trees, and prickly pear cactus. Tall cottonwood trees lining the banks of Turkey Creek most easily identify the wash area. Bear grass, along with other grasses are plentiful in this area. Finally, the plains, which consist of about one fourth of the area of the site, contain yucca plants, bear grass, and blue gamma grass.

Given the natural resources on this site, the materials available for building are numerous. Rocks from the hills and creek bed can be used in paving roads, walkways and trails. Soils are fertile enough to grow wheat or a variety of other plants useful for food and building materials. Soils are rich enough in clay and sand to make an excellent adobe brick or adobe weatherproofing material. Cottonwoods and juniper trees can be trimmed back enough for ample firewood for the family and still frame structures without harming the trees. Their branches are also flexible enough to use in wattle and daub construction. Agave plants and prickly pear cactus, when fermented can be used as a finish for walls and floors. Even the bear grass is excellent for the thatching of roofs.

MASTER PLAN AND EDUCATION CENTER DESIGN

In developing the master plan three questions were addressed: How to separate the family residence from the main educational center; How to alleviate the need for more storage space for construction materials for the family; How to create enough housing to accommodate long term and short term guests.

The master plan has been divided into five important zones, each important to the organization of the site (figure 1). The first zone (number one on master plan) is where the new family residence is to be built. This site works the best because it is relatively flat ground, offers the owners a good view of their property and is removed enough from the education area to give the family privacy. Ultimately, a straw bale house can be built on this site with minimal impact to the site. The second zone is used for storage; parking and a new bridge to the new home would be placed here. There is a need for a garage; the family has two family vehicles, an earthmover, and a dump truck. This garage can be made large enough to include storage. This structure is perfect for the wattle and daub construction method, because a highly insulated building is not needed. Zone three is the most flat land in the site; it would be excellent for any crops the family would like to grow, or a possible expansion of the small apple orchard. Some guests prefer to tent camp when staying for the workshop and this site is the best site that is readily accessible to the educational center. The fourth zone is the site for the educational center, which will be explained in detail in the next section. Finally, the fifth zone is for wind power production and residential expansion. The wind is predominately southeastern majority of the year. With the addition of wind turbines the site could eventually free itself from the local power grid. This area is also excellent for residential buildings and one currently exists here. With the addition of residential buildings to the educational center, expansion is not going to be immediately necessary.

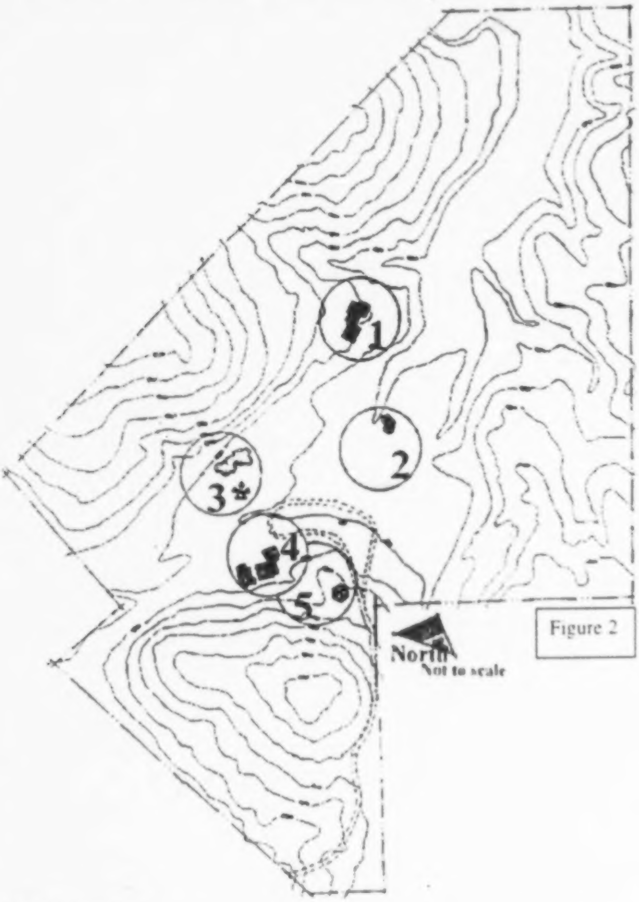

Figure 2

The site design for the education center must meet many needs (figure 2). This area must give the owners ample room to hold their workshops. These workshops usually consist of 15-20 people attending over a long weekend. It must be able to house the people that attend those workshops and the people that stay for extended periods. People also stay at the residence for a few months to research the methods taught here and needed longer-term housing. The family residence will become dormitory style housing. The guesthouse already serves as a dormitory, sleeping about eight to ten people. The family residence, after the new house for the family is built, will sleep about ten to twelve people. The front of the main house will be made into amphitheater seating for the presentation of lectures and slides. On the bottom level of the seating is a fire pit for guest to gather around; the temperature at night, even in the summer can get quite chilly. A path paved with river rock connects the three long-term residences; they can also serve as couple housing for the weekend workshops. A storage building has been put into this area. This solves both a long and short term need for storage. With the amount of materials that the owners require for the workshops this building is necessary. All of these buildings serve a dual purpose; they house the guests at the workshops and demonstrate of the construction methods and materials being taught at the Canelo Project. In the center of the courtyard the water feature completes the gathering area for the guests.

This site design and master plan will address the three main concerns. The family is separated from the educational center, which gives them some privacy. Storage buildings have been placed around the site, so they are accessible and convenient. The educational center has been enlarged and formalized, which increases the housing on site and demonstrates the application of the alternative materials and methods.

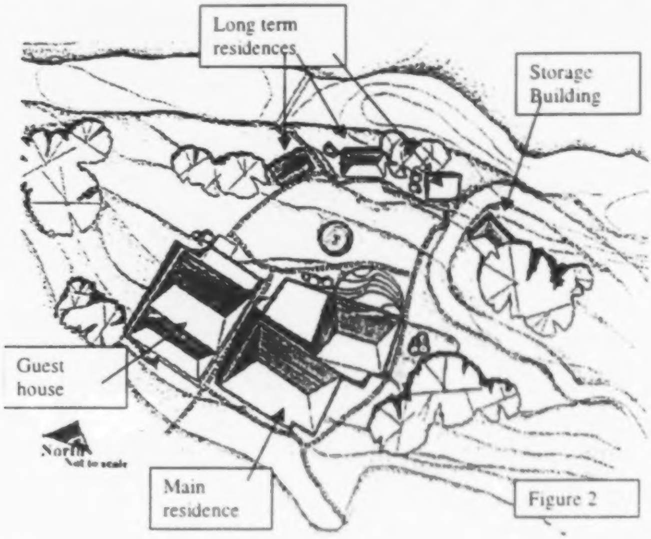

Figure 2

CONCLUSION

These historic methods and materials are what the site requires to have a sustainable design. The application of these methods and materials in the site shows that sustainability in a family residence is possible. Historic materials are a good way of revisiting the past, and finding a sustainable design and applying it to the present. It has been shown these historic methods can be applied on a small scale to a rural area. As for the next step, this sustainable designing needs to be applied on a larger scale. Currently, these methods and materials have been used sparingly in an urban environment. Investigating the application of these methods to a larger urban fabric must start on a grassroots level. Much like the operators of the Canelo Project, they educate about these historic methods hoping to create new paths in the future. Because as Rob Krier stated in his book Urban Space, "proper appreciation of our historic heritage will filter the experience of the past to the advantage of the planning the future" (1979).

BIBLIOGRAPHY

Brunskill, R.W. Illustrated Handbook of Vernacular Architecture. Faber and Faber Publishers, London and Boston, 1971.

BEST COPY AVAILABLE

Bryce, Robert. Casting a Straw Vote, The First Straw. World Wide Web address: http://www.auschron.com/issues/spec/greenbuild/straw.html.

Chronic, Halka. Roadside Geology of Arizona. Mountain Press Publishing, 1983.

Garrison, Paul. How to build Adobe Homes. Blue Ridge Summit: Tab Books, 1979.

Pijawka, David K. and Kim Shetter. The Environment Comes Home: Arizona Public Service's Environmental Showcase Home. Arizona State University, 1995.

U.S. Department of Energy Efficiency and Renewable Energy (U.S.D.O.E). House of Straw-Straw Bale Comes of Age. World Wide Web address: http://www.eren.doe.gov/EE/strawhouse.html. April 1995.

Van Der Ryn, Sim and Stuart Cowan. Ecological Design. Washington D.C. Island Press, 1996.

Yarwood, Doreen. The Architecture of England, From prehistoric Times to the Present Day. B.T.Batsfprd LTD., London and G.P. Putnam's Sons, New York, 1963.

"Thatch as a Modern Building Material," by Darby, Keith. Architects Journal. September 3, 1986, pg. 57-60,66-68.

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An Analysis of Ancient Maya Obsidian Artifacts From Belize

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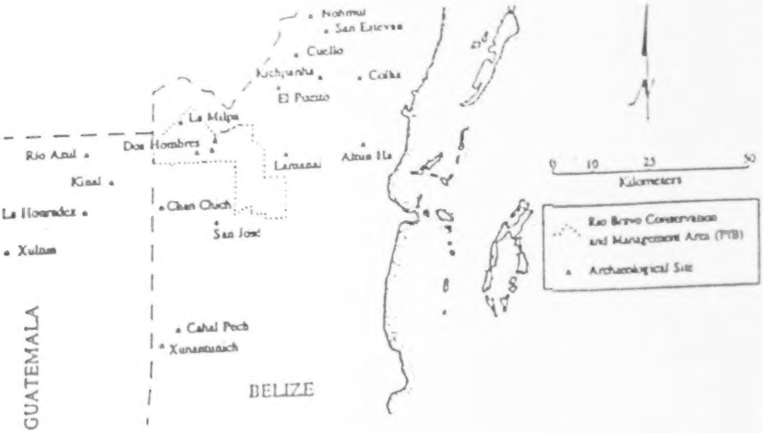
Recent excavations in northwestern Belize, Central America, have produced numerous obsidian blades and tools. The various artifact forms have been analyzed according to morphological characteristics and use-wear patterns. The latter fall into seven significant categories and were used to determine possible function(s) of the obsidian in ancient times. These were then correlated with contextual data for determining activity areas at excavated sites.

INTRODUCTION AND BACKGROUND

The Programme for Belize (PfB) Archaeological Project is a long term research effort in northwestern Belize aimed at identifying and recording archaeological remains of the ancient Maya in the Rio Bravo Conservation and Management area (Figure 1). The 1996 field season produced an obsidian collection of 46 artifacts excavated from four sites: Guijarral, Dos Hombres, My Lady, and Ma'ax Na. The collection of 46 obsidian specimens used for this study are identified as obsidian blade fragments (45) and one is an obsidian flake.

Obsidian is a volcanic glass usually associated with central Mexico and southern Guatemala. Obsidian has long been an item of trade or exchange particularly into lowland regions where it does not naturally occur. In the Maya lowlands this natural glass is a prized item often found in special contexts including burials and offerings.


Nohmul
San Estevan
Cuello
Kichpanha
Colha
El Pozito
La Milpa
Dos Hombres
Rio Azul
Kinal
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Chan Chich
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Rio Bravo Conservation and Management Area (PfB)
Archaeological Site

Figure 1. Map of Northern Belize and the Rio Bravo Conservation and Management Area. Map Courtesy of Programme for Belize Archaeological Project

The major objectives of this analysis were to provide: 1) a descriptive morphological analysis, 2) a descriptive analysis of use-wear characteristics derived from macroscopic observations, 3) possible function(s) of the obsidian based on the morphology and use-wear patterns, and 4) a determination of possible activity areas based on distribution areas within the sites.

DESCRIPTION OF OBSIDIAN SAMPLE

All pieces of the collection were examined and categorized as to morphology (shape) and edge wear patterns. The analysis and categorization performed followed the patterns set out from earlier studies (e.g., Clark and Lee 1979, Hester 1975; Shafer 1969; Sheets 1972; Valdez 1986, 1989, 1994). This study used the term "edge-wear" and "use-wear" interchangeably. Seven categories of wear were established by Thomas R. Hester (1975) while he studied the obsidian industry of Beleh, Guatemala. These same use-wear classifications were later utilized by Fred Valdez (1986, 1994) for obsidian collections from El Salvador and Honduras. The use-wear types are listed in detail below. When possible the proximal pieces were categorized into platform type as well.

A total of 46 pieces were retrieved as follows per site: 34 from Guijarral, four each from Dos Hombres, My Lady, and Ma'ax Na. There are 21 proximal fragments, 22 medial fragments, and two distal fragments. An interesting observation can be made of the distribution of the proximal, medial, and distal pieces between the four sites. Within the smaller samples of the Dos Hombres, My Lady, and Ma'ax Na sites there are only two medial fragments, while in Guijarral 20 of the 34 fragments are medial. Caution about interpretations or what this means must be voiced due to the small sample size. More than 99% of the specimens are identified as prismatic blade fragments comprised of proximal, medial, and distal segments. One artifact is a lithic flake.

Prismatic blades have parallel edges with one or more medial ridges on the dorsal side. Prismatic blades are at least twice as long as they are wide and are removed from a specially prepared core (Hester 1975, Valdez 1994). Core platforms are usually prepared by chipping or abrading the surface (see Hester 1975; Shafer 1969; Sheets 1973). Platforms are generally categorized as single or simple facet platforms, multiple facet platforms, and natural platforms (Shafer 1969). Single or simple platforms are predominate in this sample. Four possible multiple facet platform types can be observed. Four platform types are undetectable and are considered for the purpose of this analysis crushed platforms.

RB18 (Guijarral). Of the 34 total fragments (74% of total collection) there are 11 proximal, 20 medial, and two distal fragments. The proximal fragments measure from 11.07 to 56.01 cm (length), 8.23 to 12.02 cm (width), and 2.22 to 3.58 cm (thickness). The above measurements and those that follow represent the maximum measurements per dimension. The medial fragments measure from 11.64 to 35.39 cm in length, 6.51 to 15.41 cm in width, and 1.92 to 3.78 cm in thickness. The distal fragments, of which there are only two in the entire collection, measure from 13.50 to 22.99 cm in length, 6.98 to 9.33 cm in width, and 1.61 to 2.06 cm in thickness. One of the longer proximal specimens can be articulated, but was not broken prehistorically. It measures 53.04 x 9.49 x 2.22 cm (length x width x thickness). Of the proximal fragments, six exhibit signs of single facet platforms, two exhibit pointed platforms, one exhibits a multiple facet platform, and two are crushed and therefore undetectable macroscopically.

RB2 (Dos Hombres). There are four fragments (8.6% of total collection) from this site and all are proximal fragments. The fragments measure from 14.81 to 34.59 cm (length), 8.35 to 14.49 cm (width), and 2.52 to 4.23 cm (thickness). Of these proximal pieces, two exhibit single facet platforms, and two are crushed and undetectable.

RB48 (My Lady). There are again four fragments (8.6% of total collection) from this site, three are proximal and one is medial. The proximal fragments measure 32.02 to 40.25 cm in length, 10.31 to 19.68 cm in width, and 3.45 to 6.72 cm in thickness. The medial piece measures 19.52 x 15.48 x 3.49 cm. Of the proximal pieces, one is a flake. It appears to have the same characteristics as a lipped flake as described by Shafer (1969). The flake has cortex remaining on the dorsal side and exhibits signs of a multiple facet platform. The remaining two proximal pieces have single facet platforms. One of the proximal fragments and the medial fragment appear to have come from the same blade. They can not be articulated, however because the proximal end of the medial fragment was intentionally modified prehistorically. The modified end has had minute flakes removed creating a beveled profile. The altered edge is on the dorsal side leaving a flat plane on the ventral surface (Figure 2). This type of modification is reminiscent of scraper type tools. Thus, this small blade may have functioned as a tool used in minute scraping or smoothing activities.

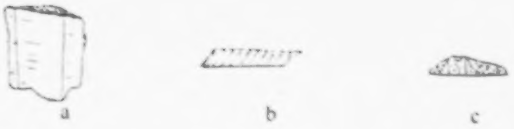

Figure 2. Various Perspectives of the Obsidian Blade Medial Fragment with End Modification, a) dorsal view, b) side view, c) direct view of modified edge.

RB49 (Ma'ax Na). Of the remaining four pieces in the collection (8.6%) three are proximal and one is medial. The proximal fragments measure 12.52 to 28.64 cm (length), 8.89 to 10.75 cm (width), and 2.50 to 2.63 cm (thickness). The medial piece is 12.69 x 12.89 x 2.47 cm. All three proximal pieces are of the single facet platform type.

WEAR PATTERN OBSERVATIONS

The use wear patterns for the collection fall into seven distinct categories (Figure 3) when using the same criteria as Hester (1975) and Valdez (1989,1994). Six blades from the collection exhibit two simultaneous types of wear and are counted separately below unless otherwise noted. The use-wear categories are as follows:

1) *Nicking* or miscellaneous wear is the predominant form of edge wear for the collection. Edge-wear in this category can result from use, depositional activity, or recent activity including excavation, transportation, and storage. Twenty-six specimens fall into this category and at least an additional four specimens exhibit this characteristic in addition to other edge-wear. The cause of the wear in this category is difficult to ascertain.
2) *Dorsal trimming* is considered observable wear on the dorsal side of the blade. This category of edge-wear may be the result of intense use. Edge modification of this type results from continued use in a specific motion for an extended exercise (time). Five specimens fall into this edge-wear category.
3) *Ventral trimming* is edge-wear to the ventral side of the blade. The edge modification referred to here may result from similar activity as mentioned for dorsal trimming. Only two of the blade fragments fall into this category.
4) *Fracturing* is seen as large areas or sections of the blade having been removed in one large piece or several small pieces. This type of wear can result from hard activity such as cutting bone or incising stone. Two blades can be included in this category of wear.
5) *Notching* or concave trimming is wear resulting in the removal of minute flakes from one or both lateral edges of the blade forming a clear notch. Six blades have edge-wear that is categorized as notching.
6) *Miscellaneous patterned wear* is represented by a segment or two of continuous minute flake removals. This type of wear is much more distinctive than nicking. Slicing and cutting activity result in this type of wear. Only one specimen from

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this collection can be categorized with miscellaneous patterned wear.

7) *No wear* is the remaining category. Five blades can be categorized as such, and are blades that exhibit no edge modification.

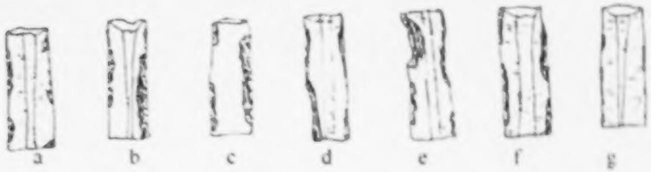

Figure 3. Stylized Examples of Use-Wear Categories. Modifications Depicted: a)Nicking, b) Dorsal Trimming, c) Ventral Trimming, d) Fracturing, e) Notching, f) Miscellaneous Patterned Wear, g) No Wear.

OVERVIEW AND INTERPRETATIONS OF THE PFB OBSIDIAN

In this paper 45 prismatic blades and one lipped flake were systematically analyzed for macroscopic edge-wear. At this time no microscopic use-wear analysis has been performed. The largest part of the collection came from Guijarral where extensive excavations took place. The small number of specimens from the other sites may reflect collection strategies that did not lend themselves to significant artifact recovery. Therefore statements of comparison between sites are not appropriate at the present.

Some type of use-wear is found on the majority of specimens indicating general use. However, fracturing, which might imply hard or extensive use, is minimally represented. Five blades showed no use-wear. These may have been curated for special placement (such as a cache) or for future use.

The Guijarral sample is best suited for comments about site activities. Most of the obsidian was collected from small residences away from the ceremonial center. These residences are believed to be the households of farmers in the area. The majority of the blades recovered from Guijarral are in the use-wear category of nicking. These blades were probably used in minor household activities such as simple (perhaps soft) cutting and slicing. Microscopic use-wear studies may reveal patterns of use such as sawing and slicing motions.

CONCLUSIONS

It is clear that obsidian was prized in this community where the raw material was not subjected to more difficult or hard tasks. In this way, the obsidian lasted longer.

As a general model the PfB sample is similar to other lowland Maya collections for obsidian form, mostly blades, and the number of blades in each use-wear category. It seems most likely that obsidian arrived or was traded into the region in blade form rather than as cores. It may be that the specialization of producing blades was most developed in highland areas near the obsidian sources.

REFERENCES CITED

Clark, John E. and Thomas A. Lee, Jr.
1979 A Behavioral Model for the Obsidian Industry of Chiapa de Corzo. *Estudios de Cultura Maya* 12:33-50.

Hester, Thomas R.
1975 The Obsidian Industry of Beleh (Chinautla Viejo), Guatemala. *Actas del XLI Congreso Internacional de Americanistas* 1:473-488.

BEST COPY AVAILABLE

Shafer, Harry J

1969 Archeological Investigations in the Robert Lee Reservoir Basin *Texas Archeological Salvage Project, Papers*, No 17

Sheets, Payson D

1972 A Model of Mesoamerican Obsidian Technology Based on Preclassic Workshop Debris In El Salvador In *Ceramica de Cultura Maya et al.*, No 8, edited by James C Gifford Department of Anthropology, Temple University, Philadelphia

1973 Edge Abrasion During Biface Manufacture *American Antiquity* 38(2) 215-218

Valdez, Fred, Jr

1986 The Santa Leticia Obsidian Assemblage Form, Technology, and Use Wear In *The Archaeology of Santa Leticia and the Rise of Maya Civilization*, publication no 52, edited by Arthur A Demarest, pp 210-216 Middle American Research Institute, Tulane University, New Orleans

1989 An Analysis of Obsidian Artifacts From the Copan Valley Project, 1975-1977 A Preliminary Statement In *La Obsidiana en Mesoamerica* edited by Margarita Gaxiola and John E Clark, pp 81-88 Instituto Nacional de Antropologia e Historia, Mexico, D F

1994 Chipped Stone (Obsidian) In *Ceramics and Artifacts from Excavations in the Copan Residential Zone*, Gordon R Willey, Richard M Leventhal, Arthur A Demarest, William L Fash, Jr Papers of the Peabody Museum of Archaeology and Ethnology, Harvard, Cambridge

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Effects of Detention Time on Sedimentation Performance

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A full scale sedimentation basin was constructed with a total capacity of 1800 ft^3. Four experimental runs were conducted, each of which had identical 1630 ft^3 inflow hydrographs over a 100 minute period. Six hundred pounds of soil were added to each run in increments with the hydrograph. Two runs had detention times of six hours, and two runs had detention times of seven days. For each detention time, one run was conducted with a perforated riser as the principal spillway and the other with a skimmer. Both seven day runs resulted in considerably higher sediment retention efficiencies (98.5% for the skimmer and 97.1% for the perforated riser) than the six hour runs (92.9% for the skimmer and 84.0% for the perforated riser). For both detention times, the skimmer had a higher sediment retention efficiency than the perforated riser. The seven day skimmer resulted in a finer effluent particle size distribution throughout the dewatering than the other three spillways.

INTRODUCTION

Accelerated erosion resulting from human activities has long been recognized as a serious concern. Displacement of soil can cause reduced agricultural productivity, and sediment deposition can shorten the life of reservoirs. In addition, transport and deposition of soil is to blame for a plethora of environmental problems.

Eroded soil and runoff from non-point sources is a major transporter of nutrients. According to the USDA (1989), 80 percent of the total phosphorus and 73 percent of the kjeldahl nitrogen in U.S. streams is attributed to erosion. Phosphorus, the limiting nutrient in aquatic systems, can cause algae blooms which block sunlight penetration to deeper waters which ultimately depletes the dissolved oxygen necessary for aquatic life. Nitrogen can aid in oxygen depletion, and in addition, high nitrate (NO_3) concentrations can cause methemogobanemia, a potentially deadly condition to which infant mammals are susceptible.

There are also physical problems associated with erosion and sedimentation. Suspended sediment cause high turbidity which is unhealthy for aquatic organisms and a concern for public water supplies. Sediment deposition in streams, lakes, reservoirs, and estuaries smothers benthic organisms, interferes with fish spawning, and, as previously mentioned, prematurely fills reservoirs.

It is clear that soil erosion and sedimentation is a problem that merits serious consideration. Clark et al. (1985) estimated that soil erosion by water costs the United States $6.1 million annually. It is difficult to put a price tag on the environmental damage that is caused.

Best management practices on farms, construction sites, and other earth disturbance areas can prevent or reduce the detatchment and transport of soil particles, or on-site erosion. When on-site erosion does occur, however, measures must be taken to prevent the transport of this soil accross propety lines or into waterways. Sedimentation basins are commonly used in this role, and they have been proven effective in reducing off-site transport of sediment by runoff.

Sedimentation basins are impoundment structures designed to intercept runoff from storm events and dewater slowly to allow settling of suspended soil particles. These structures have been used extensively at mining sites as well as urban and construction areas. Although agriculture is responsible for the greatest percentage of the total sediment load in the United States (Goldman et al., 1986, Ward et al., 1979), use of sedimentation basins on farmland has been avoided in favor of on-site control practices.

OBJECTIVES

The objectives of this research were to evaluate the sediment retention capability of an 1800 ft^3, full scale sedimentation basin to determine:

1. The relationship between basin detention time and sediment retention efficiency,

2. The effect of basin detention time on effluent particle size distribution, and

3. The effects of basin detention time on effluent water quality as a result of using a perforated riser and a skimmer as principal spillways to control the effluent discharge rates and position within the water column from which the effluent was withdrawn.

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FACILITIES AND PROCEDURES

Sedimentation Basin

An 1800 ft^3 sediment retention basin was designed and built at the Pennsylvania State University's Russel E. Larson Center at Rock Springs (see Figure 1). The basin length from inlet to outlet was 40 feet, and the bottom width at the lower end was 16 feet. The crest of the emergency spillway was at a depth of 3.5 feet.

Water was supplied to the basin from a permanent Pond, located directly upslope. Water was delivered from the permanent pond by gravitational flow through a six-inch PVC pipe. The flow rate was metered through an orifice plate by a differential manometer system and controlled by a gate valve housed in an instumentation pit (see Figure 1). A four-inch PVC pipe delivered water from the gate valve to an 18-inch double-walled polyethylene pipe. A large funnel in the top of the polyethylene pipe allowed soil to be injected into the water before it entered the basin. Water exited the basin through the principal spillway and the six-inch PVC barrel which discharged into a 0.8-foot HS-Flume. The effluent was then released into a nearby swale.

Data Collection

The outflow hydrograph was measured by a float in the stilling well of the flume. The depth of water in the flume was recorded by a Belfort 5-FW-1 portable liquid level recorder. This depth was converted to a flow rate using the flume calibration.

Water quality samples were collected automatically from the flume by an ISCO model 2900 sampler. One-liter samples were taken at pre-programmed intervals for sediment concentration and particle size analysis.

Experimental Runs

Four experimental runs were conducted consisting of all combinations of two principal spillways and two detention times (see Table 1).

Table 1. Description of Experimental Runs

Run	Detention Time	Spillway	Orifice / Hole Diameter
1	6 Hours	Skimmer	2.25 inches
2	6 Hours	Perforated Riser	0.906 inch
3	7 Days	Perforated Riser	0.156 inch
4	7 Days	Skimmer	0.400 inch

All four spillways were designed to dewater the basin in the appropriated amount of time. The perforated risers were designed based on the technique developed by Jarrett (1993) using the stage-storage relationship for the basin. Both perforated risers were constructed from four inch PVC pipe with a single column of holes at six-inch vertical intervals. The six hour riser had 0.906-inch holes, and the seven-day riser had 0.156-inch holes.

The other principal spillway used was a skimmer (figure 2), designed to withdraw effluent from the surface of the basin. In theory, the cleanest water should be present at the top of the water column. One skimmer with interchangeable orifice plates located at the top of the skimmer arm was used for both detention times. Orifice sizes, which were determined using the skimmer equation developed by Jarrett (1996), were 2.25 inches for the six-hour run and 0.4-inch for the seven-day run.

All four runs had identical inflow hydrographs and sedigraphs (Figure 3). Approximately 1630 ft^3 of water was metered into the basin for each run, which represented runoff from a two-year, 24-hour storm in State College, PA from a one-half acre watershed (1% slope, SCS-CN = 80). The inflow hydrograph took 100 minutes to enter the basin, with inflow rates adjusted every 2.5 minutes. Six hundred pounds of Hagerstown silt loam A-horizon soil were added through the soil injection funnel during each run before the water entered the basin. Buckets were used to measure the soil which was added in ten, ten-minute intervals to create the sedigraph shown in Figure 3.

Water quality samples were collected at ten minute intervals while the basin was being loaded. During dewatering, samples were taken at 30-minute intervals for the six-hour runs, and six-hour intervals for the seven-day runs.

Laboratory Analysis

Each effluent sample was analyzed for sediment concentration and particle size distribution. The one-liter samples were shaken and 125 mL was poured into smaller bottles for particle size analysis. The remaining sample was allowed to settle for 24 to 48 hours. Samples were then weighed, filtered, oven dried, and weighed again to determine mass of sediment, volume of water, and ultimately, sediment concentration. Sediment concentration of the influent pond water was also determined, but was found to be negligible.

Particle-size distributions were determined using a Shimadzu Laser Diffraction Particle Size Analyzer (SALD 1100). The particle size distribution of a composite soil sample of the soil used for injection was also determined.

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RESULTS AND DISCUSSION

Hydrographs

Each of the four runs had a distinct outflow hydrograph. Figure 4 shows the outflow hydrographs for the six-hour spillways. The seven-day outflow hydrographs had the same general shape as the six-hour hydrographs. The perforated risers had a peak flow at the end of the 100 minute loading period, and the flow declined gradually through the duration of the run. Outflow rates from the skimmers also peaked at about 100 minutes, but because of the orifice control and nearly constant head, the peak was lower relative to the perforated riser, and flow rates only declined slightly throughout the dewatering period. Peak flows were 0.067 cfs for the six-hour skimmer, 0.119 cfs for the six-hour perforated riser, 0.0069 cfs for the seven-day perforated riser, and 0.0025 cfs for the seven-day skimmer. Detention times were slightly longer than six hours and seven days for the respective runs, but the discrepancies were negligible.

Sediment Loss

Sediment concentrations (Figure 5) for the six-hour runs peaked during the first 100 minutes, and fell sharply, remaining low for the remainder of the runs. The perforated riser had a peak concentration of almost 10 g/L, while the skimmer peaked at just over 4 g/L. After two hours, both risers maintained sediment concentrations below 1 g/L.

The seven-day runs showed a similar pattern (Figure 6), with the perforated riser peaking at 1.94 g/L and the skimmer peaking at 2.24 g/L. The sediment concentration from the skimmer dropped more dramatically following the peak than did the perforated riser, falling to 0.65 g/L in only ten minutes. After 20 hours, concentrations from both risers were less than 0.25 g/L. Surprisingly, the perforated riser maintained lower concentrations than the skimmer after this point.

The skimmer had a higher sediment retention efficiency for both detention times. The skimmer's higher sediment concentrations relative to the perforated riser throughout most of the seven day run did not result in a higher total sediment loss because the flow rate and the sediment concentration of the perforated riser was much higher than the skimmer prior to the 20-hour point in the run. Most of the sediment that was lost was lost before this time.

Retention efficiencies for both spillway designs were considerably higher for the seven-day runs. Soil loss ranged from 8.77 lbs. for the seven-day skimmer to 96.06 lbs. for the six-hour perforated riser. Those losses translate to retention efficiencies of 98.5% and 84.0% respectively (Table 2).

Table 2 Total Soil Loss and Sediment Retention Efficiency

Run	Total Soil Loss	Retention Efficiency
6 Hr Skimmer	42.44 lbs.	92.9%
6 Hr Perf. Riser	96.06 lbs.	84.0%
7 Day Skimmer	8.77 lbs.	98.5%
7 Day Perf. Riser	17.27 lbs.	97.1%

By extending the detention time by a factor of 28 (six hours to seven days), the sediment loss was decreased by a factor of 11 when the perforated riser was used. The same increase in detention time decreased sediment loss by only a factor of 2.5 when the skimmer was used. Althought the skimmer discharged less sediment at both detention times, the perforated riser showed a greater degree of improvement from the six-hour to the seven-day detention time.

Particle Size Analysis

Particle size distributions were determined for each sample. The perforated risers for both detention times had nearly identical distributions at each time shown, and the distributions varied very little throughout the runs. The six hour skimmer distribution was similar to that of the perforated risers at 25% duration, but at 50% duration the skimmer distribution shifted to the left indicating a lower percentage of larger particles. This trend was reversed, however, as the depth of water decreased and the skimmer approached the bottom of the basin. By the 95% duration point, the six hour skimmer particle size distribution had shifted to the right of the perforated riser distributions.

Throughout the entire run, the seven day skimmer particle size distribution was considerably finer that the other three treatments. The distribution also became finer as the run progressed. This was expected because the larger particles should settle faster than smaller particles according to Stoke's Law. Therefore, the particle size distribution in the basin, especially at the surface where the skimmer is located, should become finer with time.

Figure 7 illustrates percent soil loss with respect to particle sizes. There was a strong relationship between the particle size distribution of the soil entering the basin and the distribution in the effluent. This relationship was also seen by Millen and Jarrett (1996). The skimmer was more efficient in removing silt sized particles when compared to a perforated riser designed for the same dewatering time, but the difference was not as clear for clay sized particles. Detention time, however, had the greatest impact on soil retention for each particle size.

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CONCLUSIONS

1a. Increased detention time improved sediment retention efficiency from 84.0% to 97.1% when perforated risers were used.

1b. Increased detention time improved sediment retention efficiency from 92.9% to 98.5% when skimmers were used.

2a. Increased detention time had no significant effect on particle size distributions when perforated risers were used.

2b. Increased detention time resulted in a finer particle size distribution when skimmers were used.

3. Skimmers had higher retention efficiencies than perforated risers for a given detention time.

4. Effluent particle size distribution was strongly related to influent particle size distribution regardless of principal spillway or detention time.

REFERENCES

Clark, E. H., J. A. Haverkamp, and W. Chapman. 1985. Eroding Soils: The Off Farm Impact. The Conservation Foundation, Washington, D.C.

Goldman, S.J., K. Jackson and T.A. Bursztynsky. 1986. Erosion and Sediment Control Handbook. McGraw-Hill, Inc.

Jarrett, A.R. 1993. Design of Perforated Risers to Control Dewatering of Sedimentation Basins. Applied Engineering in Agriculture. 9(1):37-42.

Jarrett, A.R. 1996. Sedimentation Basins Evaluation and Design Improvements. Final Completion Report for Research Grant-in-Aid funded by Orange County, NC Board of Commissioners.

Millen, J. and A.R. Jarrett. 1996. Reducing Sediment Discharge from Sedimentation Basins with Barriers and a Skimmer. 1996 ASAE Annual International Meeting. Phoenix, AZ.

United States Department of Agriculture. 1989. The Second RCA Appraisal, Soil, Water and other Related Resources on Nonfederal Land in the United States, Analysis of Condition and Trends. U.S. Govewmment Printing Office, Washington, D.C.

Ward A.D., C.T. Haan and B.J. Barfield. 1979. Prediction of Sediment Basin Performance. Trans. ASAE 22(1):126-136.

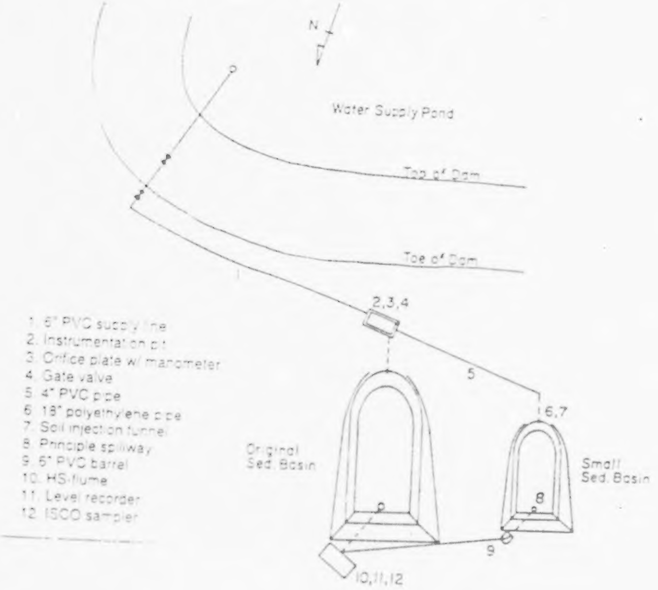
N
Water Supply Pond
Top of Dam
Toe of Dam
1
2,3,4
5
6,7
Original Sed. Basin
Small Sed. Basin
8
9
10,11,12
1. 6" PVC supply line
2. Instrumentation pit
3. Orifice plate w/ manometer
4. Gate valve
5. 4" PVC pipe
6. 18" polyethylene pipe
7. Soil injection funnel
8. Principle spillway
9. 6" PVC barrel
10. HS-flume
11. Level recorder
12. ISCO sampler

Figure 1. Sedimentation Basin Site Diagram

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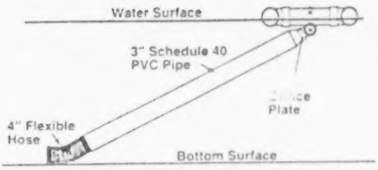
Water Surface
3" Schedule 40 PVC Pipe
Orifice Plate
4" Flexible Hose
Bottom Surface

Figure 2. Skimmer Diagram

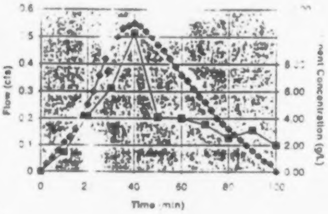

Figure [illegible]. Inflow Hydrograph and Sedigraph

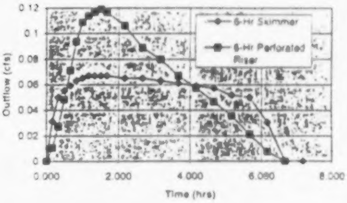

Figure 4. Six-Hour Outflow Hydrographs

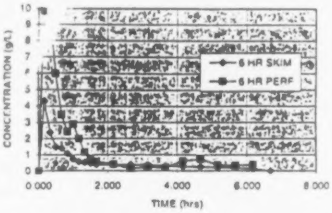

Figure 5. Six-Hour Skimmer/ Perforated Riser Sediment Concentrations

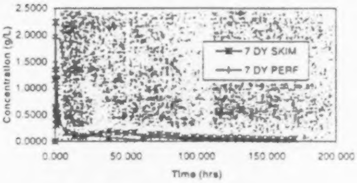

Figure 6. Seven-Day Skimmer/ Perforated Riser Sediment Concentrations

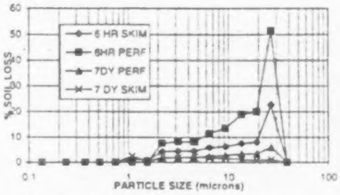

Figure 7. Percent Soil Loss vs. Particle Size

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CHARACTERIZATION OF WASTE SITES IN GREATER NEWARK AREA USING GEOGRAPHIC INFORMATION SYSTEMS (GIS)

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The objective of this project was to identify and delineate existing potential hazardous waste sites and establish a buffer zone using the technology of GIS to protect both human and natural resources within the study site. The study site is the southeast portion of the Newark metropolitan area, a highly industrial area, potentially producing high levels of hazardous materials. The methodology consisted of interpretation of various geospatial data sets derived from different sources and their integration into a GIS to generate the database. The GIS contains information on characteristics and locations of waste sites and their impacts on environmentally sensitive areas (i.e. wetlands and surface water resources) and human resources. A buffer zone was established to assess the proximity and potential hazards of these sites to both human and natural resources. In conclusion, the technology of GIS can be used as a non-invasive and cost-effective tool in gaining detailed information on waste sites and their impacts on the ecosystem and human welfare.

INTRODUCTION AND CHARACTERISTICS OF THE STUDY SITE

The Newark Metropolitan area is a densely populated and highly industrial area. Various types of industry, currently active or inactive have produced and disposed of many potentially hazardous materials over the past decades. Many of the plants have closed their operations after the EPA has set stricter regulations, but their former locations have remained contaminated. Some of the contaminants found are various liquids and vapors designated as Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Hazardous Substances. Many of the substances present a potential threat to the public through direct contact and spillage or may cause fire and/or explosion through vapor emission (USEPA, 1993).

The objective of the project was twofold: 1) to identify and delineate these sites, and assess their location as well as their proximity to the residential and environmentally sensitive areas, and 2) to establish a buffer zone and rank them for better management of the existing and incoming industries as well as the preservation of Newark's natural resources.

The study site is located within the Newark Metropolitan area in Essex County, New Jersey (Figure 1). This area is densely populated and located adjacent to a highly industrial zone. The predominant industries in this zone produce chemicals, paints, oils, and lubricants. These plants have historically produced and stored various chemicals and hazardous wastes at levels dangerous to human health and environment.

Geologically the study area is a part of the Piedmont province and it's Triassic Lowlands (Widmer, 1964). The sedimentary rock is of the Brunswick and Stockton formations of the Newark Basin group. Locally, the Brunswick formation consists of red shale with interbedded sandstone. The Stockton formation consists of red micaceous sandstone with interbedded sandstone. Diabase Igneous rock has intruded into the sedimentary rocks. Glacial features of Wisconsin age (Pleistocene Epoch) represent the hummocky topography and consist of poorly sorted clay to boulder size material. The soft red shale of the Brunswick formation underlies the glacial deposits usually at depths greater than 15 feet. The thickness of the shale varies between six to eight thousand feet. The drainage is generally good, the depth to water table is estimated to be 6-10 feet (Engineering Soil Survey, 1951).

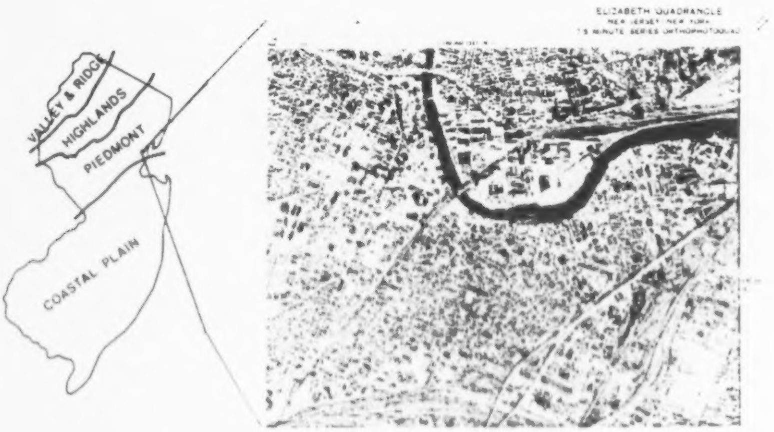

Figure 1. Portion of the Elizabeth Orthophoto Quadrangle Showing the Study Site.

RESEARCH MATERIALS AND DATABASE DEVELOPMENT

The characteristics of input data integrated into the GIS are listed in Table 1.

Table 1. Sources of Data integrated into the GIS.

Data Source	Scale	Type
USGS Elizabeth Quadrangle Orthophoto	1:24,000	analog
USGS Elizabeth Quadrangle Topographic Map 7.5 minutes series	1:24,000	analog
US Census Bureau Essex County, NJ Tiger 94	1:100,000	digital
USGS Digital Line Graph (DLG) hydrography and boundaries	1:24,000	digital

The descriptions of the input data are as follows: USGS DLG data files are digital representations of cartographic information, containing a full range of attribute codes (i.e. node, line and area identifier elements) and topological structuring (EROS web site, 1996). Topologically Integrated Geographic Encoding and Referencing (TIGER)'94 data files are various census and geographical data in digital format, developed by the U.S. Census to support their mapping needs starting with the Decennial Census of 1990 (U.S. Census web site, 1997).

Industrial Recovery Sites Act (ISRA) data layer was based on information introduced by the New Jersey Department of Environmental Protection. ISRA guarantees prospective buyers of commercial sites that these sites will be fully evaluated for contamination above and below ground. All contaminants are required to be identified and remediated by the seller (Bergen County web site, 1995). Currently the type of contamination present and the level of health risks to public and the environment are not yet determined. Many of the sites are abandoned chemical plants, landfills and junk yards covering large areas within the study site.

Integration of data into GIS was accomplished using ArcView, a GIS software developed by ESRI (ESRI, 1996). The Elizabeth quadrangle orthophoto was scanned to digital format and georeferenced to the Universal Transverse Mercator (UTM) projection system using ERDAS (ERDAS, 1995) image processing software. The digital orthophoto was then used as the base map. The USGS 7.5 minutes topographic quadrangle of Elizabeth was used as a reference map in order to verify the airphoto interpretation derived from the orthophoto. The TIGER'94 file data was reprojected to the UTM projection system using the PC-Arc/Info Data Automation Kit (ESRI, 1996). The Digital Line Graph (DLG) containing hydrography and boundary data used for delineation of wetlands, streams and canals were reformatted for input into GIS. All data sets were on the same projection, datum, ellipsoid and scale.

To achieve the objective of the project, human component (i.e. schools and hospitals) and environmentally sensitive component (i.e. parks and green areas) were delineated and identified using the standard symbols. In addition to the layers mentioned above, the ISRA layer was generated and input along with its attribute table, which contains information on the partial listing of abandoned ISRA sites. The method of identifying and delineating the individual ISRA site was largely based on the information found in TIGER'94 attribute table (containing street addresses). Data from Tables 2 and 3 shown here were linked together by means of a unique identifier--street addresses.

Table 2. ISRA Sites Attribute Table.

Shape	Feature	Company Name	Address	Owner	Size (acres)
Polygon	ISRA site	Signo Trading Corp	130 Thomas Street	City	[illegible]
Polygon	ISRA site	Albert Steel Drum Premises Site	328 Wilson Avenue	NHA	13.75
Polygon	ISRA site	Scientific Chemical Processing	411 Wilson Avenue	Sigmund & Presto	4.00
Polygon	ISRA site	Courtesy Container Landfill	Rear 411 Wilson Avenue	NHA	45.00
Polygon	ISRA site	Diamond Shamrock Site	Rear 88 132 Lister Ave		5.82
Polygon	ISRA site	Sita Landfill	183 Raymond Blvd	City	3.45
Polygon	ISRA site	Bayonne Barrel & Drum	145 Raymond Blvd	Frank Lanzera	12.75
Polygon	ISRA site	N.J. Transport	701 Ferry Street	NJ Transit	8.52
Polygon	ISRA site	Arkansas Chemical Co	185 Foundry Street	City	1.70
Polygon	ISRA site	Pot Consol Site	193 273 Avenue P	Sudom	27.50
Polygon	ISRA site	Fiore Pistol Range	284 Avenue P	City	3.50
Polygon	ISRA site	S & J Trucking Site	310 338 Avenue P	NHA	3.49
Polygon	ISRA site	S & J Trucking Site	338 Avenue P	NHA	15.25
Polygon	ISRA site	S & J Trucking Site	333 355 Avenue P	Passaic Urban Renewal Cor	1.85
Polygon	ISRA site	S & J Trucking Site	357 405 Avenue P	NHA	3.98
Polygon	ISRA site	Numerous Junk Yards	481 549 Avenue P	NHA	8.55
Polygon	ISRA site	Numerous Junk Yards	527 589 Avenue P	Federal Storage Warehouse	3.79
Polygon	ISRA site	Textiles	421 453 Avenue P	[illegible]	2.85

Table 3. Segment of the TIGER'94 Streets Attribute Table.

Shape	Length	Fename	Fetype	Leftadd1	Leftadd2	Rgtadd1	Rgtadd2
PolyLine	155.854750	Mc Carter	Hwy	933	541	900	930
PolyLine	182.582150	Center	St	[illegible]	27	2	52
PolyLine	74.454555	Halsey	St	32	55	91	99
PolyLine	111.361300	Warren	St	[illegible]	78	[illegible]	27
PolyLine	78.673900	Lister	Ave	95	122	85	90
PolyLine	38.987215	University	Ave	258	254	251	257
PolyLine	244.499000	Raymond	Blvd	1292	1328	1279	1335
PolyLine	23.201480	Mc Carter	Hwy			888	888
PolyLine	132.218500	Broad	St	528	878	875	877
PolyLine	142.558250	Park	St		[illegible]		47
PolyLine	87.735490	High	St				
PolyLine	183.844500	Lister	Ave	18	34	31	97
PolyLine	234.926150	I 95					
PolyLine	71.257780	Lister	Ave	23	52	35	49
PolyLine	232.259050	Park	Pl	33	53	37	85
PolyLine	71.113200	Halsey	St	152	118	157	112
PolyLine	131.987300	Washington	St	124	92	181	183
PolyLine	128.123600	Raymond	Blvd	128	278	1247	1277

For the purpose of model development a buffer zone was established around the delineated waste sites/landfills. Proximity analysis was performed in order to assess the impacts of such sites on the human welfare (i.e. schools and hospitals) (Figure 2). The criteria used to rank the susceptibility of both human and natural resources are as follows:

1. 500 ft – unsatisfactory
2. 1000 ft – marginal
3. 2000 ft – satisfactory

Note: Based on the criteria set by NJDEP waste disposal sites should not be within 2000 ft of human and natural resources (NJDEP, 1984).

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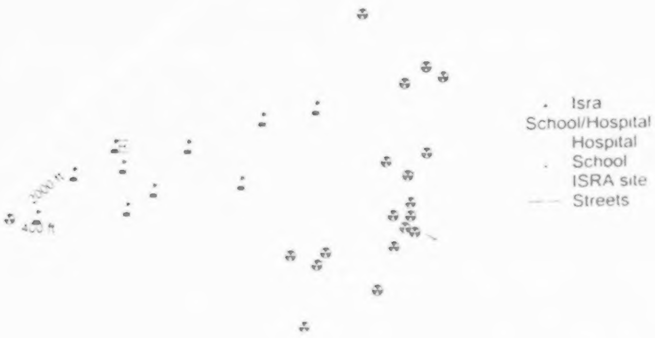

Figure 2. Location of Stored Waste Sites and Their Proximity to Schools and Hospitals.

CONCLUSION

The GIS developed in this study contains a variety of data and information useful for purposes of site assessment and planning, monitoring and management of waste sites and their impact on environmentally sensitive areas. It proves as an efficient and cost effective tool for planners, engineers, developers, and industry.

ACKNOWLEDGMENT

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REFERENCES

Bagheri, S. and Dios R.A., 1990. "Suitability Analysis for Location of Hazardous Waste Sites in New Jersey Piedmont Province", GIS/LIS '90 Proceedings, Vol. 1, pp. 299-306.
Bergen County Web Site, 1995. http://168.229.3.2/Bergen/Business/envregs.html
Engineering Soil Survey of New Jersey, 1951. Report Number 2. Rutgers University, NJ.
ERDAS, 1995. ERDAS Imagine, Atlanta, GA.
EROS Web Site, 1996. http://edcwww.cr.usgs.gov/glis/hyper/guide/24kdlg
ESRI, 1996. PC-Arc/Info Data Automation Kit & ArcView, Redlands, CA.
NJDEP, 1984. Division of Waste Management, Guidelines, 16 NJ.R 986 (a), 16 NJ.R 1766 (a).
U.S. Census Web Site, 1997. http://census.gov/geo/www/tiger/
USEPA, 1993. "Administrative Record File Newark Street Abandoned Tanker Site", pp. 1-5.
Widmer, K., 1964. "The Geology and Geography of New Jersey", Princeton, NJ.

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ELECTROCHEMICAL AC IMPEDANCE TECHNIQUE TO INVESTIGATE THE INHIBITION EFFICIENCY OF AN INHIBITOR FOR STEEL REBAR IN CONCRETE

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The purpose of this investigation was to determine the effectiveness of an aromatic anodic inhibitor to the corrosion of rebar in concrete which will be referred to as INHIBITOR. The corrosion behavior of reinforced concrete was monitored for 28 days in solutions of NaCl and $FeCl_3$ utilizing the AC impedance technique. A number of variables were considered. These included the amount of concrete cover (1" or 2"), as well as the presence or absence of the inhibitor admixture. In addition, half of the samples contained holes to increase the rate of chloride diffusion to the rebar. Bode plots were generated to determine the effectiveness of the inhibitor as a corrosion inhibitor. Furthermore, the open circuit potential of all specimens was monitored as a function of time to examine the probability of specimen corrosion, this was done accordance with ASTM C876

INTRODUCTION

The corrosion of reinforcing rebar in concrete is a major problem affecting the integrity in of numerous structures [5,3]. Corrosion of steel rebar takes place in the presence of moisture, oxygen and chloride ions. These elements enter reinforced concrete through pores, capillaries and tiny cracks in the surface and attack the steel rebar [1]. Reinforced concrete may also be of exposed to chloride ions which exist in deicing salts and marine environments [5,3]. Moisture containing these chloride ions diffuses through the surface and comes in contact with the rebars[1]. In spite of concrete's characteristically high pH (10-13) chloride ions depassives the steel reinforcement [1,4]. As chloride ions penetrate, they form electrolytes within the concrete, increasing the formation of corrosion cells, thus creating rust (oxidation)[1]. As the oxidation continues, rust build up on the rebars causes them to expand many times their its original size[1]. This may cause the concrete to crack and spall, further exposing the rebars and leaving them open to additional corrosion[1].

An attempt to alleviate these corrosion problems, a chemical company has developed a new corrosion-inhibiting admixture inhibitor. The manufacturer claims that the inhibitor effectively reduces corrosion by depositing a protective layer that inhibits corrosion on imbedded steel and actually increases corrosion protection as the structure ages. Once the layer is formed it is claimed to remain, thus extending the service life of structures subjected to chloride attack.

EXPERIMENTAL PROCEDURE

A total of 48 reinforced concrete specimens were obtained. All specimens, with dimensions of 4"x4"x12", were prepared from pre-mixed concrete and were cured for 28 days. Half of the specimens had concrete cover of two inches, and half had one inch of cover. A 1/2 inch, grade 60, steel rebar was placed one inch from an Inconel 800 counter electrode in each specimen to complete and electrochemical cell with an external $Cu/CuSO_4$ reference electrode. Various specimens contained holes to increase the diffusion of chloride. In addition, a total of twenty-four concrete samples were prepared with the inhibitor to study the effectiveness in inhibiting corrosion of the steel rebar. The addition of the inhibitor was in accordance with the manufacturers' recommendations (1/2 gallon per cubic yard of concrete, or 2650 ppm).

Immersion and testing of the twenty-four specimens in 60,000 ppm NaCl solution began on February 1 of 1996. Beginning two weeks thereafter, simultaneous tests were conducted on the remaining twenty-four specimens submerged in a 400 ppm $FeCl_3$ solution. The concentration of the $FeCl_3$ solution was increased on day 47 from 400 ppm to 4000 ppm, since there was no indication of the occurrence of corrosion in either set of samples. On day 112, five of the specimens, which showed very low resistance polarization and open circuit potential were

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sectioned to inspect for corrosion. Every rebar had a rim of corrosion product around it (rust formation). Testing duration was 28 weeks of immersion in NaCl and $FeCl_3$.

The following specimen identification was utilized throughout the study: a b c d where,

a = inches of concrete cover (1" or 2")
b = presence of holes on the specimen (indicated by "Y") or absence of holes on the specimen (indicated by "N")
c = presence of inhibitor x on the specimen (indicated by "Y") or absence of inhibitor x on the specimen (indicated by "N")
d = sample number (1 through 6)

DISCUSSION OF RESULTS

The data gathered in this investigation for the submerged concrete specimens in NaCl and $FeCl_3$ solutions were reduced to Bode plots and Potential vs. Time graphs. Bode plots generated through the use of AC impedance spectroscopy allow for conclusions to be drawn as to changes in the resistance polarization of the reinforcement in the concrete with respect to time of submersion in solution. This resistance polarization value or Rp is a measure of the steel's surface resistance to corrosion. The Bode plots contained in this report demonstrated clearly that with time the impedance of the rebar is decreasing and approaching the impedance of the solution in all case conditions.

Figure 1 consists of specimens with holes submerged in NaCl solution with one inch of concrete cover. This graph compares the effectiveness of the inhibitor admixture. A drop in impedance occurs in the specimens containing the admixture and the same holds true for those specimens which do not contain the admixture. Figure 2 consists of specimens without holes submerged in NaCl solutions with one inch of concrete cover. The same behavior occurred as a drop of impedance was illustrated in samples with and without the inhibitor admixture. Figure 3 correlates the probability of corrosion problems in accordance with ASTM C876. A drastic change occurred in specimen 1ny3 as its open circuit potential experienced a voltage drop from -0.241 V to -0.698 V after test day 108 indicating that depassivation of the rebar had occurred [3]. Figure 4 consists of specimens without holes submerged in $FeCl_3$ solution containing one inch of concrete cover. A drop of impedance was again significant in both cases regardless of the presence or absence of the inhibitor admixture. Figure 5 correlates the probability of specimen corrosion to an accompanied voltage drop. This figure indicates that there is a 90% probability of corrosion attack in both cases after day 90.

Figure 6 consists of specimens with holes submerged in NaCl solution containing two inches of concrete cover. A decrease of 50 times impedance occurred in the sample 2yy3 containing the inhibitor admixture from day 8 to day 183 and a decrease of 5.5 times its impedance occurred in the sample 2yn3 without the admixture from day 8 to 189. Figure 7 consists of specimens without holes submerged in NaCl also containing two inches of concrete cover. A drop of 5 times its impedance occurred from day 43 to 189 for the sample 2ny3 containing the admixture, while a decrease of 6 times its impedance occurred from day 35 to 189 for the sample 2nn3 without the admixture.

Figure 8 consists of specimens with holes submerged in $FeCl_3$ solution containing two inches of concrete cover. A decrease of 3.5 times its impedance from day 5 to 166 occurred in the sample 2yy5 with the admixture while a decrease of 2 times its impedance from day 30 to 166 occurred in the sample 2yn5 specimens.

CONCLUSIONS

AC electrochemical impedance spectroscopy indicated that INHIBITOR in ineffective as a corrosion inhibitor for steel rebar in concrete in a chloride containing environment. Thus the following conclusions were established:

1. Concrete specimens with one-inch of cover experienced a reduction in resistance polarization, Rp, (indicative of corrosion), regardless of the presence or absence of the inhibitor, after 70 days of immersion in NaCl.
2. Concrete specimens immersed in $FeCl_3$ showed reduction in Rp after 90 days.
3. Physical evidence of rebar corrosion was observed after 112 days of immersion within the one inch concrete cover samples.

4. Concrete specimens with a two inch cover experienced a significant reduction in resistance to polarization toward the latter end of the project (140 days) for both solutions. This slower rate of corrosion may be attributed to inward diffusion of chloride through the concrete.

ACKNOWLEDGMENTS

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REFERENCES

1. R. Jha, S.K. Singh and Anint Chatherjee, " Development of New Corrosion-Resistant Reinforcing Bars" *Journal of Materials Performance*, Vol. 31, April 1992, pp. 68-73

2. Gary N. Kirby "Fight Chloride Corrosion in Aqueous Systems", *The Journal of Chemical Engineering Progress*, Vol. 91, February 1995, pp. 47-53

3. Vladimir Novokshchenov "Corrosion of Reinforced Concrete in the Persian Gulf Region", *Journal of Materials Performance*, Vol. 34, pp. 51-54

4. S.R. Yromans "Performance of Black, Galvanized, and Epoxy-Coated Reinforcing Steels in Chloride Contaminated Concrete" *Journal of Corrosion*, Vol. 50, Jan. 1994, pp. 72-81

5. D.D. Macdonald, M.C.H. Mckuble and M.Urquidi-Macdonald, "Theoretical Assessment of AC Impedance Spectroscopy for Detecting Corrosion of Rebar in Reinforced Concrete", *Journal of Corrosion*, Vol. 44, January 1988, pp. 2-6.

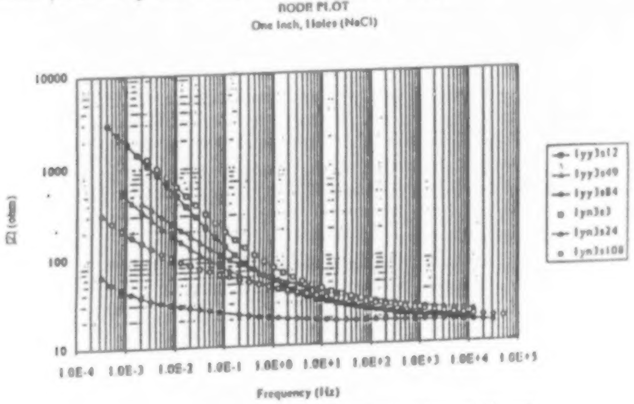

Figure 1. Comparative plot illustrating the effect of the inhibitor on samples with holes and a 1-in. cover

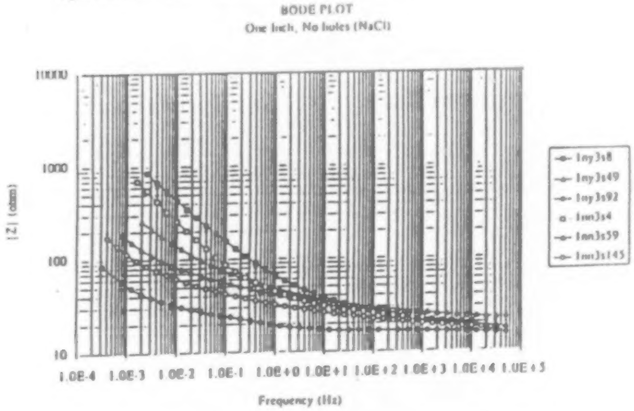

Figure 2. Comparative plot illustrating the effect of the inhibitor on samples with no holes and a 1-in. cover

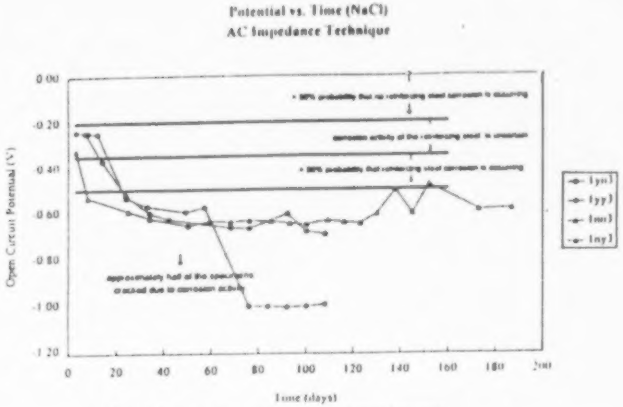

Figure 3. Potential vs. Time graphs monitored over a project of 28 weeks

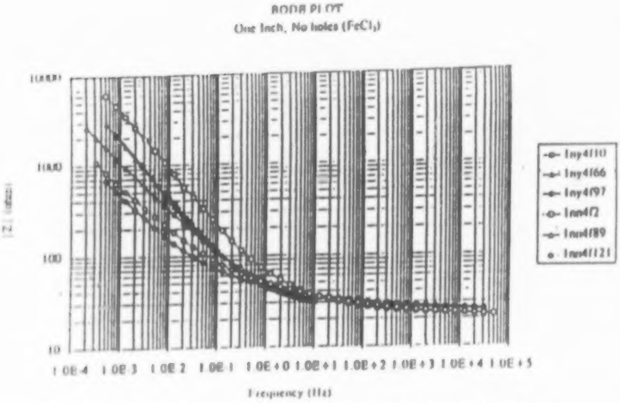

Figure 4. Comparative plot illustrating the effect of the inhibitor on samples with no holes and a 1 in. cover

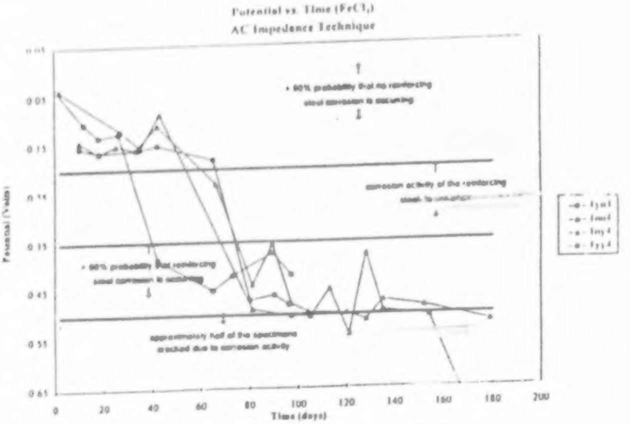

Figure 5. Potential vs. Time graphs monitored over a project of 28 weeks

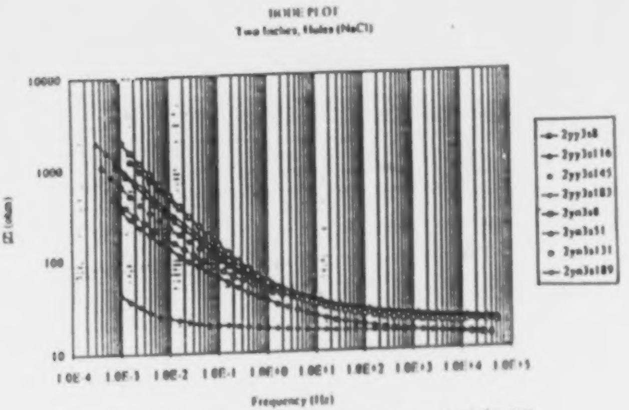

Figure 6. Comparative plot illustrating the effect of the inhibitor on samples with holes and a 2 in. cover

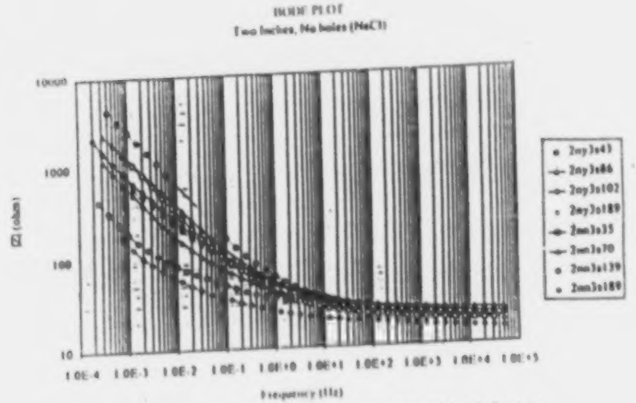

Figure 7. Comparative plot illustrating the effect of the inhibitor on samples with no holes and a 2 in. cover

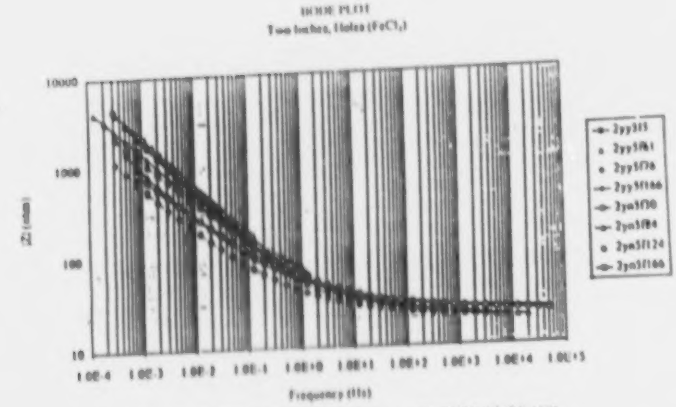

Figure 8. Comparative plot illustrating the effect of the inhibitor on samples with holes and a 2 in. cover

Prototype Designs of Concrete-Filled Steel Tube Composite Building Frames

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Research technology can offer any enterprise a competitive edge, but before employing a research result, structural engineers require evidence that it can reduce design time as well as construction costs. This paper illustrates design and analysis procedures for a new structural column, the concrete-filled steel tube (CFT), by developing prototype building frame configurations. Although prior research has demonstrated the improved strength and economy of individual CFTs over more common concrete or steel columns, this paper explores their behavior as a part of complete structural systems by integrating CFTs into building frames and pinpointing the aspects of CFT behavior fundamental to achieving efficient design. The composite CFT framing configurations included in the study vary in number of stories, number of bays, and bay spacing. The member sizes, patterns of deformation, and sequence of failure due to wind and seismic loading are examined for each CFT configuration and contrasted to the behavior of steel buildings. Several configurations produced efficient designs, exhibiting consistent, predictable response to both load types. These prototypes provide a basis for the practical design of CFT frames in the future.

INTRODUCTION

This research project examines the behavior of building frames consisting of steel wide-flange girders rigidly-connected to concrete-filled steel tube (CFT) columns. Although currently in limited use in practice, prior research has shown improved strength of CFTs over similarly-sized steel or reinforced concrete columns (Bridge and Webb, 1993). The perimeter location of the steel within the cross section provides optimal flexural strength and stiffness, and continuous confinement by the steel tube allows concrete to retain strength and deformation capacity beyond initial crushing and enhances seismic ductility. Additionally, the concrete resists local buckling of the steel, and the tubes provide ready-made construction forms for pouring the concrete.

Because the present design specification for CFT members accounts for the presence of concrete only by increasing the compressive strength and not the flexural capacity (AISC, 1993), engineers have typically applied CFTs to structural systems where compressive load dominates behavior, such as in mega-braced frames (Griffis, 1992). However, assessing CFT behavior more comprehensively can lead to a better understanding of how to use CFTs efficiently in more common structural systems, including low- and medium-rise moment-resisting frames.

The analysis used to assess CFT member behavior in this research project is a concentrated plasticity finite element formulation which models material nonlinearity through the use of plastic hinges at the member ends (Gourley and Hajjar, 1994). The analysis software, named *cftmacro*, is suitable for conducting "advanced analysis" for direct structural design. Advanced analysis approaches use geometrically and materially nonlinear formulations to calculate structural strength and stability at increasing loads and to determine the load of failure, i.e., the structural limit load. When the structure fails at a load increment at least equal to the factored design load, it is considered to be safely designed. In effect, using advanced analysis for design alleviates the need to perform the tedious design checks specified in building codes for each individual beam and column, since the behavior encompassed by these design checks is assessed directly by the analysis (White and Chen, 1993).

Several comparisons of frame behavior are drawn in this research project—based on geometric frame configuration, lateral load type, design philosophy, and type of column (steel or CFT). Specifically, four different frame configurations are used to determine the effect of geometry on frame behavior and the applicability of CFTs to lower-rise construction. Two lateral load types, wind and seismic, are examined to establish consistency of CFT frame behavior in multiple loading conditions. Finally, a comparison of two design philosophies, the advanced analysis procedure mentioned above, and current Load and Resistance Factor Design (LRFD) procedure (AISC, 1993; NEHRP, 1994), are used to confirm that new, comprehensive design criteria are required to produce efficient CFT frames.

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DESIGN PROCEDURE

The four two-dimensional composite CFT frame configurations chosen for the study, representative of low- and medium-rise buildings typical of current construction practice, vary in number of stories, number of bays, bay width, and bay symmetry. This variety allows a comparison of several geometric characteristics using a small number of frames. In particular, the four frames include a three-story frame with two unsymmetric 20- and 30-ft. bays, a four-story frame with four 20-ft. bays, and six- and ten-story frames, each with two 30-ft. bays. All story heights are 13 ft, and all ground supports are fixed. Additionally, the six- and ten-story frames include a stack of leaning columns. The primary purpose of the leaning columns is to increase the mass of the structure, thereby increasing the magnitude of seismic base shear, so that this value compares closely with the magnitude of the wind load, which is unaffected by the addition of the leaning columns. Furthermore, a two-dimensional, steel-only frame design accompanies each CFT frame configuration.

The material properties of each frame were also chosen to reflect current construction standards. The yield strength of the steel tubes is 46 kilo-pounds per square inch (ksi), and the concrete compressive strength is 5 ksi. The yield strength of the columns in the steel frame is 50 ksi, and the yield strength of all steel girders is 36 ksi. The finite element discretization consists of twelve elements per CFT column and eight elements per steel girder in the composite frames, and three elements per column and two elements per girder in the steel frames. All meshes were refined until their solutions converged.

The load on each frame was computed based on current standard design specifications. The same assumptions and calculation procedure were used for all configurations. The unreduced gravity load is representative of typical office building space (ASCE, 1995). The wind and seismic load magnitudes were chosen to produce approximately equal values of base shear and total wind load, to achieve comparable frame behavior under both types of lateral load. The wind load was applied using the procedure outlined in ASCE-7 (ASCE, 1995), and the seismic load was applied using the NEHRP guidelines, assuming a composite special moment resisting frame in computing the response modification factor (NEHRP, 1995).

Each CFT frame in the study was designed using two different design methodologies, which differ in the criteria used to describe failure: second-order inelastic advanced analysis, as described in the Introduction, and elastic-based design according to AISC LRFD (AISC, 1993). Advanced analysis defines failure as a loss of system strength or stability, whereas the LRFD Specification determines failure by comparing the forces present in each individual member to their calculated strength limit states. Each CFT frame configuration was designed using both advanced analysis and the LRFD procedure for the governing gravity or wind load combination, and using the LRFD procedure for the seismic load combination. This resulted in three CFT frame designs for each configuration: an advanced analysis design, a wind LRFD design, and a seismic LRFD design. These designs were each analyzed and the behavior examined under all three load types, including those which did not govern its design. Finally, the steel frames corresponding to each configuration was designed for the governing wind or gravity load combination using advanced analysis, for a total of four frame designs for each configuration.

Girders for all the frames and both design methodologies were designed according to the LRFD Specification, because the advanced analysis model used in this project does not account for lateral-torsional buckling behavior, a likely failure mode for 30-ft. girders (AISC, 1993). An unbraced length equal to half the bay width was used to model a beam framing in at mid-span, and a moment distribution (C_b) factor of 1.75 was used to calculate the nominal girder moment strength for an approximately linear lateral load moment diagram (AISC, 1993). To simplify behavior comparisons, the same girder sizes were retained for all steel and CFT frames in a given configuration, and to retain geometrically-compatible connections, the flange widths of each girder do not exceed the width of the column into which it frames. This requirement also placed an lower limit on the CFT sizes used, often resulting in over-strong upper-story columns.

In advanced analysis design, the target load magnitude derived from code specifications is applied to each frame in proportional load steps until system failure occurs, i.e., the structural limit point is detected. A load factor of 1.11, equal to 1.0 divided by 0.9, the resistance factor specified by AISC for bending, must be reached prior to failure to achieve an adequate design. Using the bending phi factor reflects that system failure is initiated by hinging in the girders, and that column failure, particularly in the CFT frames, is dominated by flexural strength capacity. Member sizes producing system failure at a load factor less than 1.11 prompted an increase in column sizes, and a system load capacity much greater than 1.11 required smaller column sizes.

After changing the column sizes accordingly, the analysis was performed again. During this design procedure, the girder sizes were held constant at their most efficient size based on LRFD.

The LRFD procedure is based on calculating interaction values for each member. These values are derived from forces obtained by a second-order elastic analysis of each frame. Columns exceeding an interaction value of 1.0 are increased in size and the frame is re-analyzed to produce new forces and re-check interaction values. Effective length (K) factors in the non-leaning frames were based on the nomograph in the LRFD Commentary Section C-2, and story-based K-factors were used for the leaning frames (AISC, 1993). In addition, the strong-column, weak-beam provision specified by AISC (1992) was applied to the seismic designs.

A linear elastic analysis was performed on each final frame design to determine inter story drift profiles. The limit of inter story drift for wind load was taken to be the story height divided by 400, using a reduced wind load (Ellingwood, 1996). The drift limit for seismic load was determined to be the story height divided by 50, using a drift amplification factor of 5.5, as defined in NEHRP Table 2.2.2 for special composite moment-resisting frames (NEHRP, 1995).

RESULTS

The resulting frame designs are summarized below, followed by an assessment of their behavior. Behavior is compared on the basis of load type, design methodology, and material used (i.e., steel or CFT columns). Results of the six-story frame design are shown in Figure 1. Detailed results of all frame designs may be found in (Fetterer and Hajjar, 1997).

In general, the design of the four CFT frame configurations was governed by different load combinations, but within a given configuration, similar load types governed the different designs of that frame. All three three-story CFT frames were governed by the gravity load combination. The load which governed failure of the four-story, four-bay frame designed by advanced analysis varied between stiffness limitations, the gravity, and the wind load combination, depending on the particular member proportions. .The chosen design was governed by stiffness. The four-story LRFD wind frame was governed by the gravity load combination, and the seismic load combination governed the four-story LRFD seismic frame. The six-story frame was governed by stiffness limitations for the advanced analysis and LRFD seismic designs, and by the wind load combination for the LRFD wind design. All ten-story frames were governed by stiffness limits.

The strategy for reducing CFT frame drift with minimal increases in member size differs according to the configuration in question. For the ten-story frame, increasing girder sizes contributes a great deal to stiffening the frame, but increasing the CFT sizes is more effective in reducing drift on the six-story frame. Drift in the three- and four-story frames is minimal, due to the shorter total frame height and the increased system stiffness provided by the additional bays.

Lateral Load Type Comparisons

Different lateral load types caused differences in both frame design and frame behavior. Designing the CFT frames using the LRFD procedure produced comparable member sizes for wind and seismic loading conditions, but different member proportions along the frame height. Rapid increases in load magnitude along the height of the frame, characteristic of a seismic load distribution, causes column forces inversely proportional to the decreasing gravity force, and a relatively constant total demand on each column along the building height. Therefore, column sizes are more uniform along the height of the frame and thus larger in the upper stories of the LRFD frames designed for the seismic load combination than the LRFD wind-designed frames.

The behavior differences within a given CFT frame design subjected to two different lateral load types was measured by drift profile, sequence of plastic hinge formation, and load factor at failure. Wind load causes the highest values of inter-story drift at the first or second story, which taper off to small values at the upper stories. Conversely, seismic load causes approximately uniform inter-story drift values along the frame height, with the most severe values occurring in the upper stories. This difference can be attributed to the difference in load distribution—the seismic load is more concentrated at the upper stories than the wind load distribution. High seismic load values at the upper stories can also account for seismic load causing maximum drift values about twice the magnitude of the maximum drift due to wind load, despite approximately equal values of seismic base shear and total wind load.

Differences in the sequence of plastic hinge formation are not easily distinguished between the two load types, confirming similar behavior of CFT frames under both lateral load types. In general for the CFT frames under both wind and seismic load, the first girder hinge occurs at a load about 20% less than the load causing the first column hinge. This strong-column, weak-beam behavior is generally a preferred failure mechanism for any load combination, so that conspicuous girder rotations precede catastrophic collapse. For these frames, the initial column hinge caused by the wind load combination is generally a first-story central column, also the most frequent location of critical inter-story drift. The first column hinge to form under seismic load is generally at the top story, where the load magnitude is highest. Additionally, for most CFT frame designs, the first column hinge occurs earlier in a wind load history than in a seismic load history, even though in many frame designs, seismic load causes failure at a lower load factor than wind. This again indicates the greater spread of column demand under wind load—as the "weaker" columns slowly shed load to the "stronger" columns, the failure load increases.

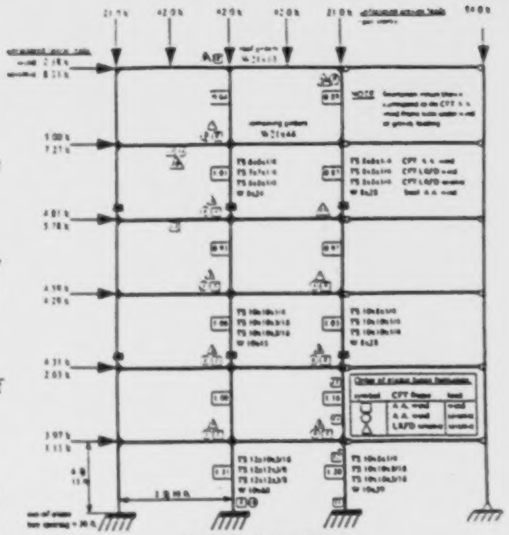
Figure 1: 6-story frame

Design Methodology Comparisons

Differences in CFT frame behavior based on design methodology are primarily a result of the overall difference in member sizes. When the LRFD design criteria are applied to the advanced analysis design member sizes, interaction is breached for several columns in all configurations. The degree to which the configuration was controlled by stiffness, i.e., the greater the overstrength of the frame, the fewer advanced analysis columns breach interaction. For example, about one quarter of the CFTs in the ten-story advanced analysis frame breach interaction, whereas more than half the CFTs in the six-story frame breach interaction. These inflated interaction values indicate that the LRFD procedure underestimates ultimate CFT capacity, and sizes stronger and larger than necessary are used in CFT frames designed with LRFD. The degree of CFT overstrength in the LRFD frames is further implied by a global increase in total steel weight on the order of 20% compared to the frames designed using advanced analysis.

Another indicator of overstrength is that when the final LRFD frames were analyzed under the load type for which they were designed, failure was detected at a load factor substantially greater than 1.0. This value was as great as 1.73 in the 10-story frame designed for seismic load, where the member size differences between the two design methods are large. However, the degree of overstrength is only 1.20 in the 3-story frame designed for gravity load, whose girder sizes, which are the same in both the LRFD and advanced analysis frames, are the trigger for failure. Overstrength is further shown by the fact that stiffness limitations govern only the design of the ten-story LRFD wind frame, and that column hinges form at 30% higher loads in the LRFD frames than in the advanced analysis frames.

CFT Comparisons to Steel

Since steel frames corresponding to each configuration were designed only for wind load using advanced analysis, comparisons drawn between steel and CFT frame behavior are limited to the two advanced analysis frames. The design of the three- and four-story steel frames were governed by gravity load, and the six- and ten-story steel frames were governed by stiffness limitations. Steel weight of the wide-flange columns exceeds the steel weight of the CFTs by 20 to 30%, with the greatest difference occurring in the ten-story frame. Plastic hinge formation in the girders follows a similar sequence in both frames, but a comparison of column plastic hinge formation is not meaningful due to different cross-sectional material models.

Differences in drift profiles between the steel and CFT frames exist for all configurations—although both profiles show less inter story drift at the upper stories than at the lower stories, the CFT frames exhibit sequentially greater inter story drifts along the frame height than the steel frames, causing a greater total lateral drift. The taller frames exhibit a greater drift difference. The methods used to control drift in the design of the steel and CFT frames differed in a manner similar to the different drift control strategies among the various CFT frame configurations. Whereas increased girder sizes contribute more effectively to drift control in the steel frames, increasing column sizes is more effective at reducing drift in the CFT frames.

CONCLUSIONS

Characteristics of CFT frame behavior can be shown through comparisons of design methodology, frame configuration, load type, and a comparison to steel frame behavior. Because the current CFT design specification is based on rudimentary behavioral assumptions, some of the most distinguishing CFT frame characteristics are shown by comparing frames designed using LRFD and advanced analysis design methodologies. Large differences in member sizes between advanced analysis and LRFD design methods indicate that the current specification substantially underestimates CFT capacity. In particular, the extent of CFT flexural capacity is poorly accounted for. This is exhibited most clearly in the six-story configuration, where the LRFD design is governed by individual member strengths under wind load, but the advanced analysis design, which accounts more explicitly for CFT behavior, shows that a frame consisting of significantly smaller columns contains enough resistance to lateral load that its design is strongly governed by stiffness and not strength limitations.

CFT behavior is also indicated in a comparison of CFT frames to similarly-proportioned steel frames subjected to identical loads. Although the overall weight of steel is less in the CFT frames, this alone is not an accurate measure of structural economy, because CFT connections are not yet standardized and are thus often expensive. A more important difference between CFT and steel frames is the difference in lateral stiffness. Despite CFT flexural strength greater than the predicted code values, CFT flexural stiffness, as indicated by lateral drift of the frame, is still less than that the stiffness of steel wide-flange members of comparable major-axis flexural strength. This results in CFT designs controlled by stiffness for any frame not dominated by gravity load, even for an inherently stiff frame such as the four-story, four-bay frame.

Perhaps a more precise indicator of CFT behavior than pure flexural strength or stiffness is the ratio of flexural strength capacity to axial capacity. This ratio is fundamentally different for CFTs than for steel, and it must be accounted for in design. CFTs can be efficiently applied to highly gravity-dominant structural systems with the current design specification. But in order to produce efficient CFT frame designs applicable to low- and medium-rise moment-resisting frames and other common building structures, a new approach to CFT design, such as drift-based criteria which accounts for this decreased flexural capacity ratio, must be adopted.

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REFERENCES

American Institute of Steel Construction (1993). *Load and Resistance Factor Design Specification for Structural Steel Buildings*, 2nd ed., AISC, Chicago, Illinois.

American Institute of Steel Construction (1992). *Seismic Provisions for Structural Steel Buildings*, AISC, Chicago, Illinois, June.

American Society of Civil Engineers (1995). *Minimum Design Loads for Buildings and Other Structures*, ASCE 7-95, American Society of Civil Engineers, New York.

Bridge, R. Q. and Webb, J. (1993). "Thin-Walled Circular Concrete Filled Steel Tubular Columns," *Composite Construction in Steel and Concrete II*, Easterling, W. S. and Roddis, W. (eds.), American Society of Civil Engineers, New York, pp. 634-649.

Ellingwood, B. (1996). "Structural Serviceability Review and Standard Implementation," *Building an International Community of Structural Engineers, Volume 1*, Proceedings of Structures Congress XIV, American Society of Civil Engineers, Ghosh, S. K. and Mohammadi, J. (eds.), Chicago, Illinois, April 15-18, 1996, ASCE, New York, pp. 436-443.

Fetterer, K. and Hajjar, J. (1997). "Prototype Designs of Unbraced Composite Frame Structures Using Concrete-Filled Steel Tube Beam Columns," *Structural Engineering Report No. ST-96-7*, Department of Civil Engineering, Univ. of MN, Minneapolis, MN, in preparation.

Gourley, B. C. and Hajjar, J. F. (1994). "Cyclic Nonlinear Analysis of Three-Dimensional Concrete-Filled Steel Tube Beam-Columns and Composite Frames," *Structural Engineering Report No. ST-94-3*, Department of Civil Engineering, Univ. of MN, Minneapolis, MN, Nov.

Griffis, L. G. (1992). "Composite Frame Construction," *Constructional Steel Design: An International Guide*, Dowling, P. J., Harding, J. E., and Bjorhovde, R. (eds.), Elsevier, London, U.K., pp. 523-553.

NEHRP (1995). *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*, 1994 edition, prepared by the Building Seismic Safety Council for the Federal Emergency Management Agency, Washington, D.C.

White, D. W. and Chen, W.-F. (eds.) (1993). *Plastic Hinge Based Methods for Advanced Inelastic Analysis and Design of Steel Frames: An Assessment of the State-of-the-Art*, Structural Stability Research Council, Bethlehem, Pennsylvania.

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Removal of Ammonia from Contaminated Air Stream by Biofiltration

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Ammonia, a trace gas component in exhaust gas from wastewater treatment processes, must be removed because of its odorous nature. Biofiltration, with rice straw and microorganisms as the media, was chosen to clean the gas stream due to its possibility of removing the odorous gases from the gas stream at low cost and high efficiency. In the process of biofiltration, ammonia is transferred from the air stream to biofilm when ammonia and air pass through a microbiologically active filter bed, made of rice straw, and are metabolized by the embedded microorganisms, nitrifying bacteria which grow on the nitrogen supplied by the gases and the carbon supplied by the rice straw. With a 60% moisture content, pH 7±0.4, 6.5L/min air loading rate, and room temperature 20°C±1.0°C, there was a 95% ammonia removal efficiency for a duration of 30 days. The moisture content was found to be the most important parameter in this experiment since high moisture content increases the rate of degradation of the rice straw.

INTRODUCTION

Odors from wastewater treatment facilities are problems that have affected citizens for decades (Hwang, 1994). A 1978 wastewater treatment plants (WWTPs) survey showed the complaints about odors from WWTP activities (Langenhove, 1985). Since then removal of odorous gases from wastewater treatment plants has become one of the major areas that scientists focus on. Ammonia, produced as a trace gas component during wastewater treatment processes, must be removed from exhaust gas because of its odorous nature (Hwang, 1994). Various physical and chemical treatment processes, such as activated carbon and electrochemical membrane separator have been used to purify the exhaust gases from wastewater treatment processes. However, because of the large operating costs of these systems, biological processes have been developed. These processes may serve as an environmentally and economically sound alternative because of their low operating cost and minimum environmental impact.

Biological processes have been widely used for management of ammonia in exhaust gas from the wastewater treatment plants. Several studies on the biological filter that removes the odorous gases have been done (Hartikainen, 1996, Basu, 1994, Liu, 1994, Gadre, 1989, Langenhove, 1985). In our laboratory, we chose the method of biofiltration because it removes ammonia gas at high efficiency. The biofilter uses a filter media that consists of rice straw and microorganisms (nitrifying bacteria) to absorb and degrade ammonia nitrogen. The purpose of this study is to investigate the uses of low cost rice straw and nitrifying bacteria to purify ammonia contaminated air stream.

MATERIALS AND METHODS

Experimental Set-Up

A schematic diagram of a laboratory scaled biofiltration system is shown in Fig. 1. The bioreactor (height: 18.75 in, cross sectional area: 0.013 m^2) was packed with a media of ground rice straw (1 inch in length) and microorganisms (1/3 of the mass of the wet weight of rice straw). The ammonia gas stream supplied to the biofilter was generated by purging a pure air stream through deionized water (to provide a constant humidity to the system) and diluted ammonia hydroxide solution. All experiments were carried out at room temperature, 20±1.0°C.

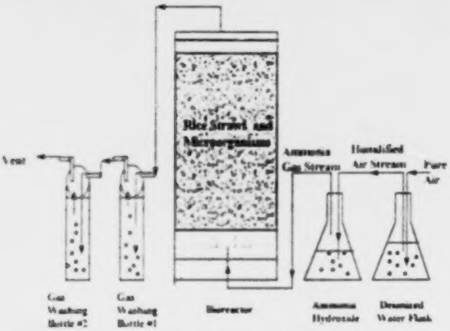

Figure 1. The experimental schematics

Biofilter medium

The rice straw used as the packing material was 1 inch in length with a 10% moisture content. The percentage moisture content was determined by drying in oven at 103°C for 12 hours. Table 1 shows the results of elementary analysis of the rice straw.

Wastewater containing nitrifying bacteria was obtained from the wastewater treatment plant at the University of California Davis and used as the seed culture of nitrifying bacteria for our biofilters.

Table 1. Some properties of the rice straw

Item	Value
pH	6.7
Moisture Content (%)	10
C (%)	34.9
N (%)	0.674
Ash (%)	20

Preparation of rice straw seeded with nitrifying bacteria and operational procedures

The rice straw was mixed with the wastewater that contained an unknown amount of nitrifying bacteria (this will be investigated in our future work). With a 5% suspended solids content, the quantity of the wastewater was 1/3 of the wet weight of the rice straw. After mixing the rice straws and the wastewater, the moisture content of the rice straw was raised to about 60% by adding additional deionized water. Then the moisture content was controlled at this level by the humidified air stream. The weight of the packed rice straw was 695g. The packing volume was 5.86L, and the starting pH was about 6.7.

The air loading rate of the inlet ammonia was 6.5L/min; the ammonia hydroxide solution, made by mixing 0.789mL of 58% concentrated ammonium hydroxide and 500mL of deionized water, was changed every 24 hour to supply ammonia gas to the biofitler at relatively constant level of 20 ppm in the air. The amount of deionized water in the water flask was kept at 1000L to provide a constant humidity. Samples of rice straw were taken from the biofilter once a week for analysis of percentage moisture content, pH, and total nitrogen and total carbon.

Ammonia Adsorption Analysis

The amount of ammonia in the NH_4OH solution at inlet gas stream and boric acid at the outlet was determined by a calibrated ammonia probe. The calibration was performed with five standard ammonia solutions (10mg/L, 50mg/L, 100mg/L, 500mg/L, and 1000mg/L), which were prepared by diluting 1000mg/L NH_4Cl solution with deionized water (for testing the inlet gas) and with boric acid (for testing the effluent gas). The procedures for calibration and measurement were from the instruction manual of the ammonia probe. The effluent gas was collected three times a week by two connected gas washing bottles containing 0.3M boric acid, which was prepared by dissolving 18.6g of boric acid powder in 1000mL of deionized water. The ammonia efficiency was calculated by formula (1).

$$\frac{\text{(Amount of Ammonia entered - Amount of Ammonia in Boric Acid)}}{\text{Amount of Ammonia entered}} \qquad (1)$$

RESULTS AND DISCUSSION

Determining the Optimal Moisture Content for the Biofilter Media

Two trials were conducted to determine the optimal moisture content for the biofilter media. In trial I, the moisture content was controlled at 80% for a three-week time period. In trial II, the moisture content was lowered to 50% for another three weeks. Both experiments were conducted under the same temperature (20°C±1.0°C), air loading rate (2.5L/min), media, and packing volume except the moisture content. After three weeks, a sample from each trial was sent to DANR Laboratory at UC Davis for percent carbon analysis. The product of the total mass and the percentage of lost carbon yielded the total carbon loss. With 80% moisture content, the total carbon content in the rice straw decreased about 6% with 177.1g carbon loss. With 50% moisture content, the total carbon content in the straw decreased by 2.5% with 26.9g loss. Table 2 shows the results from percent carbon analysis and total carbon loss calculation. The middle column shows the differences in percentage carbon in rice straws at the beginning (fresh rice straw) and the end of each trial; the third column shows these differences in unit of mass. The data shows that in Trial 1 there was a higher rice straw degradation. To extend the life of the media, we needed to choose a moisture content that contributes to a lower carbon loss. From our moisture content analysis and literature review (Langenhove, 1985), a 60 percent moisture content was chosen as the optimal condition for the filter media.

Table 2. Comparison of Rice Straw Degradation

Item	Δ %C	Δ C-Tot Loss
Fresh Rice Straw	34.9	-
Trial I (80%)	28.8	177.1 g
Trial II (50%)	32.4	26.9 g

Ammonia Removal Efficiency of Rice Straw Filter

A third trial was conducted for 46 days for ammonia removal testing. The experiment was conducted under the following conditions: pH 7±0.4, 60% moisture content, 20 ppm inlet ammonia concentration, 6.5L/min air loading rate, and 20°C±1.0°C room temperature. Two biofilters were set up with the same conditions as illustrated above but with different media. Reactor 1 contained ground rice straw, and Reactor 2 contained ground rice straw and soil particles that were used as the sources of nitrifying bacteria. The mass ratio between ground rice straw and soil particles was 3:1. Three sets of experimental data were obtained every week from the ammonia adsorption analysis of ammonium hydroxide solution and boric acid solution. The ammonia removal efficiency was determined by measuring the amount of ammonia that entered into the bioreactor, and the amount collected in the two gas washing bottles. The difference between the two would be the amount removed by the bioreactor. According to experimental results, Reactors 1 and 2 both removed ammonia with an efficiency greater than 95% for 30 and 36 days, respectively. Afterwards, the ammonia removal efficiency dropped dramatically. Figure 2 demonstrates clearly the differences between the two reactors. The one-week longer life time for Reactor 2 (rice straw with soil particles) is a consequence of the media's higher porosity, which provides more active sites for ammonia to bind to the media. Moreover, pure rice straw filter has larger air spaces for ammonia gas to escape thus lowering the ammonia removal efficiency. In order to prove that the biofilter really removed the ammonia gas, we sent in our weekly collected rice straws samples to the DANR Analytical Laboratory at the University of California Davis for nitrogen and carbon analysis. Figures 3 and 4 show the results of the analysis for Reactor 1 and Reactor 2, respectively. Both graphs show carbon loss and nitrogen build-up as the experiments proceed. Therefore, we can conclude that the media in the biofilter removes the ammonia.

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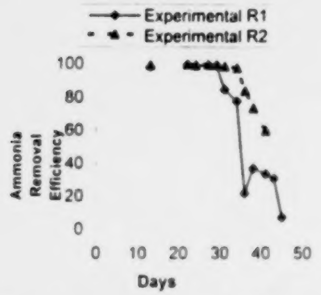

Figure 2. Ammonia removal efficiency curve (R1: rice straw, R2: rice straw and soil particles)

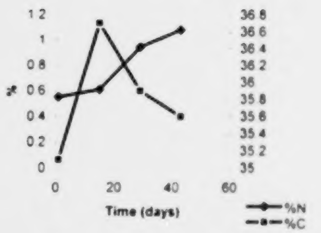

Figure 3. Changes in %N & %C in R1 (rice straw)

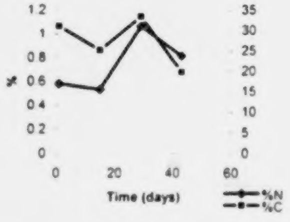

Figure 4. Changes in %N and %C in R2 (rice straw and soil particles)

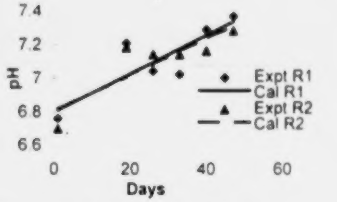

Figure 5. pH changes for both reactors

Effects of pH on Rice Straw Filter

pH of the media was measured every week by pH probe. The data we obtained through the 46-day experiment led to the graph below. Figure 5 shows a similar trend of increasing pH appeared in both reactors. Since the pH did not dramatically increase or decrease during the 46-day experiment, we concluded that pH did not affect our experimental conditions.

CONCLUSION

a) Optimal Experimental Conditions

Rice straw was found to be a good packing media for biofilters. At 60% moisture content, pH 7±0.4, 20ppm ammonia concentration in air, 6.5L/min air loading rate, and

20°C±1.0°C room temperature, there is a 95% removal efficiency lasting 30 days for pure ground rice straw and 36 days for rice straw with soil particles. Afterwards, the ammonia removal efficiency drops dramatically, indicating the break-through of filter media by ammonia. The moisture content of the packing media is a very important factor in this experiment since high moisture increases the degradation rate of the rice straw, therefore reducing the life time of the filter media. The optimal moisture content of filter media is 50-60%.

b) Soil Addictive Media

From the results we obtained, we conclude that rice straw with soil particles is a very economic filter media for the removal of ammonia from exhaust gas. First, rice straws with soil particles provide larger surface areas and active sites for ammonia to bind. Second, the air permeability of rice straw is better than other filter media such as fiber peat and household compost. Lastly, rice straw and soil particles can be obtained easily at low cost in geographical areas where rice is a dominant crop.

c) Future Work

From the difference in the efficiency of ammonia removal between rice straw and rice straw with soil particles, we predict that the amount of nitrifying bacteria in the media will have a substantial influence on the removal efficiency. It will be investigated in our future studies

REFERENCES

Hwang, Yongwoo, Water Resource, Removal of Odorous Compounds in Wastewater by Using Activated Carbon, Ozonation and Aerated Biofilter; Vol. 28, Feb 1994, No.11, pp. 2309-2319

Hwang, Yongwoo, Water Resource, Identification and Qualification of Sulfur and Nitrogen Containing Odorous Compounds in Wastewater; Vol. 29, 1995, No.2, pp. 711-718

Langenhove, H. Van, Water Resource, Elimination of Hydrogen Sulfide From Odorous Air by a Wood Bark Biofilter; Vol. 20, No. 12, pp. 1471-1476

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COMPARISON OF ANALYSIS METHODS FOR NON-CLASSICAL STRUCTURES WITH ADDED VISCOELASTIC DAMPING

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Earthquakes cause extreme damage to building structures. Therefore, it is necessary to be able to predict the response of structures during earthquakes. In predicting the response, the structure must be represented mathematically by its mass, stiffness, and damping. Normally, these properties are simplified for ease of analysis. In the case of non-classically damped structures, these linear approximations are not valid due to the sharing of energy between different structural resonant frequencies, or modes. As the response of non-classic structures must be predicted to ensure their safety, over the years different analytical models have been developed to approximate the mass and damping for such structures. Presently several analytical models exist, but few experimental tests have been performed to verify them. The focus of this project was to compare the responses obtained from the analytical models with experimental results. A non-classical three degree of freedom building structure was designed. Added viscoelastic damping (through material 3M-ISD-112, provided by 3M, St. Paul, MN) was implemented to accentuate the modal coupling. Impulse loading and harmonic input testing was done on this structure with four damping arrangements. Experimental values of response were compared with like values found through modal analysis and the Wilson-θ method.

PROJECT OBJECTIVES

The general structural dynamic equation is given by (1):

$$M\ddot{u} + C\dot{u} + Ku = P(t) \qquad (1)$$

,where M=mass matrix, C=damping matrix, K=stiffness matrix, $\ddot{u}$ =acceleration vector, $\dot{u}$ =velocity vector, u=displacement vector, and P(t) is the time dependent forcing function vector.

In structures where the resonant frequencies, or modes, are close together (within 10-20%), energy is transferred through the structure between the adjacent modes. This causes the damping matrix to be non-orthogonal, rendering modal analysis, the "classic" method of dynamic analysis, an ineffective solution method. Therefore, structures with non-orthogonal property matrices are referred to as "non-classical." The non-orthogonality of the damping matrix can be increased through additional structural damping.

Alternative dynamic analysis methods include the direct solution of Eq. (1) and iterative procedures. Solution by direct solution is very mathematically difficult and time consuming. Iterative methods involve looking at the change in the motion of the structure considering very small time intervals. With many iterative methods it is possible to use property matrices of any orientation, including non-orthogonal. The iterative method used thus far for comparison is the Wilson-θ method (Wilson, et al, 1973).[1] The Wilson-θ method is an expansion of the linear acceleration method, approximating the acceleration with the change in force with respect to a value of θ ($1.37 \le \theta \le 1.42$).

The scope of this project included the design and construction of a miniature building frame with close modes (within 3%), a damper series, instrumentation and data acquisition, testing, computer modeling, and analysis. Experimental response ($\ddot{u}, \dot{u}$, and u) was compared with the responses obtained using modal analysis (using SAP90, Computers and Structures,

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Inc., 1990) and Wilson's method. In this project, additional damping was provided through the use of 3M (St. Paul, MN) viscoelastic material, a polymer that provides both energy dissipation (behavior similar to a viscous damper, visco-) and restoring force (-elastic).[2]

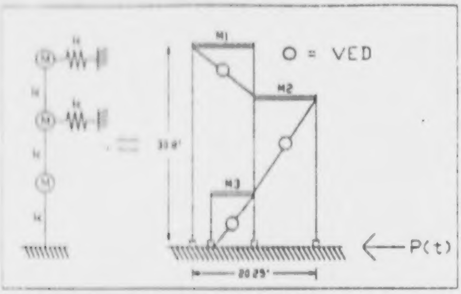

Figure 1: Modeling Concept and Physical Design

TESTING AND RESULTS

The model was tested without dampers and with three damper design series: 3%, 6.5%, and 10% critical damping. An unpredicted stiffening effect of the viscoelastic material was encountered after construction of the dampers and before testing. This caused the actual damping ratios to be closer to 4%, 10%, and 9%, respectively.

Instrumentation consisted of accelerometers (Setra, Inc.) at each building floor and the table surface. Data was collected at the rate of 200 points per second. Testing was performed on a 30 inch square RV-30-300 (L.A.B. Corporation) vibration testing table, or "shake table".

Sine sweep tests were run using the harmonic loading produced by the shake table. As the frequency of the table increases, the magnitude of the force also increases, the outline of the periodic force therefore resembling the sine function. The table was made to run systematically from 5 Hz to 30 Hz, and back down to 5 Hz. Therefore, the input acceleration passed through the modes of the frame, giving response amplitude peaks at these points. Also, each experimental test had approximately the same input motion, as the increase in frequency and amplitude was regulated by a cycling motor.

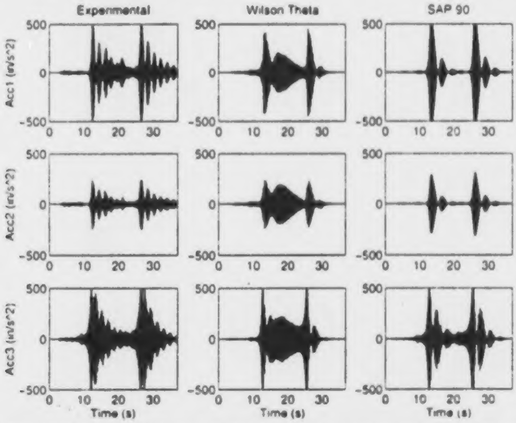

Figure 2: Undamped Sine Sweep Test With Analytical Comparisons

Figures 2-3 show experiment runs for the undamped run, and the 4% damping run, which was similar in shape to the 9% and 10% damping runs. Presented alongside the experimental plots are the acceleration response values computed by the analytical methods used. The nonclassical damping matrix used in the Wilson-θ method calculations was found using a relationship between the mass matrix and mode shapes (Clough and Penzien, ch. 13).[3] The notation used to code the Wilson-θ method was found in Bathe (1995).[4]

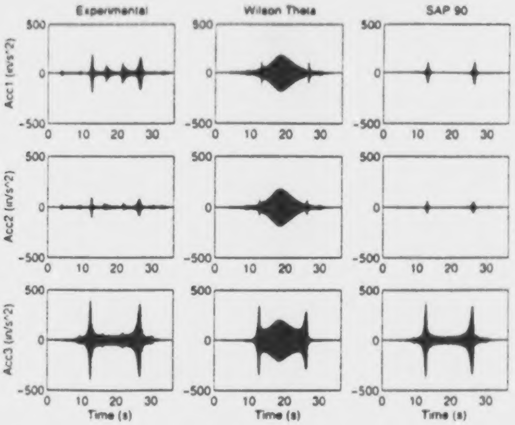

Figure 3: Four % Damped Sine Sweep Test With Analytical Comparisons

CONCLUSIONS

In viewing Figures 2 and 3, notice that when the damping is small the experimental response resembles the modal analysis response (SAP90), and when the damping is greater the response is more comparable with the Wilson method. This follows the fact that increasing damping increases the modal coupling, and therefore makes the damping matrix non-classical to a greater extent.

Also demonstrated in these figures is the great reduction in the magnitude of the acceleration response due to the addition of viscoelastic damping at only 4% of critical. Design viscoelastic damping is often in the range of 10%-20% of critical.[2] Note also that this reduction is done without greatly influencing the structural behavior (modes), or weight of the structure. These properties make viscoelastic material an attractive alternative to energy dissipation methods such as steel dampers or frictional damping, as the original structure can be protected without being radically changed in increasing weight, or vibration characteristics.

It can be seen In Figure 3 that although the response obtained with the Wilson method does not directly compare with the non-classical structure, both responses include modal coupling. It is clear that the SAP90 analysis includes no modal coupling, and only produces amplitude peaks at the resonant frequencies of the frame. Reasons for a non-exact solution could be due to one of the diagonal braces coming partly detached (which did occur), the shear failure of the viscoelastic material bond, the influence of the instrumentation wires on the frame, or misrepresentation of the frame mathematically.

Future testing should include the measuring of the dynamic damping per cycle through hysteresis loops. Investigation will also be undertaken on the undefined source of the dampers stiffening with time. Also, other iterative methods should be compared with the experimental response as well.

ACKNOWLEDGMENTS

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REFERENCES

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[1] Wilson, E.L., Farhoomand, I., and Bathe, K.J. (1973). "Nonlinear Dynamic Analysis of Complex Structures" *Earthquake Engineering and Structural Dynamics*, Vol. 1, pp. 241-252.

[2] Aiken, Ian D. (1990). "Earthquake Simulator Testing and Analytical Studies of Two Energy-Absorbing systems for Multistory Structures" Doctoral Dissertation, University of California at Berkeley.

[3] Clough, Ray W. and Penzien, Joseph (1975). Dynamics of structures. New York : McGraw-Hill.

[4] Bathe, Klaus-Jurgen (1996). Finite Element Procedures in Engineering Analysis. Englewood Cliffs, N.J. : Prentice-Hall.

Field Testing of Stone Masonry Arch Bridge #143 in Chester County, PA

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Stone masonry arches were a very common type of bridge built in the northeast U.S. during the 18th and 19th centuries. To the dismay of many, they are slowly falling victim to the increasing vehicle weights and volumes of today's roadways. Therefore, there is an urgent need for an effective and economical method of rehabilitating these structures.

This presentation will display the results of a series of load vs. displacement tests that were done on a bridge that was rehabilitated using recently developed techniques. The displacement data was used to rate the effectiveness of the repairs and to determine a load rating for the bridge.

INTRODUCTION

On April 12, 1996 a series of tests were conducted on the Wyebrook bridge, a stone masonry arch bridge in Chester County, PA. These tests were done in order to determine the deflection under loading of the bridge at several locations. This information was then used to evaluate the success of a recent rehabilitation, estimate the loading capacity of the bridge, and determine the need for a weight restriction.

BACKGROUND

Description of the Structure

The Wyebrook bridge is a three-span stone masonry arch bridge that carries Wyebrook road over Brandywine Creek. It is located in West Nantmeal Township, Chester County, Pennsylvania. The structure was originally constructed in 1888 and later rehabilitated in 1995 after a partial collapse of the spandrel wall and the arch at the southern approach.

The bridge consists of three arches. The two smaller approach arches each span 13'-1" and are semi-circular. The center arch is larger, spanning 25'-3", and has a four-centered configuration. The spandrel walls are approximately two feet thick and composed of roughly dressed random stone. The spandrel wall extends 7'-1" above the intrados at the crown of the center arch, providing a parapet that is 3'-7" high. The entire length of the structure along the top of the parapet is 100'-6".

Condition of the Structure

The center arch was probably built with the four-centered configuration in an attempt to limit the height of the structure. However, this created a "humpback" in the roadway above this center arch. At the time of the bridge's construction, this would not have posed a problem to horse-drawn carriages. However this hump in the road proved to be a danger as vehicle speed increased. Eventually, the grade at the south side of the bridge was raised to eliminate the humpback and create a uniform grade of 5%. An estimated 4 feet of clay fill was added, and the spandrel wall at that approach was extended (Boothby and Craig, 1996).

Other than a troubling pattern of cracking documented in inspection reports, the bridge appeared to be structurally sound. There was no evidence of scour or settlement of the foundations. There was also no apparent bowing or sagging of the arch rings, which would indicate hinging (Baker, 1907). As cracking problems increased, a minor rehabilitation was scheduled for 1995 (Boothby and Craig, 1996).

During the night of August 22, 1994, after a prolonged period of heavy rains, the spandrel wall over the south approach span collapsed under hydrostatic pressure. A large part of the arch ring also fell. The bridge was immediately closed to traffic and inspected thoroughly. Some smaller longitudinal cracks were discovered in the center span underneath the intact spandrel wall. Although these were not progressing at the rate of those in the collapsed ring, a portion of the spandrel wall and the exterior face of the center arch ring was removed to be reconstructed along with the collapsed portion of the spandrel wall and approach arch (Boothby and Craig, 1996).

The undamaged portions of the bridge were left intact and only the collapsed portions of the bridge were rebuilt. Because the arches had proved to be sound in the longitudinal direction, a plan to build reinforced concrete saddle arches was rejected in favor of a less expensive plan that addressed the need to alleviate the hydrostatic pressure on the spandrel walls. First, the clayey silt fill was replaced with an engineered fill material meeting PADOT specifications for structural backfill, 2A modified. This material is free-draining and has a higher angle of internal friction than the previous fill, so both hydrostatic pressures and active earth pressures were reduced significantly. Reinforced concrete walls were then constructed inside the original spandrel walls over the area where the grade had been raised; half of the main span and the entire approach span. These reinforced concrete walls were then connected with cables anchored with eyebolts to the walls at a spacing of 10 feet horizontally and four feet vertically (Boothby and Craig, 1996).

The replacement of fill and reinforcement of the spandrel walls proved to be economical, but a continued monitoring program has been determined to be necessary to ensure that the repairs successfully restrained the spandrel walls from moving outward.

LITERATURE REVIEW

Due to the unique circumstances behind this testing program, very little literature is available that is directly relevant to this report. Several in-service structures in the eastern United States have been tested to determine their load capacity. Tests to collapse have been done on full scale and reduced size models. Several in-service bridges have been tested to collapse in the United Kingdom, and a few recently constructed or rehabilitated structures have been instrumented to allow monitoring. The relevant portions of several papers related to these programs are discussed below.

Masonry Arch Bridges, a state of the art review (Page, 1993), provides a comprehensive survey of current knowledge in every aspect of stone and brick masonry arch bridges. Of particular relevance to this study, Page includes an extensive examination of common repair and maintenance problems experienced by older masonry arch structures. Movement of the spandrel walls is a frequent ailment of masonry bridges, and was the main mode of failure of the Wyebrook bridge. The other problem exhibited in the Wyebrook bridge was that the clay fill failed to drain sufficiently. This problem is also cited by Page as a case of inadequate waterproofing. Suggested repair techniques listed include placing tie bars to restrain the spandrel walls and replacing the fill with concrete. The rehabilitation plan undertaken at Wyebrook included the tied spandrel walls in addition to a pair of reinforced concrete auxiliary spandrel walls. What Page fails to mention is the replacement of the clay fill with engineered fill as was used at Wyebrook. This solution is less costly than replacement of the fill with concrete.

The TRRL Report entitled "Test on Stone Masonry Arch at Bridgemill-Girvan" (Hendry and Davies, 1985) is an account of a test to failure on an existing masonry arch bridge. The authors used several methods of analysis to determine the failure loads of the bridge and then compared these results to the results of the actual test to failure. Many of these analysis methods rely heavily on engineering judgment and were therefore found to be overly conservative in their estimates of failure load. The authors of this report observed that the bridge deflected linearly with respect to loading up until the load reached approximately one third of the failure load. They therefore suggested a form of non-destructive testing that could be carried out on bridges that are currently in service. If displacements are measured at several different levels of loading and the bridge appears to exhibit a linear response, then no significant damage has been done to the structure and one third of the ultimate capacity of the bridge has not yet been reached. This is the justification for the testing that was done on Wyebrook and the logic behind the conclusions that were drawn from the test data.

The proceedings of the *First International Conference on Arch Bridges* held at Bolton, UK in September of 1995 are contained in *Arch Bridges* (Melbourne, 1995). The papers presented at the conference provide a wealth of information on the arch bridges, but only a few are directly related to the subject of this report. Several of these papers are addressed below.

In his paper entitled "Load Tests for Assessment of In-service Arch Bridges" (Page, 1995), Page asserts that load tests of in service bridges could be used either in conjunction with other analysis methods or as a valid test method in and of itself. He also states that "the UK Department of Transport view is that load tests. . . should not be considered as replacements for usual assessment procedures." Load testing on the bridge often predicts a greater load capacity

1072

and may therefore be beneficial to the owner. He suggests that a range of loads be applied during the testing to ensure that the response is linear as a safeguard against damage.

In a paper entitled "Renovation of Masonry Bridges" (Welch, 1995), Welch summarizes many of the common problems experienced by masonry bridges and suggests methods of repair for these problems. Among these repair methods, reconstruction of the spandrel wall reinforced with a reinforced earth system supporting the fill is suggested. Welch warns against backing the spandrel walls with concrete because this creates a deep, stiff beam edge on the arch, which is inconsistent with its intended structural behavior.

The final paper from the International Conference on Arch Bridges that will be discussed here is entitled "Assessment of Masonry Arch Bridges by Service Test Loading" (Boothby et al. 1995). This paper presents the results of five separate load tests on in-service stone masonry arch bridges in various states of disrepair. The procedure described in this paper is nearly identical to the procedure used in the testing of the Wyebrook bridge. The bridges were loaded with trucks of various weights and displacements at several locations were measured with linear variable differential transformers (LVDT's). These results were interpreted in conjunction with a finite element analysis package to determine the structural integrity of the structures.

A similar series of tests were conducted at Bridge No. 270, a random stone masonry arch bridge in Chester County, PA (Boothby and Domalik, 1994). Results from load testing were compared to results from a finite element analysis and used to assess the capacity of the bridge. The displacements of the arch were linear with respect to loading and no damage was cause by the test. However, the lateral movement of the spandrel walls was non-linear, and permanent deformations were caused by the loading. Recommendations were made to the owner that weight restrictions be placed on the structure and repairs be made immediately.

A report entitled "Stone Arch Bridge Repair: A Case Study" (Boothby and Craig, 1996) discusses the history, failure, and subsequent rehabilitation of the Wyebrook bridge in Chester County. Much of the background presented in this paper was obtained from the report by Boothby and Craig. This paper actually presents the results of the monitoring program recommended by Boothby and Craig.

PROCEDURE

Instrumentation

A pair of light steel frames was constructed along the bridge's spandrel walls. These frames extended from the edge of the parapet along the south approach span to the center of the southern approach arch. Another reference frame was also set up at the edge of the stream on the southern side of the main arch at the west spandrel wall, near the location of a longitudinal crack in the arch barrel. Additionally, a frame was built directly under the southern arch.

Ten linear variable differential transformers (LVDT's) were clamped at various points on these frames and used to measure the deflections of the bridge under loading. Eight of the LVDT's were attached to the reference frames along the spandrel walls in order to measure horizontal movement of the walls. One LVDT was placed directly under the southern approach arch to measure vertical displacement of the arch. The last spanned a longitudinal crack just below the spandrel wall in the main arch to detect widening of the crack.

In addition to the LVDT's, five strain gauges had been attached, during the reconstruction of the bridge, to the eyebolts that anchored spandrel walls together. The strain gauges were also connected to the computer during the testing so that the strain on the cables connecting the concrete walls could be read.

Test Procedure

During the different tests, a truck of known weight was driven over the bridge at various locations with respect to the centerline of the roadway. For each test, the truck started at the center of the bridge and backed slowly to the south abutment, then returned to the center of the bridge. The location of the truck along the bridge was to be measured during each test by a linear motion transducer. Unfortunately, this piece of equipment malfunctioned during the first test. For the remaining tests, a trigger mechanism was used to spike the voltage when the truck passed cones placed at 25' intervals on the road.

Each individual test has been given a name that indicates the nature of that test. The first letter in the test name indicates the weight of the truck that was used.

E = empty truck (30,350 lb.)
H = half full truck (50,350 lb.)
F = full truck (69,600 lb.)

The characters in the middle of the name indicate the location of the truck along the road.

R = right (east) side, along parapet
R48 = 48" from the parapet on the right side
L = left (west) side, along parapet
L--a = the truck ran along the entire length of the bridge on the left side

RESULTS

The nature of this paper prevents a complete listing of results. Table 2 is an example of the magnitude of displacements observed in the spandrel walls during a pass of the full truck.

Table 1: Maximum Displacements (in*10^{-4})

LVDT#	1**	2	3	4**	5	6	7**	8	9	10
fru01	24.4	27.1	38.2	30.7	36.6	1.0	**7.1**	6.7	2.8	51.9
fru02	**22.2**	10.8	33.7	26.0	33.7	3.7	**12.6**	**4.1**	1.1	51.4
fru03*	**33.0**	21.3	32.5	**58.0**	17.4	14.6	**-26.5**	6.4	**-1.0**	48.0
fr48u01*	**21.4**	12.5	25.4	**20.5**	12.3	-0.2	**18.1**	5.7	**1.4**	47.4
fr48u02*	**23.7**	10.5	24.1	**23.9**	-10.0	-0.1	**-26.0**	-13.0	1.2	49.7
fr48u03	**26.9**	13.7	24.1	**15.1**	14.4	**-9.9**	**38.1**	4.4	-0.8	51.1
flu01	**-9.6**	-0.2	3.5	**23.0**	5.7	16.7	46.9	56.4	-8.2	27.4
flu02	**16.6**	0.3	1.3	**-18.0**	3.7	17.1	63.3	41.8	-8.9	24.7
flu03	**-14.6**	**-3.1**	-1.5	**-13.6**	**-4.0**	13.7	37.5	31.8	-9.9	25.4
flu01a	**6.8**	0.2	-1.9	**-18.7**	-6.0	11.0	**41.6**	54.9	-7.4	23.6
flu02a	**-11.5**	-0.1	-2.9	**27.1**	**6.0**	9.1	**-150.0**	52.1	-5.4	26.3
flu03a*	**13.1**	0.2	3.0	**-8.4**	**-2.0**	9.9	**32.2**	44.1	-4.5	28.5

* Tests began late ** Generally unreliable instruments
Shaded entries are results that are known to be unreliable.

OBSERVATIONS

Wind Effects

As can be seen from the above table, many of the tests have been declared unreliable. The reason for this is the effect that the wind had on the frame used to anchor the instruments measuring the movement of the spandrel walls. Many of the tests showed erratic and completely random movement that could not have been the result of movement of the spandrel walls.

Timing Effects

The malfunction of the linear motion transducer also influenced the overall quality of the results. Because the trigger mechanism relied on human reaction to the truck passing by a cone, no completely reliable indication of the truck's location was obtained. This made precise analysis of the displacement data with respect to the location of the truck impossible.

As a result of inaccuracy in triggering the test, the computer began collecting data during each of the tests with the truck at a different point on the bridge. This inconsistency produced final displacement readings that are misleading. When the computer began collecting data after the truck had been in motion for some amount of time, the displacement had already started when the computer began collecting the data. In many cases, this resulted in an erroneous negative final displacement. Also, the magnitude of the maximum displacement misrepresents the total amount of motion that occurred. In these cases, the actual displacement must be found by adding the absolute values of the maximum positive and negative displacements.

Comparison

When the valid results from these tests are compared with the tests done on bridge #270 in Chester County (Boothby and Domalik, 1994), the bridge appears to be in excellent condition. The tests on bridge #270 were done with a truck that was one third the weight of the truck used at Wyebrook. However, the displacements for bridge #270 were much larger than the displacements at Wyebrook. At the crown of the arch, the maximum displacements were three times as large. They were three times as large at the walls, and the cracks opened five to ten times as wide. Rehabilitation was recommended for bridge #270, of course, but this shows that the Wyebrook bridge is in excellent condition. Table 2 compares a few critical values.

Table 2: Comparison of Displacement Data

Full Truck Weights	Wyebrook Bridge 69,600 lbs.			Bridge #270 33,150 lbs.		
Displacements (in. x 10^{-4})	Inst. #	Max	Final	Inst.#	Max	Final
Crack	9	8	1	12	88	33
Spandrel Wall	2	21	15	13	30	10
Spandrel Wall	3	33	7	14	100	30

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Regression Analysis

The quality and consistency of the data from the present testing program may not be good enough to draw certain conclusions about the precise loading capacity of the bridge. However, some linearity can be observed from the more reliable instruments.

The linear regression analysis for LVDT2, LVDT3, LVDT5, and LVDT10 was done using the data from the last three trials of tests beginning with the letters eru, hru, and fru. These instruments were located on the "right" side of the bridge, so the "r" tests are the ones that show the most significant results. The analysis for LVDT6 and LVDT9 used the data from elu, hlu, and flu tests because the instruments were located on the "left" side of the bridge. The data from LVDT1, LVDT4, LVDT7, and LVDT8 were deemed unreliable, and therefore were not analyzed.

With the exception of LVDT5, all of the tests show a clearly linear relationship between truck weight and displacement. There is no reliable evidence of non-linear behavior. The non-linearity exhibited by LVDT5 is probably due to bad data, rather than a weakness in the bridge. This conclusion can be drawn because of the singular data point that seems to cause the problem.

CONCLUSIONS AND RECOMMENDATIONS

Based on the tests carried out on April 12, 1996, it can be concluded that the rehabilitation of the Wyebrook bridge was successful. The engineered fill and the transverse cables seem to have alleviated the earth pressure on the spandrel walls, and the arches are structurally sound. The observed displacements were minor at all of the instrument locations, and we found no real evidence of residual displacements, even with the fully loaded truck. Most importantly, no non-linear behavior was observed in the displacement data, which leads to the conclusion that one third of the failure load of the bridge was not reached (Hendry, 1985). Therefore, it is safe to conclude that little or no damage was done by a truck weighing 35 tons. Considering a safety factor of approximately 2.0, it is recommended that the bridge remain posted for a weight limit of 15 tons to avoid damage to the structure.

Although this report has shown that the bridge is currently structurally sound, this type of testing should be repeated periodically to monitor the performance of the structure over time.

REFERENCES

Baker, Ira. 1907. *A Treatise on Masonry Construction*, 9th ed. John Wiley & Sons, New York.

Boothby, Thomas E. and Domalik, Daniel E. 1994. "Field Testing of Random Stone Masonry Arch Bridge #270 in Chester County, Pennsylvania." Pennsylvania Transportation Institute, The Pennsylvania State University, Research Report No. PTI 9513.

Boothby, Thomas E., Daniel E. Domalik, and V. Dalal. 1995. "Assessment of Masonry Arch Bridges by Service Load Testing." Proceedings of the First International Conference on Arch Bridges. C. Melbourne, ed. London, Thomas Telford.

Boothby, Thomas E. and Craig, Richard J. 1996. "Stone Arch Bridge Repair: A Case Study". Proceedings of the Seventh North American Masonry Conference. South Bend, IN, Notre Dame University.

Hendry, A.W., S.R. Davies, and R. Royals. 1985. "Test on Stone Masonry Arch at Bridgemill - Girvan". Department of Transportation TRRL, Crowthorne, Contractor Report 7.

Melbourne, C., ed. 1995. *Arch Bridges*. Proceedings of the First International Conference on Arch Bridges. London, Thomas Telford.

Page, J. 1995. "Load Tests to Collapse on Masonry Arch Bridges". Proceedings of the First International Conference on Arch Bridges. C. Melbourne, ed. London, Thomas Telford.

Page, J., ed. 1993. *Masonry arch bridges*. TRL State of the Art Review. London: Her Majesty's Stationery Office.

Welch, P.J. 1995. "Renovation of Masonry Arch Bridges". Proceedings of the First International Conference on Arch Bridges. C. Melbourne, ed. London, Thomas Telford.

Determining Suitability of Irrigation in Developing Countries

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The Third World is facing a staggering food and water crisis in the approaching decades. Population trends and lack of food supplies call for research in engineering solutions to these problems. One engineering solution is the use of irrigation in developing countries to increase crop production. Problems arise however if irrigation is inappropriate for use in a country. The purpose of this study is to determine the economic, demographic, and geographic variables that may influence irrigation in a country. Regression analyses are made on 11 different variables from 30 countries in Africa. The final result is a model showing irrigated area as a function of population, cultivated surface area, percent labor force in agriculture, annual rainfall, and irrigation potential. This information may be useful in evaluation of irrigation potential of a developing country.

INTRODUCTION

Background

Despite past efforts to assist the shortages in lesser developed countries (LDCs), the Third World is facing a staggering food and water crisis in the approaching decades. Current research has found that the world's population of 5.3 billion will increase to 9 billion over the next 40 years with approximately 95% of the growth occurring in LDCs. This means that the food requirements of the already malnourished nations will more than double in the next 30 years (Pereira, Gilley, and Jensen 172). It is crucial that research continue in the area of applying appropriate technology to developing countries in order to bring these billions of people their basic necessities.

The realization of this need for appropriate engineering solutions to this crisis led to a workshop held in Vimeiro, Portugal during March of 1994. Entitled "Sustainability of Irrigated Agriculture (Sustainability of Water Resources Utilization in Agriculture)," the workshop focused on the evaluation of irrigated systems in agriculture and prioritizing what research on irrigation is needed to meet the forthcoming challenge of population growth (Pereira, Gilley, and Jensen 175). The participants of this workshop consisted of the leading irrigation authorities in the world. This prestigious workshop made the point that irrigation is one form of modern technology that will be important in ameliorating the LDCs' capability of feeding their population.

Irrigation is the strategic redistribution of water to create arable land in normally arid areas. There are any different types of irrigation that vary in effectiveness depending on the conditions of an area. For example, dry land areas in proximity to a large source of water supply may afford to use surface flooding or a furrow form of irrigation. On the other hand, areas with limited water or sensitive crops may require a more precise use of water in the form of drip irrigation. In addition, between these two extreme forms of irrigation there is a variety of other methods to choose from.

With the wide range of irrigation methods applicable to different land conditions, it may seem logical to assume that irrigation should be implemented in all developing countries to increase the food production. On the contrary, there are likely to be economic, demographic, and geographic factors that suppress the ability of a country to irrigate. Determining these variables and how they affect irrigation potential could be very useful in the strategic implementation of irrigation to developing countries. If a specific LDC has large magnitudes of variables that are negatively correlated with irrigation, it may be unwise or ineffective to use irrigation as a means to aid in the food crisis in that area. In the same way, finding considerable quantities of variables in a LDC that encourage irrigation means that country has the conditions that are appropriate for irrigation.

Purpose of Study

The purpose of this independent study is to determine the economic, demographic, and geographic factors that govern the amount of irrigation in a developing country. To complete this objective, eleven variables will be compared to the amount of irrigated area in developing countries to see if a correlation exists. Through several regression analyses, the wide range of variables will be narrowed to a few variables that have the greatest correlation with irrigated area. Due to extensive information available by the Food and Agriculture Organization on irrigated area in Africa, the regression analyses will focus on data from the developing countries within this continent.

DESCRIPTION OF RESEARCH

Choice of Variables

With any attempt to determine which independent variables govern the quantity of another variable, it is essential that many independent variables are chosen initially covering the many areas that can potentially influence the dependent variable. The more independent variables at the onset of the study, the more credible the governing independent variables at the conclusion of the study. For this reason, the variables chosen in this study must include representation from the diverse range of economic, demographic, and geographic factors.

After discussions with economic and engineering faculty at Lafayette College, variables that might influence irrigation in a country were chosen for use in the regression analyses. The economic variables chosen were gross domestic product (GDP), quantity of agricultural imports and exports, and rate of inflation. The demographic variables deemed important were population, and percent of labor force in agriculture. The initial geographic variables included total surface area of the country, amount of land cultivated, amount of land cultivable, amount of land that has irrigation potential, and average annual precipitation.

Summary of Data Collected

After choosing a preliminary list of pertinent variables that may influence irrigation, the next step was to collect a sufficient amount of data to run a credible regression analysis. The majority of the data collected on the selected variables was obtained from AQUASTAT, the Food and Agricultural Organization's statistical database for irrigation in African countries located on the World Wide Web (http://recoda.fsagx.ac.be:80/faoweb/waicent/faoinfo/agricult/aquastat/aquastat.htm). Where AQUASTAT lacked information, data was found in the CIA World Fact Book also located on the WWW (http://www.itaiep.doc.gov/eebic/econcomm/cia/html).

In summary, data for all of the variables were obtained for a total of 30 African countries. The data collected for Senegal and Sudan is given in Table 1 as an example.

Table 1: Data Collected for Senegal and Sudan

Variable	Senegal	Sudan
Irrigated Area (ha)	141,400	1,946,000
Population (in 1994)	8,102,000	27,361,000
Total Surface Area (ha)	19,672,000	250,581,000
Cultivable Area (ha)	3,782,000	105,000,000
Cultivated Area (ha)	2,300,000	7,600,000
Exports ($ Thousands)	153,393	418,931
Imports ($ Thousands)	385,613	295,948
% Labor Force in Agriculture	77	80
GDP ($ Billions)	12.3	23.7
Inflation Rate (%)	-1.8	112
Annual Precipitation (km^3)	146	1092.6
Irrigation Potential (ha)	400,000	4,842,600

Discussion of Regression Analyses

In this study, the independent variables are those that were predicted to influence the dependent variable of irrigated area. In order to obtain multiple regression analyses quickly, a statistical computer application, Minitab, was used to develop the best model. Minitab has an option of running several regression analyses involving combinations of different variables to develop the best model based on R^2. The results of these analyses are given in Table 2. The variables in the heading of the table are defined as population (P), total surface area (TA), cultivated area (CDA), exports (EXP), imports (IMP), % labor force in agriculture (L), gross domestic product (GDP), inflation rate (INF), annual precipitation (R), and irrigation potential (IP). The variables marked with an "X" in a particular regression analysis were included in that analysis and resulted in the R^2 value given.

Table 2: Regression Analysis Results

Analysis	R^2	P	TA	CA	CDA	EXP	IMP	L	GDP	INF	R	IP
1	.346						X					
2	.334				X							
3	.576						X			X		
4	.559						X					X
5	.628							X			X	X
6	.625						X			X		X
7	.715	X			X			X				X
8	.698			X				X			X	X
9	.755	X			X			X			X	X
10	.749			X		X		X			X	X

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11	.776	X			X			X		X	X	X
12	.765	X		X	X			X			X	X
13	.783	X			X	X		X		X	X	X
14	.782	X			X			X	X	X	X	X
15	.787	X		X	X	X		X	X		X	X
16	.785	X		X	X			X	X	X	X	X
17	.790	X		X	X	X	X	X	X		X	X
18	.789	X		X	X	X		X	X	X	X	X
19	.792	X	X	X	X	X	X	X	X		X	X
20	.791	X		X	X	X	X	X	X	X	X	X
21	.793	X	X	X	X	X	X	X	X	X	X	X

What is informative about the results given in Table 2 is that the eleven-variable model (R^2=.793) is not significantly better than the five-variable model in the ninth analysis (R^2=.755). This implies that amongst the variables chosen in this study, the most important variables are the five given in the ninth analysis. These five variables are population, cultivated area, percent of labor force in agriculture, annual precipitation, and irrigation potential. The final model relating these factors to irrigated area is given in Eq. 1.

$$I = 518440 - 0.0216\,P + 0.113\,CDA - 7190\,L - 211\,R + 0.298\,IP \qquad (1)$$

A measure of the accuracy of this model in estimating the influence of these five variables is given in Figure 1. In this figure, the y axis are the values for irrigated area after inputting the data used for the regression analysis into Eq. 1. The x axis is the actual value of irrigated area in the data. While there seems to be a few points where the model was relatively inaccurate in judging the actual irrigated area, the model does appear to show most of the points following the line of a perfect model. It may be concluded from this that these five variables have governing correlations with irrigated area in this study.

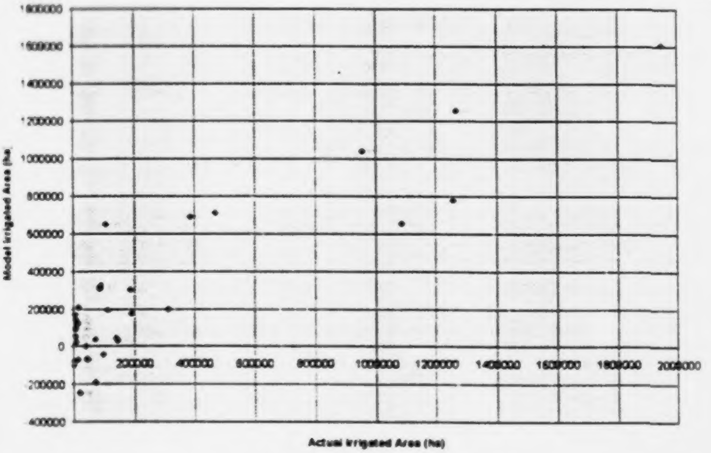

Figure 1: 5-Variable Model vs. Actual Irrigated Area

CONCLUSIONS

Reasons for Positive and Negative Correlations of Variables

As concluded in the above discussion of the research, the five variables found in this study to most govern the amount of irrigated area in African countries are population, cultivated area, percent of labor force in agriculture, annual precipitation, and surface area with potential for irrigation. Having established the correlations between irrigated area and these variables indicated in Eq. 1, it is now pertinent to discuss possible explanations for these correlations. The actual reasons for the positive or negative correlation of the five variables with the amount of irrigated area in a country are beyond the scope of this study. However, simple speculation may explain the feasibility of these correlations.

The negative correlation of P and L may be due to the fact that the more people there are in a country, the more people will be working in agriculture. This is especially the case in a country where there is a large percentage of the labor force working in agriculture. The more people working on an agricultural project means there is less of a need for an automated irrigation system because there will be more hands to properly water and tend to the crops manually.

The negative correlation of the R may be speculated simply by the relationship that the more rainfall there is, the less need there is for an irrigation system to bring water to dry soil. Contrary to arid areas, countries that have high precipitation will have an adequate water supply and will not need some form of forced water supply.

The positive correlation between CDA and I is illustrated by the common sense that the more area cultivated, the more of a need there is for irrigation. As the demand for cultivated area increases, the ratio of total agricultural workers available to cultivated area decreases. The ratio of water supply from precipitation to cultivated area decreases as well. Hence, there is more of a need to direct water to agricultural sites through irrigation because of the shortage of water and manual labor.

IP is positively correlated to I because the more potential for irrigation there is, it is to be expected that a country will utilize that potential. If crops are in a location that can be more easily irrigated, it would be easier and more efficient to irrigate those crops.

Usefulness of Information

Having found five specific variables that potentially influence irrigation amounts, the objective of this research has been fulfilled. The results of this research will be useful in determining the appropriateness of irrigation in the approaching food and water crisis.

The best use for the five most influencing variables is in analyzing whether irrigation is practical for use in a developing country. Before using irrigation as a means of relieving famine in a LDC, it may be useful to determine if the variables that positively correlate with irrigated area are prominent in that country. If the negatively correlated variables are more significant, perhaps a different solution instead of irrigation needs to be developed for that area.

Another result of this research is the realization that a variety of variables can be correlated significantly to the amount of existing irrigation in a country. This indicates that more research should be done on other variables that could influence irrigation. It seems from this study that such research could be very helpful in ameliorating the food and water crisis predicted for the approaching decades.

REFERENCES

Alam, M. (1991). "Problems and Potential of Irrigated Agriculture in Sub-Saharan Africa." Journal of Irrigation and Drainage Engineering, ASCE, 117(2), 155-172.

Krinner, W., Garcia, A. And Estrada, F. (1994). "Method for Estimating Efficiency in Spanish Irrigation Systems." Journal of Irrigation and Drainage Engineering, ASCE, 120(5), 979-986.

Pereira, L.S., Gilley, J. R., and Jensen, M. E. (1996). "Research Agenda on Sustainability of Irrigated Agriculture." Journal of Irrigation and Drainage Engineering, ASCE, 122(3), 172-177.

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Development of a Generic, Robust, and Reliable Networking Protocol for a Motorola Microcontroller

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The Motorola 68HC11 based Mini Board is a single-board computer developed for use in small, mobile robot control. It is readily available and an economical choice for hobby, educational, and introductory robotics. Although limited by its small memory size (2K of EEPROM), its computing capabilities can be substantially increased by parallel processing. The 68HC11 incorporates a mechanism to network together multiple Mini Boards with the Serial Peripheral Interface (SPI). This research explored the issues of creating a generic, robust and reliable networking protocol for the 68HC11. Significant factors considered in the creation of this protocol are write collisions, master/slave selection, compiled code size, and network contention.

INTRODUCTION

Influenced by MIT's 6.270 Robot Design course, this research began with a project to build a small, mobile robot using the Mini Board from MIT. The Mini Board is a single-board computer developed for use in small, autonomous mobile robot control. It is readily available and an economical choice for hobby, educational, and introductory robotics.[1] It is built around the Motorola microcontroller, MCU 68HC811E2, part of the 68HC11 family and has support for motors, analog and digital inputs, and outputs. However, the Mini Board's capabilities are limited by its available memory, having only 2K (2,048) bytes of memory (EEPROM, Electrically Erasable Programmable Read Only Memory) and allowing only approximately 100 lines of 'C' code using the specially designed 'C' compiler. However the microcontroller does provide networking functionality that may be utilized to overcome the memory limitation.

The 68HC11 family of microcontrollers incorporates the SPI (Serial Peripheral Interface) subsystem, "an independent serial communications subsystem, [which] allows the MCU to communicate synchronously with peripheral devices ... [and] is also capable of inter-processor communication in a multiple master system."[2] Two of the Mini Board's RJ-11 connections ("telephone jacks") allow multiple Mini Boards or other devices to communicate. Using this system, it is possible to connect multiple Mini Boards in a network. However, Motorola does not provide a generic networking protocol. Dr. Fred Martin, designer of the Mini Board, included hardware support for the networking functionality, but he left the development of a generic networking protocol as a "challenge."[1]

Using this networking capability, it is possible to increase the available memory by creating a parallel processing system. Thus, while the individual Mini Boards have only a small amount of memory, the system has a larger amount, dependent upon its size. Another benefit of this approach is that a robotic system lends itself naturally to a "divide and conquer" parallel processing system (i.e. problems are divided into smaller units which single processors complete). Many different functions of a robot, such as different sensing, movement, and their fusion are inherently parallel and can be divided into smaller units.

Consequently the purpose of this research is to explore the issues of developing a generic, robust, and reliable networking protocol for the Motorola 68HC811.

METHODOLOGY

This research began by gaining an understanding of the SPI subsystem through readings of the technical literature, including Motorola's M68HC11 Reference Manual. As there is a large body of research in data networking and telecommunications, pertinent literature was read to develop an understanding of existing protocols. The next step was to demonstrate that two Mini Boards could communicate in some fashion. If they could not communicate, as the simplest case, then creating a network would be impossible. Lastly, after deciding what issues needed to be addressed to create the protocol, a theoretical model was developed, implemented and tested.

RESULTS

Obstacles

The first step in creating a system is to understand the obstacles that must be overcome. The following are the five obstacles that were discovered:

The first obstacle was the *limited memory available*. If the protocol required a large amount of memory, then it is useless, as there is no memory left to implement other functions. Therefore, an arbitrary limit of one-half (.5) of the available memory was established for the protocol. Since there is a total of 2,048 bytes of memory, this yielded 1024 bytes for the compiled protocol. This was a reasonable amount of memory in which to implement the protocol that left a significant amount of memory for other functions.

The second obstacle was the *physical topologies available*. Every Mini Board can be connected to a maximum of two others (there is no one "bus" that all can be connected to). Therefore the available physical topologies were severely limited.

The third obstacle concerned *which Mini Board controls the transfer of data*. Since transfers occur only at the request of a master, slaves have no control over when data will be sent. If a slave is not ready for a transfer, the master has no means to detect that until a transfer has been attempted. Conversely, if a slave has data to transfer, it must wait until the master initiates the transfer. This could result in problems such as a master spending a significant amount of time "polling" a slave by repeatedly attempting transfers and data not being sent within a reasonable amount of time (i.e. "old data").

The fourth obstacle involved the *single master constraint* There can only be one master among Mini Boards connected within two "steps." In Figure 1, only Mini Board C can be configured as a master. If Mini Board A is configured as a master and attempts to transfer data (to B) while C is transferring data (to B), then a "multiple master bus contention error" occurs and the system fails. To ensure that this does not occur, only Mini Board C in the figure may be in master mode.

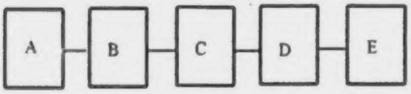

Figure 1 Master v. Slave Mode

The last obstacle was the *data transfer "size."* Due to hardware limitations, only 8 bits can be transferred at one time from master to slave and vice versa. This severely limits the existing networking protocols, as many require a large number of bits for "wrappers", that include information such as the destination address, data content type, source address, and error checking codes.

Physical Topology

The physical topology that most adequately corresponded with the physical requirements of the Mini Board was the ring. Figure 2 shows an illustration of a ring. A ring is a "network topology in widespread use for the interconnection of communities of digital devices distributed over a localized area... each device is connected to its nearest neighbor until all the devices are connected in the form of a closed loop or ring."[1] As Mini Boards can be connected directly to a maximum of two others, the ring topology, which connects each device to two others, seemed a natural choice.

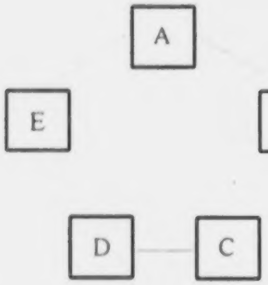

Figure 2 Ring Topology

Network Initialization

Since only Mini Boards configured as masters can begin a data transfer, only by becoming a master and attempting to transfer data to a slave (i.e. polling) can it be determined if the slave is ready for data. However, if all Mini Boards did this upon powering on to assure that the network was functioning, there would be a high probability that a large number of bus contention errors would occur. Thus, some way to initialize the network needed to be developed so that no bus contention errors would occur. The algorithm devised to initialize the network is as follows:

1. A Mini Board designated as the "Master" (similar in some ways to the "monitor" of a token ring network) attempts to transmit its ID number to its successor.

2. The Mini Board designated as the successor of the Master, upon receipt of data, then transmits its ID to its successor. (This step in designating the second Mini Board was needed because of the bi-directionality of the links.)
3. From this point, each Mini Board, upon receipt of the ID of its predecessor, sends its ID to its successor. (Note, that the ID of each Mini Board is its predecessor's ID incremented by one. Therefore, a Mini Board must only transmit its ID when it receives a lower valued ID.)

4. When the Master receives the ID of its predecessor, it transmits a NETWORK_UP packet, signaling that the network is functioning.

5. When a Mini Board receives the NETWORK_UP packet, it sends the packet to its successor, then defaults to slave mode and enables its SPI interrupt. When the Master receives the NETWORK_UP packet, it sends out the CONTROL_TOKEN, then defaults to slave mode and enables its SPI interrupt. At this point, the network initialization is complete.

To guard against bus contention errors, the default of all the Mini Boards in the network is slave mode. When it is necessary that data be sent, the Mini Board changes to master mode, sends the data, and then immediately reverts to slave mode. This is discussed more fully in the next section.

Data Transfers/Network Operation

The data transmission is controlled by the use of a control token. The control token is transmitted from one Mini Board to another until it is received by a Mini Board (source) wishing to send data. It then sends a frame with the destination ID, followed by the data sent in data packets (of 8-bit length as required by the SPI subsystem). When all frames have been sent, an end-of-transmission frame is transmitted. The source then transmits the control token. Note that during these transfers, each Mini Board received data as a slave, parsed the data and, if necessary, changed to master mode to send the data, after which changing back to slave mode. Thus the possibility of bus contention errors has been eliminated.

CONCLUSIONS/SUMMARY

In developing this protocol, all the obstacles outlined earlier were circumvented. Overcoming the limited amount of memory available proved to be difficult. There were many features that would have been useful additions, however their implementation necessitated more memory than was feasible. Features such as data validity, error checking, and the retransmission of corrupted packets are useful, but not required and thus were not included in the final protocol. Although the number of physical topologies available was limited, the hardware configuration lended itself naturally to the ring topology. The single master constraint and the transfer of data being controlled solely by a master required the unusual technique of Mini Boards defaulting to slave mode. However, this sufficiently thwarted bus contention errors resulting from multiple masters, required to both initialize and send data around the network. The data transfer size generated more network traffic than would have been necessary given a larger packet size. Since there is no means to deal with corrupted packets, the greater the number of packets, the greater the probability that the data will be corrupted. However, as discussed earlier, because of the physical transfer medium, packet errors are at a minimum.

The protocol has been implemented and tested on an experimental network of two Mini Boards. The protocol implementation functions as expected. Due to the nonavailability of more Mini Boards, the protocol has not been tested on a larger network.

REFERENCES

1. Martin, Fred. "Mini Board Technical Reference." `http://lcs.www.media.mit.edu/people/fredm/papers/mb/` (March 1997)
2. Motorola M68HC11 Reference Manual. (Motorola, Inc., 1991)
3. Halsall, Fred. Data Communications, Computer Networks, and Open Systems. (Addison-Wesley Publishing Company, 1992)

Proceedings — NCUR XI (1997)

Ideal Case Modeling of Optical Preamplifer Receivers at the 10Gb/s Data Rate

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It is important when designing optical preamplifier receivers (OPRs) to define the critical parameters and predict performance based on these parameters. An ideal case simulation can give important preliminary information to direct research and development. In this research, a simplified approximation relating effective gain and receiver noise in the ideal case was developed and its significance as it relates to receiver sensitivity was investigated. As a result, receiver noise was shown to dominate the low gain regime, while spontaneous noise factor and input coupling efficiency dominate the high gain regime. A design tool was employed which used symbolic math programming to model the important design parameters. Simulation results indicate that the receiver sensitivity penalties due to the extinction ratio (the ratio of the signal level on the ones to the signal level on the zeros) and the optical bandwidth of the OPR are coupled, all other parameters investigated are independent of each other.

INTRODUCTION

The advent of wavelength division multiplexed (WDM) all-optical networks is revolutionizing the telecommunications industry. Especially significant to the development of this new technology are the erbium-doped fiber amplifiers (EDFAs) which operate in the 1500 nm telecommunications window. EDFA-based OPRs can be used to overcome signal losses associated with long transmission distances and high data rates.

The purpose of the OPR is to improve the receiver sensitivity while maintaining a bit error rate (BER) of 10^{-9} (one error for every 10^9 bits transmitted). In wavelength multiplexed systems, the OPR can compensate for splitting losses and amplify the signal before regeneration. While amplifying the signal increases the signal to noise ratio (SNR), the use of optical amplifiers introduces amplified spontaneous emission noise (ASE) into the signal path.[1] If the SNR is degraded there is a corresponding degradation of the receiver sensitivity. This research investigated the receiver sensitivity penalties associated with major OPR design parameters and developed a simplified equation for modeling the ideal case receiver sensitivity.

OVERVIEW OF CRITICAL PARAMETERS

The theoretical model has been described by the author and others in the literature[2-4] and will not be covered in this paper. Table 1 lists the parameters investigated along with their ideal and experimentally measured values. Employing the design tool, the incurred receiver sensitivity penalties are calculated cumulatively in the order listed. Optical bandwidth (B_o) is the bandwidth of the optical filter in the OPR. The optical filter serves to eliminate some of the ASE noise produced by the EDFA; however, it is important to characterize how it affects receiver sensitivity because a WDM system will require a wider bandwidth than a single wavelength system. Extinction ratio (ϵ) is the ratio of the dB level of the ones to the dB level of the zeroes. It becomes difficult to maintain high extinction ratio at high data rates; therefore, the trend towards higher data rates make it imperative to characterize the effect of extinction ratio on receiver sensitivity. Input coupling loss (η_i)

includes all losses incurred when coupling the signal from the fiber into the EDFA portion of the OPR. Noise figure (NF) is the internal noise figure which is dependent upon the ASE power from the amplifier. Electrical bandwidth (B_e) is the filter bandwidth of the receiver portion of the OPR. Gain is the internal gain of the EDFA. . Unaccountable is the difference between the experimentally measured receiver sensitivity and the calculated sensitivity. The receiver thermal noise for all the simulations is assumed to be 13 pA/sqrtHz.

Table 1

Sources of the Receiver Sensitivity Penalty and Their Penalty Values for a 10Gb/s Prototype Optical Preamplifier Receiver

Penalty Source	Ideal Value	Experimentally measured value	Incurred penalty (dB)
Optical bandwidth (B_o)	10 GHz	42 Ghz	0.8
Extinction ratio (ϵ)	> 30 dB	14 dB	1.0
Input coupling (η_i)	1	0.8	1.0
Amplifier noise figure (NF)	3 dB	3.7 dB	0.7
Electrical bandwidth(B_e)	5 GHz	7 GHz	1.3
Gain for $I_s = 13\frac{pA}{\sqrt{Hz}}$	> 50 dB	33.0 dB	0.0
			Total penalty = 4.8 dB
Unaccountable	0	1.0 dB	
Receiver sensitivity for 10^{-9} BER	-42.6 dBm	-36.8 dBm	

IMPROVEMENT OF DESIGN TOOL

The design tool based on the theoretical model was created using Mathematica 2.2, a symbolic math programming environment. This allows significant design parameters to be varied so that the effects on performance could be studied. The design tool has been improved by implementing an algorithm based on the work of Paul Moser[3]. The factors α_s, γ_{ss}, δ, γ_1, γ_0, are parameterization factors based on the design parameters. The theoretical model[2] can be expressed as a single modeling equation based on a BER of 10^{-9} using these parameterization factors. This yields the following second order equation which can be solved for P_l, receiver sensitivity:

$$\alpha_s^2P_l^2-2\alpha_s\gamma_{ss}P_l+(\gamma_{ss}^2-4\delta\alpha_s-4\gamma_1\gamma_0)=0 \qquad (1)$$

Equation 1 can be solved for P_l, the receiver sensitivity.

This algorithm greatly improves the computing speed of the design tool.

INTERACTION BETWEEN PARAMETERS

It should be noted that in Table 1 the incurred penalties are calculated cumulatively in the order recorded in the table. The order in which the penalties are calculated was found to be independent for all parameters except optical bandwidth (B_o) and extinction ratio (ϵ). In addition, when all the parameters are varied independently, slightly higher values are obtained for optical bandwidth and extinction ratio penalties. These values are listed in Tables 2 and 3.

Table 2

Interaction of B_o and ϵ

Order in which calculated	Parameter	Incurred penalty (cumulatively calculated)	Incurred penalty (independently calculated)
1	Optical bandwidth (B_o)	0.8	1.4
2	Extinction ratio (ϵ)	1.0	0.9

Table 3

Interaction of B_o and ϵ

Order in which calculated	Parameter	Incurred penalty (cumulatively calculated)	Incurred penalty (independently calculated)
1	Extinction ratio (ϵ)	1.4	0.9
2	Optical bandwidth (B_o)	0.4	1.4

The results show that when the two parameters are taken together the overall cumulative penalty remains the same but their individual values varied. When these parameters are calculated independently their sum is 0.5 dB higher.

DEVELOPMENT OF IDEAL CASE EQUATION

Assume the following:

1) extinction ratio (ϵ) is very large,

2) Spontaneous-spontaneous beat noise and shot noise are negligible,

3) effective gain G_{eff} is the product of intrinsic amplifier gain and input and output coupling efficiencies.

When these assumptions are substituted into the algorithm used for the simulation[3], after some calculations a simplified approximation for the receiver sensitivity P_l can be made.

$$P_l = 6\frac{\sqrt{N_e}}{G_{eff}} + 72 B_e h\nu \frac{N_{sp}}{\eta_i} \qquad (2)$$

where N_c is the receiver circuit noise, hv is the photon energy of the signal, and N_{sp} is the amplifier spontaneous emission factor.

It can be seen from Figure 1 that this simplified approximation closely follows the simulation results up to ~25 dB. At gains above 25 dB there is ~0.5 dB difference.

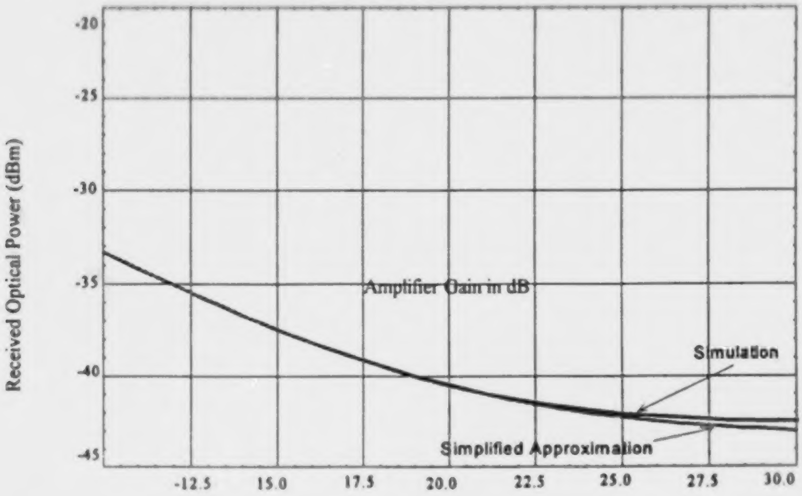

Figure 1: Comparison of Simulation to Simplified Approximation in the Ideal Case

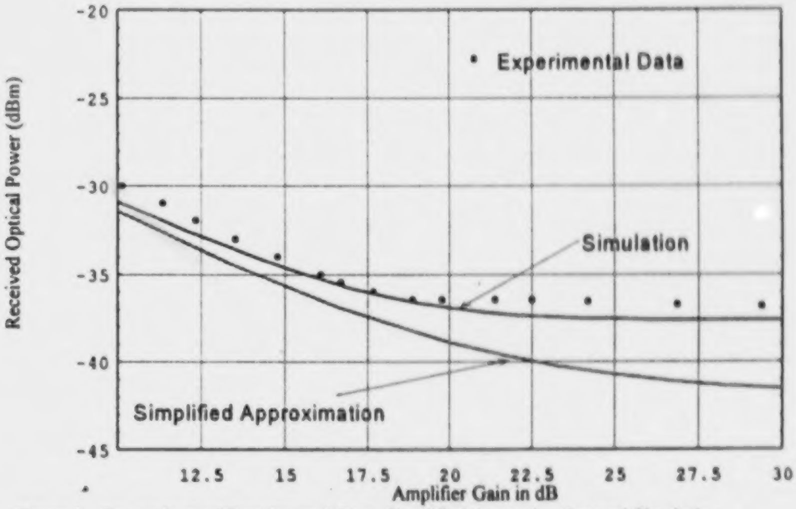

Figure 2: Comparison of Experimental Data, Simplified Approximation and Simulation

COMPARISON WITH EXPERIMENTAL RESULTS

It can be seen from Figure 2 that the simplified approximation does not model the experimental results (obtained from a prototype OPR) well. This is because it was developed on the assumption of high extinction ratio which reduces noise contributions on the zeros, and on the assumption that the spontaneous-spontaneous beat noise is negligible. Therefore, its usefulness is limited to modeling the ideal limit rather than practical design limitations. The simulation remains within 1 dB of the experimental data throughout both gain regimes and is shown to be useful for modeling practical limitations[4].

CONCLUSIONS

The design tool simulation remains within 1 dB of the of the experimental data (obtained using a prototype EDFA-based OPR) throughout both gain regimes (Figure 2). This makes the simulation useful for practical design applications. Further development of the simulation should include ISI (intersymbol interference) contributions to more accurately model the receiver sensitivity.

When employing the simulation, care should be taken in stating the penalties incurred due to optical bandwidth (B_o) and extinction ratio (ϵ) because they are dependent on the order in which they are calculated if calculated cumulatively. These parameters also have slightly higher values when calculated independently. The independent calculation is of limited practical use, however, since in a real system all parameters will be less than ideal.

Analysis of Eq. 2 clearly shows that there are two gain regimes. In the low gain regime, receiver circuit noise will dominate and there is a linear increase in receiver sensitivity as gain increases (~1 dB increase in receiver sensitivity for 1 dB increase in gain). In the high gain regime, the first term will become negligible and the noise floor will be reached (no further increase in receiver sensitivity). The noise floor will be primarily dependent on N_{sp}, the amplifier spontaneous emission factor and η_{in}, the input coupling efficiency. In Figure 1 it can be seen that the parameters in Eq. 2 account for the general shape of the receiver sensitivity curve. In Figure 2 the remaining parameters incur penalties which serve to shift the curve towards overall degraded sensitivities. While this approximation has limited use in practical design, it can quickly yield the ideal limit allowing the designer to easily compare prototypes.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Blumenthal, D. *et al*. "Physical Limitations to Scalability of WDM All-Optical Networks, Optics & Photonics News, Vol. 8 No. 2, 17-22(1997).

[2] Granlund, S.W., and Park, Y.K., " Optical Preamplifier Receivers: Application to Long-Haul Digital Transmission", Optical Fiber Technology, 1, 59-71 (1994).

[3] Desurvire, Emmanuel, Erbium-Doped Fiber Amplifiers, (John Wiley & Sons, Inc., 1994), pp. 68-70.

[4] Hart, D. S., "Optical Preamplifier Receivers: Modeling at the 10 Gb/s Data Rate", Proceedings of the 10th Annual National Conference on Undergraduate Research (1996)

[5] Moser, Paul, "Theorie Du Preamplificateur Optique", Master's Thesis

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Nonlinear Filtering and Enhancement of Digital Ultrasound Imagery

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Ultrasound medical images are inherently noisy, since acoustic waves are reflected back to the sensor rather erratically after striking tissue and bone. Several powerful nonlinear image processing techniques have been applied to digital ultrasound imagery to both filter the noise and enhance the data. First, two morphological filtering operations, namely the opening and closing, have been used to remove noise while preserving important image features such as edges. Visually, the quality of the digital ultrasound images is improved, and analysis of the filtered biomedical imagery becomes easier. Next, a Bayesian enhancement technique was applied to the digital ultrasound image to increase spatial resolution. The enhanced image appears to have a higher resolution than the same image enhanced using bilinear and cubic B-spline interpolation. Finally, a Bayesian multiframe resolution enhancement technique has been applied to a digital ultrasound image sequence, in which several frames are integrated to compute a high-resolution video still image. All three nonlinear filtering and enhancement techniques will be compared visually in this paper.

INTRODUCTION

Ultrasound medical images are inherently noisy, since acoustic waves are reflected back to the sensor rather erratically after striking tissue and bone. In an effort to obtain an enhanced ultrasound image, several nonlinear filtering techniques will be employed, including morphological filtering (Gonzalez, R. C. and Woods, R. E., 1992), Bayesian single frame enhancement (Schultz, R. R. and Stevenson, R. L., 1994), and Bayesian multiframe resolution enhancement (Schultz, R. R. and Stevenson, R. L., 1996).

An ultrasound image of a dog's heart is shown in Figure 1. This image is a frame extracted from a short digital image sequence of a dog's beating heart. Initially, the most common image enhancement techniques, bilinear and cubic B-spline interpolation (Schultz, R. R. and Stevenson, R. L., 1994), will be applied to this data. Both methods expand the original $N \times N$ pixel image by first interpolating each of the N rows by a factor of q, and then by expanding each of the resulting qN columns by the same factor. Figures 2 and 3 contain more precise details than the original ultrasound image, and these two images will be used as benchmarks of comparison for the nonlinear filtering and enhancement techniques. Each of the filtering and enhancement techniques proposed in this paper will be applied to either the single frame or to multiple video frames. A visual comparison of the results will take place to determine the efficacy of each method for the purpose of image analysis.

MORPHOLOGICAL FILTERING

Set theory is the basis of morphological filtering. These sets represent the structure, or morphology, of objects in an image. Dilation and erosion are the two basic morphological operations (Gonzalez, R. C. and Woods, R. E., 1992), and they will be used to perform a morphological opening and closing on the grayscale digital ultrasound image.

Morphological Dilation and Erosion

Consider binary images containing black and white pixel values with sets A and B contained within Z^2. The dilation of set A by the structuring element B is defined as

$$A \oplus B = \left\{ x \,\middle|\, (B)_x \cap A \neq \varnothing \right\}. \tag{1}$$

The structuring element B, in this case a 3 x 3 digital square, is translated throughout the binary image pixel-by-pixel. If a single point contained within set A is present within the structuring element at point x, the output image turns on at that point. The resulting output image contains an expanded, or "dilated," version of the original set A. For grayscale image data, the result is a brighter image than the original, since each image pixel intensity value is increased by a 6-point structuring element representing a digital sphere. This is certainly evident in the morphological dilation of the grayscale ultrasound image shown in Figure 4.

Again, for binary images, the erosion of set A by the structuring element B is defined as

$$A \otimes B = \left\{ x \,\middle|\, (B)_x \subseteq A \right\}. \tag{2}$$

The 3 x 3 square structuring element is once again translated throughout the binary image pixel-by-pixel. In this case, the output image pixel at location x is not turned on unless the entire structuring element is contained within A. The final output image contains a smaller, or "eroded," version of the original set A. For grayscale image data, the result is a darker image than the original, since each image pixel intensity value is decreased by the 6-point spherical structuring element. Morphological erosion of the grayscale ultrasound image can be seen in Figure 5.

Morphological Opening and Closing

A morphological opening is simply an erosion followed by a dilation, with the nonlinear filtering operation defined as

$$A \circ B = (A \otimes B) \oplus B. \tag{3}$$

The morphological opening operation filters a grayscale image by first eroding the intensity values and then filling in gaps by dilating the remaining data. Figure 6 shows the results of an opening operation applied to the grayscale ultrasound image.

A morphological closing consists of a dilation followed by an erosion, and it is defined as

$$A \bullet B = (A \oplus B) \otimes B. \tag{4}$$

A closing tends to smooth sections of the image by first filling in gaps between intensity values and then eroding away the excess data. See Figure 7 for an example of a morphological closing applied to the grayscale ultrasound image.

BAYESIAN IMAGE ENHANCEMENT TECHNIQUES

Image enhancement can be posed as the following estimation problem: given the N x N pixel low-resolution image **y**, estimate the qN x qN pixel unknown high-resolution image **z**. Bayesian maximum *a posteriori* (MAP) estimation is a statistical technique based on Bayes' theorem which can accurately compute the high-resolution image. The estimate is defined as

$$\hat{\mathbf{z}} = \arg\max_{\mathbf{z}} \left\{ \log \Pr(\mathbf{y} | \mathbf{z}) + \log \Pr(\mathbf{z}) \right\}, \tag{5}$$

where Pr(**y**|**z**) is the probability density function of the noise, and Pr(**z**) is the prior probability density of the image data. First, the Bayesian single frame enhancement algorithm will be described, and then the algorithm will be extended to include multiple image sequence frames.

Bayesian Single Frame Image Enhancement

In our subsampling model, the average of $q \times q$ high-resolution pixels is assumed to be the value of a single low-resolution pixel. This image observation model is given as

$$\mathbf{y} = \mathbf{A}\mathbf{z}, \tag{6}$$

where **A** is known as the subsampling matrix. Each row of **A** averages a block of pixels from the $qN \times qN$ pixel image **z**, resulting in a single intensity value within the $N \times N$ pixel image **y**. No noise has been incorporated into the image observation model, since the intent is to expand the image without smoothing. Assuming a Huber-Markov random field model (Schultz, R. R. and Stevenson, R. L., 1994) for the image data, the Bayesian estimate is given as

$$\hat{\mathbf{z}} = \arg \min_{\mathbf{z} \in Z} \left\{ \sum_{m,n=1}^{qN} \sum_{p=1}^{4} \rho_{\alpha}\left(\mathbf{d}^{t}_{m,n,p}\mathbf{z}\right) \right\}. \tag{7}$$

In this optimization problem, the estimate must belong to the constraint set $Z = \{\mathbf{z} \mid \mathbf{y} = \mathbf{A}\mathbf{z}\}$. Four second-order differences are used as edge detectors at each image point, and these values are arguments of the Huber edge penalty function, $\rho_{\alpha}(x)$, which preserves discontinuities. Since the function to be minimized is convex, the gradient projection algorithm (Schultz, R. R. and Stevenson, R. L., 1994) is used to efficiently compute the unique image estimate. Figure 8 shows the ultrasound image enhanced using the Bayesian single frame estimation technique.

Bayesian Multiframe Resolution Enhancement

If a short digital image sequence is available, it may be possible to further enhance the image data by integrating multiple frames. Object motion between frames can be utilized to estimate a high-resolution video still (HRVS) image which is visually improved over the Bayesian single frame estimate (Schultz, R. R. and Stevenson, R. L., 1996). The unknown high-resolution image $\mathbf{z}^{(k)}$ is to be estimated in this case from not only the low-resolution center frame of the image sequence $\mathbf{y}^{(k)}$, but also the surrounding low-resolution frames $\mathbf{y}^{(k-1)}$ and $\mathbf{y}^{(k+1)}$. For the center frame of the video sequence, the image observation model $\mathbf{y}^{(k)} = \mathbf{A}^{(k,k)}\mathbf{z}^{(k)}$ is identical to the single frame model in equation (6). The other low-resolution frames within the sequence should appear similar to the center frame, but with the objects moved slightly with respect to the center frame. An observation model used to accommodate for this motion is given as

$$\mathbf{y}^{(l)} = \tilde{\mathbf{A}}^{(l,k)}\mathbf{z}^{(k)} + \mathbf{n}^{(l,k)}, \quad l \neq k. \tag{8}$$

The motion-compensated subsampling matrix incorporates subpixel-resolution motion vectors that have been calculated between frames $\mathbf{y}^{(l)}$ and $\mathbf{y}^{(k)}$, with the error in the motion estimates represented by a Gaussian-distributed noise vector $\mathbf{n}^{(l,k)}$. Subpixel-resolution motion vectors are estimated by first expanding each low-resolution frame, $\mathbf{y}^{(l)}$ and $\mathbf{y}^{(k)}$, by a factor of q in both directions, and then applying the block matching motion estimation algorithm (Musmann, H. G., Pirsch, P., and Grallert, H.-J., 1985) to the up-sampled data. Once the two motion vector fields have been estimated, the Bayesian multiframe estimate can be computed as

$$\hat{\mathbf{z}}^{(k)} = \arg \min_{\mathbf{z}^{(k)} \in Z} \left\{ \sum_{m,n=1}^{qN} \sum_{p=1}^{4} \rho_{\alpha}\left(\mathbf{d}^{t}_{m,n,p}\mathbf{z}^{(k)}\right) + \lambda \sum_{l=k-1}^{k+1} \left| \mathbf{y}^{(l)} - \tilde{\mathbf{A}}^{(l,k)}\mathbf{z}^{(k)} \right|^{2} \right\}. \tag{9}$$

The new terms which arise in the objective function are due to the error in the motion vector estimates. The gradient projection algorithm is used to minimize the convex objective function, resulting in the high-resolution video still image. Figure 9 shows the HRVS estimate computed from three frames of the digital ultrasound image sequence of the dog's beating heart. Note that in some areas, the resolution is enhanced significantly. However, some artifacts are present due to the inaccurate estimation of motion vectors.

DISCUSSION OF SIMULATION RESULTS

The morphological opening and closing operations tend to remove noise artifacts within the data while leaving the edge structures intact. In the case of medical images, the dilation or erosion of critical information may not be in the best interest of the patient. Thus, morphological filtering may not be appropriate for use in digital radiology, but it can be a useful technique when applied to ultrasonic nondestructive evaluation images (Song, Y.-W. and Udpa, S. S., 1996).

By comparing the image computed through Bayesian single frame enhancement to the images generated by bilinear and cubic B-spline interpolation, it is quite apparent that sharper details are present within the estimate. This added resolution can be important to a radiologist and other medical professionals, since small tumors which cannot be easily detected in the data may become more pronounced in the expanded image.

Bayesian multiframe resolution enhancement is capable of extracting the most detail from the data, since three images from the video sequence are integrated to produce a high-resolution video still image. Provided that the motion vectors can be estimated accurately, the resolution enhancement can be dramatic. In the case of this particular ultrasound image sequence, block matching does not perform well in estimating the motion of the heart valve. These poor motion vectors manifest themselves in the HRVS as ringing artifacts. With the exception of these artifacts, the multiframe enhancement method does generate a high quality image estimate.

CONCLUSION

Several nonlinear filtering and enhancement techniques were applied to digital ultrasound imagery. The morphological opening and closing filtering operations remove much of the noise inherent in ultrasound data, while the Bayesian single frame and multiframe enhancement algorithms extract image details not present in the original frames. Applications arise in the filtering and enhancement of medical and nondestructive evaluation ultrasound images.

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REFERENCES

Gonzalez, R. C. and Woods, R. E., 1992, Digital Image Processing, Addison-Wesley Publishing Co.

Musmann, H. G., Pirsch, P., and Grallert, H.-J., 1985, "Advances in Picture Coding," Proceedings of the IEEE, Vol. 73, No. 4, pp. 523-548.

Schultz, R. R. and Stevenson, R. L., 1994, "A Bayesian Approach to Image Expansion for Improved Definition," IEEE Transactions on Image Processing, Vol. 3, No. 3, pp. 233-242.

Schultz, R. R. and Stevenson, R. L., 1996, "Extraction of High-Resolution Frames from Video Sequences," IEEE Transactions on Image Processing, Vol. 5, No. 6, pp. 996-1011.

Song, Y.-W. and Udpa, S. S., 1996, "A New Morphological Approach for Reducing Speckle Noise in Ultrasonic Images," Proceedings of the 39th Midwest Symposium on Circuits and Systems, (Ames, IA), pp. 1397-1400.

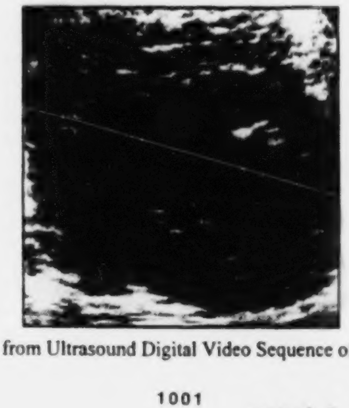

Figure 1: Still Image from Ultrasound Digital Video Sequence of a Dog's Beating Heart

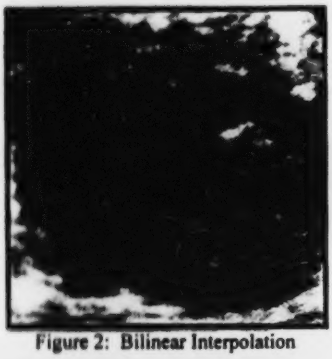

Figure 2: Bilinear Interpolation

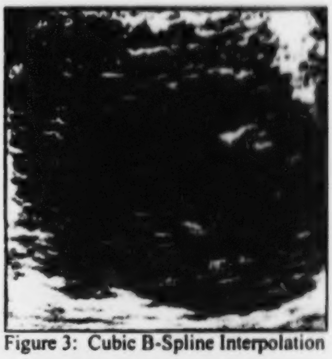

Figure 3: Cubic B-Spline Interpolation

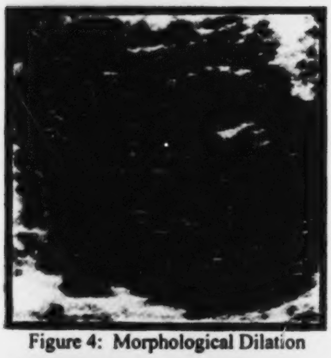

Figure 4: Morphological Dilation

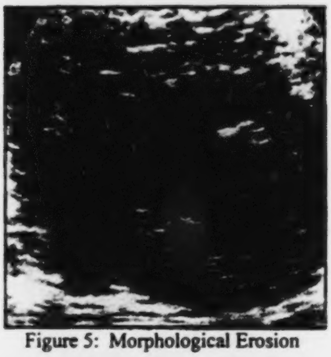

Figure 5: Morphological Erosion

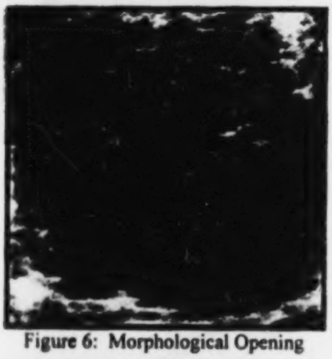

Figure 6: Morphological Opening

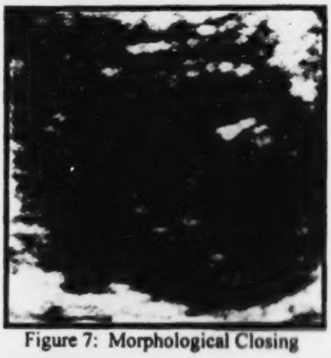

Figure 7: Morphological Closing

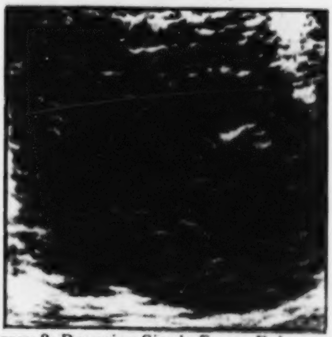

Figure 8: Bayesian Single Frame Enhancement

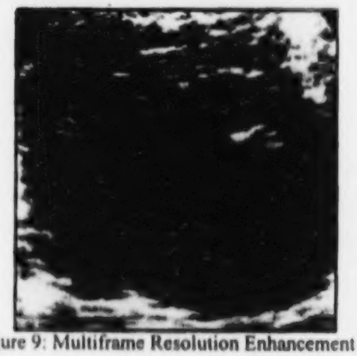

Figure 9: Multiframe Resolution Enhancement

Mathematical Modeling of a Fuzzy V-Chip

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Recently, President Clinton signed a telecommunications bill into law that required every new television sold in the United States to be equipped with a V-chip. This chip will block inappropriate programming, as determined by the user, from being shown. The V-chip works on a discrete rating system that is sent as a signal over the airwaves. Using fuzzy set theory and fuzzy decision making, we have modeled a V-chip that uses a range of fuzzified values to determine a rating for a show, and uses fuzzy multiperson decision making to determine whether or not a program is blocked by the V-chip.

BACKGROUND

Fuzzy set theory and fuzzy logic are extensions of classical, or crisp, set theory and traditional logic that were developed by Lofti Zadeh in 1965. The difference between fuzzy set theory and classical set theory is that all values between truth and falsehood (one and zero) are used in fuzzy set theory, whereas only truth or falsehood are used in classical set theory. This ambiguity in the level an element belongs to its membership set allows for the linguistic description of variables. For example, in crisp logic, an element in the set "Violent" could only be considered violent (1), or not violent (0). In fuzzy logic, an element can be considered "Violent" to varying degrees, such as somewhat violent (.7), a little bit violent (.2), or just violent to a specific numerical degree between one and zero.

A fuzzy set is consists of elements in a universal space that each have a value of membership in the set. This is why another name for a fuzzy set is the membership set. The value of membership is a number less than or equal to one and greater than zero. The universal space consists of all the elements in all of the membership sets.

Fuzzy decision making is a technique that uses fuzzy sets to describe a decision space and state space, relates these spaces by use of a fuzzy relation to produce a result, and uses a utility function to choose the best alternative. This utility function produces a resultant fuzzy set, and the best alternative is chosen out of the resultant set. Fuzzy decision making is an extension of classical decision making theory using fuzzy sets instead of classical sets. All uses of classical set theory and logic are at the core of fuzzy set theory and logic; classical theory is simply a special case of fuzzy theory.

The current V-chip has three blocking categories. These categories are violent content, sexual content, and mature language. An integer in the range of zero to five is established in each of the categories. Zero corresponds to no offensive content, and five corresponds to the highest level of content. The user of the V-chip decides what level they consider appropriate for each of the three categories. If the show's number rating is higher than the V-chip's number rating for any of the categories, the show is blocked from being shown on the television screen.

Using fuzzy logic to model the V-chip allows the use of linguistic variables to describe the degree of violence, sexual content, or language. Fuzzy logic also describes with uncertainty to allow for differences in a program from episode to episode without re-rating the show. Also, with fuzzy logic, other features that describe educational content or realism can be added to bias the decision to make it more effective.

The most exciting reason to use fuzzy logic in this type of decision making process is that fuzzy sets can be easily aggregated to come up with a final fuzzy set. This allows shows that are educational or informative to offset ratings of content. After aggregating the functions into a final fuzzy set, a user's decision and a show can be compared against each other in order to decide if the show is blocked, and a show rated particularly high in one area has a chance to be a successful decision if it is rated low in other areas, and high in a bias set like educational content. This is related to traditional fuzzy decision making by the use of a decision space (the television programs), state space (the user threshold set), and a fuzzy relation that also serves as utility function to evaluate whether or not a show is blocked.

MATHEMATICAL MODELING

The model of a two-valued V-chip in figure 1 is shown as a special case of fuzzy set theory. Each rating singleton fuzzy set has one element, and each element has a membership rating of one. There are large areas of uncertainty between membership sets that have no membership values in any set. There are different universal spaces for each of the types of content in the V-chip, but the fuzzy sets representing the levels of content are the same.

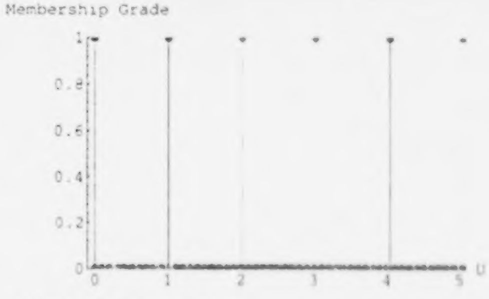

Figure 1: Model of a current V-chip

The current V-chip works in the following manner. Three singleton sets exist for each program, each one is a rating for a type of content. Three singleton sets are determined by the user as a threshold for the level of content, one for each type of content. The rating set for a type of content in a show is compared against the threshold set, for the same type of content, stored in the V-chip. If the rating set has a higher level of content than the threshold set does, for any type of content, the show is blocked. In other words, a decision is made that the show is not fit to be shown.

In the model of a fuzzy V-chip in figure 2 there are still six fuzzy sets representing the various levels of content, but each fuzzy set spans the universal space. This means that any value of content will have a level of membership in each set. Having a membership in each set allows the aggregation of sets into a final set that spans the universal space. Also, the membership sets fill the universal space, meaning that each element has a membership of one in some membership set. As in the case of classical theory, there are universal spaces for each of the types of content, with the same fuzzy sets representing the levels of content.

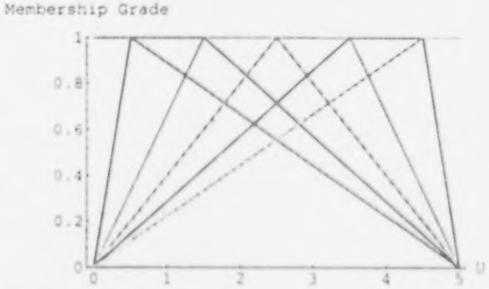

Figure 2: Model of a fuzzy V-chip

In this model, the approach taken in deciding whether or not to pass a show is somewhat different than the approach of the current V-chip. In order to come up with a single representative rating set for each show, and for the content threshold set, the individual sets are aggregated by one of several different methods. The first, and simplest method discussed, is done by taking the min-intersection of all of the individual content rating sets to produce a rating set. The min-intersection of the individual content threshold sets is taken to produce a threshold set. After the rating set and threshold set are produced, they are compared against each other. If the rating set has a higher content level than the threshold set, it is blocked.

The aggregation of sets is done for several reasons. The most important reason to aggregate the sets is to take into account all criteria of the rating of the show to decide whether

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or not to block it, instead of taking individual ratings into account. This allows a show with an overall low level of offensive content to make up for having a high level of content in a specific area. Aggregating sets also allows for the use of more sets to bias the outcome set. For example, a show with high levels of content that is educational and informative, or is presented in a serious manner can be offset by a bias set to reduce the overall set. A final advantage in aggregation is that only one set of information, a cumulative rating, needs to be sent over the airwaves for comparison to the threshold set, thus saving valuable bandwidth.

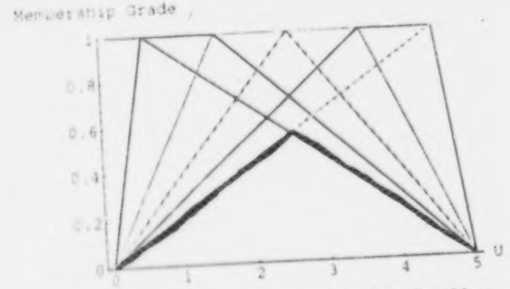

Figure 3: Graphical representation of the "zero and five" problem

Problems dealing with information loss arise when min-intersection is used to aggregate the content sets in figure 2. The most vexing problem involves any show that has both individual rating content sets of five and zero, as shown in figure 3. Due to the shape of these sets, when a show of this type is aggregated, only the five set and zero set are important, and all other information about the show is disregarded. Any show with a five set and a zero set will end up with the same resultant rating set. The other main problem is that of multiple sets. If there are duplicate content sets, only one of them is important in calculating the resultant set, the other is not noticed. Clearly this information loss needs to be avoided by use of a different form of aggregation.

IMPROVEMENTS IN CREATING THE RESULTANT SETS

By use of the product operation to determine the resultant membership sets, many of the min-intersection problems are eliminated. First, the "zero and five" problem no longer exists because the information from all content sets is retained by the resultant set. Also, product takes into account multiple uses of the same content set, and weights the resultant set properly using the information of the duplicate sets. Overall, the product operator is much better at weighting the resultant membership set than the min-intersection operator. Product, however is probably not the most mathematically correct operator to use.

For mathematical correctness, an average would seem to be the best way to find the resultant set. Using an arithmetic mean gives probably the most mathematically correct averaging, and is just as effective as product at removing the min-intersection problems from the weighting. Arithmetic mean also produces sets with higher membership values, and larger fuzzy sets using more elements of the universal space.

The method used to compare which set is larger involves individually finding the center of area of the rating set and the threshold set. The centers of area are discrete numbers between zero and five. If the center of area representing the rating set is greater than the center of area representing the threshold set, the show is blocked. This causes the advantages of using arithmetic mean to be near useless in deciding whether or not a show is blocked. In the final determination, using product or arithmetic mean is up to the discretion of the user, depending on how the rating set and threshold set are compared. Other methods of comparison include finding Hamming Distance, or the MAX and MIN fuzzy operators.

MULTIPERSON DECISION MAKING

To allow for more than one user to decide the threshold set, one of two things must be done. Either all the users' sets must be aggregated to determine an all encompassing threshold set, or a rating set must pass each individual threshold set. To better approximate real reasoning, the latter was chosen.

In a family, a child will ask each parent if they can watch a particular program. The final decision is determined by how much the program is liked or disliked by the individual parents. For example, if Mom dislikes a show greatly, but Dad is somewhat ambiguous about letting the child watch the program, the child will more than likely not be able to watch the show. The final decision is a sort of compromise between the two individual decisions. This is what was implemented by equation (1) using fuzzy arithmetic operators.

$$F(Rule1, Rule2, Show) = (Rule1 - Show) + (Rule2 - Show) \quad (1)$$

The algorithm takes into account a numerical value of the difference between the threshold set and the rating set. Passing is represented by a positive value, failing by a negative value. It sums the results of passing or failing, and if the final number is positive or zero, the show passes; if it is negative, the show is blocked.

CONCLUSIONS

It is obvious that the current model for the V-chip is inflexible and somewhat inaccurate as a model for something as complex as a television show. The ability of fuzzy logic to model linguistic variables offers hope for a rating system that better approximates the real world decision of whether or not a person wants to view a television program. Hopefully the simple solution modeled currently can be implemented into an intelligent system that will save people time searching for appropriate television programming.

REFERENCES

Beall, L., and Stachowicz, M.S., Fuzzy Logic Package for Mathematica, Mathematica, Wolfram Research, 1995

Herrera, Herrera-Viedma, Verdegay, "A model of consensus in group decision making under linguistic assessments", Fuzzy Sets and Systems, vol. 78, pp. 73-87, 1996

Klir, G.J., and Yuan, B., Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, Englewood Cliffs, NJ, 1995

Klir, G.J., and Folger, T.A., Fuzzy Sets, Uncertainty, and Information, Prentice Hall, Englewood Cliffs, NJ, 1988

Ruttan, S., "V-chip will give parents more control over TV", Calgary Herald Online, March 13, 1996

Effect of Thin Film Disk Texture on Magnetic Recording Head-Medium Clearance Measurements

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The quest for a larger magnetic recording areal density is the primary factor underlying magnetic storage developments. The reduction of physical spacing between the magnetic transducer and recording media has enabled incredible progress in storage density improvements. However, the current optical methods used for measuring this clearance are time consuming and cumbersome. A novel method is clearly necessary.

In this paper, the effect of thin film disk texturing on head to medium clearance values is investigated. Physical clearance values representative of the analogue readback signal analysis are measured. Readback signal resolution values are also measured. A comparison of ten vendor 95mm Co-alloy thin-film disks is completed and verified. The resulting clearance values strongly correlate to disk surface texture. Flyheight values remain appreciably constant. Uniformity of disk surface texture is more influential than the quality of the analogue readback signal resolution over the accuracy of clearance values. Clearance values can now be taken efficiently. Also, quick and accurate *in situ* clearance measurements are now possible.

I. INTRODUCTION

The quest for a larger magnetic recording areal density is the primary factor underlying magnetic storage developments. The reduction of physical spacing between the magnetic transducer and recording media has enabled incredible progress in storage density improvements. In an actual disk drive, the magnetic transducer or head is mounted on a slider which is designed to fly over the rotating disk. The gap formed between the slider and disk makes up the largest portion of the total head to medium spacing. As this gap is reduced, an accurate and rapid clearance measurement becomes increasingly important.

A clearance measurement strongly correlates to the disk surface texture. Therefore, using this measurement it is possible to make comparisons of different disk types in regard to their surface properties and physical characteristics. Measurement results will aid in the development of both head and disk design so as to bring the industry closer to optimizing the magnetic storage process.

It is evident that head to medium spacing is extremely vital to the storage industry. A reliable and robust method is necessary to determine this value. The measured clearance values in this report are derived from specific characteristics of the analogue readback signal of the recording head. Therefore, the method only needs access to this readback signal. Previously reported systems use an optical approach which was limited by the requirement that the two surfaces be substantially coplanar. A newer laser interferometer system was then introduced which solved this problem to some extent. However, even with this newer design, it was extremely time consuming to characterize a full rotation due to the significant amount of trace averaging necessary to reduce differences arising from random rotational sampling points. This became an even larger problem when simulating modern disk drive motor characteristics which halt rotation in only several seconds. In addition, *in situ* testing of manufactured disk drives was not possible with this optical method. Utilizing analysis of the readback signal to obtain clearance measurements, it is possible to obtain accurate clearance vs. velocity measurements in a minimal amount of time. In addition, rotational synchronous sampling allows for clearance values to be taken from the same point on each rotation, eliminating the need for trace averaging. Also, it is now possible to simultaneously analyze the resolution of the analogue readback signal during the measurement procedure, in addition to obtaining measurements for disks inside an actual completed storage product. It is obvious that this more advanced process is not only more flexible, but will also result in clearance values which are more accurately representative of the true head and disk surface characteristics.

The main purpose of this report is to discuss results from a clearance comparison of ten different disk types using measurement data from the processing of the analogue readback signal. The focus will be on disk surface characteristics. Therefore, the same recording head is used throughout the experiment. Due to confidentiality restraints, each disk will be referred to as disk1, disk2, etc. The clearance measurements will be compared and verified with data from various optical and physical texture analysis tools. From the analysis presented in this report, it will be made evident that accurate head to medium clearance values derived from an analysis of the analogue readback signal is truly representative of various disk surface textures.

II. EXPERIMENTS

Recording experiments were conducted using vender 95mm Co-alloy thin-film disks and magneto-resistive (MR) thin-film heads in a precision teststand. The various disks consisted of cross-hatched, pad, tape, diamond and laser textures. An orthogonal mount (i.e. 0 skew) of the magnetic recording head was used for all clearance tests in this experiment. The head had a gap flyheight specification of 65nm at 8.5m/s as measured by a Phase Metrics flyheight tester. Tracks of equidistant transitions were recorded using a write current of 70mA$_{pp}$. Readback signals were read using a MR read bias of 13mA$_{pp}$. The write frequency was held constant at 2.5MHz. Tracks were written at radii of 45, 40, 35, 30, 25, 20, 19, and 18.5mm. Data zone measurements consist of those measurement results from 45 to 25mm. Landing zone measurements consist of the remaining 3 test radii. This differentiation is used because of landing zone bump texturing used on the inner radii of laser textured disks. (typically <20mm)

A spindown from 8.5m/s was performed at each test radii after a track was written and verified. This ramping was done using a function generator with a 20mHz frequency and a variable duty cycle to adjust for different rotational periods at various radii. Spindown was terminated at a velocity such that a roll-up due to the positive crown slider was observed after the landing point.

Each test disk was divided into 8 sectors. 16 measurements were taken per sector, the first of which was a velocity measurement. The latter 15 consisted of clearance measurements. Full speed readback signal resolution measurements were taken for 2 complete revolutions.

The velocity vs. clearance spindown profiles clearly show the clearance, clearance margin, and touch-down point for each test. The clearance values in this report represent distance from the nominal flying height at 8.5m/s to the rest height at landing. (This is not to be confused with flyheight values which represent distance from the nominal flying height to the mean roughness plane.) Clearance margin values represent distance from the nominal flying height to the point of first contact with the disk surface. (i.e. peak roughness or R_p.) This has strong correlation to take-off height (TOH) values, however, due to the ambiguity of the TOH definition, it may be more proper to use the velocity at this point of first contact for comparisons. Touch-down values represent the point at which the head is at its rest height above the mean roughness plane. This can be associated with the absolute minima of the roll-up at then end of each spin-down curve. (see Fig. 1)

The rotational synchronous sampling used in this measurement procedure also provides the basis for plots consisting of clearance and resolution vs. angle. Clearance variation plots are extremely useful for viewing clamping induced warp, while resolution variation plots are helpful for determining magnetic variation along the write track.

A scattered light roughness verification measurement was handled using a device which aimed a focused laser beam at the disk surface and measured roughness corresponding to the resulting intensity of the scattered light. This device was designed to take measurements in arbitrary units. Therefore, results were only used for comparison purposes.

Tencor roughness measurements were taken using a Tencor P-12 Profiler with a stylus radius of .1μm and no data filtering. This instrument was used mainly to obtain R_p and R_q values. Sweeps were completed using 1mm lengths and both 8 and 16 samples per radius were measured. Both radial and tangential sweeps were performed to characterize differences in results due to the various types of disk texturing.

III. RESULTS AND DISCUSSION

The readback signal full speed resolution reference is based on a resolution value of 115nm. Note that this value is obtained from a calculation involving the half amplitude pulse width (PW_{50}) of the head signal obtained from a measurement using the head/disk combination specifically designed for this head. Because of an offset parameter which can be adjusted, the magnitude of this value is arbitrary. However, the units are in nanometers. The offset was held constant for all measurements taken for this experiment, therefore the magnitudes of the results are relative. A poor readback signal content correlates to a higher resolution value. Because the resolution units in nanometers can cause confusion with both clearance and flyheight values, resolution units will be left out from this point forward.

Full speed resolution measurement results show that 4 disks, disk6, disk7, disk8, and disk10 show poorer resolution than those disks belonging to the rest of the test set. Therefore, it is noted that clearance measurements *may* be affected as a result. Full speed readback signal resolution is better for laser and diamond textured disks, than for tape and pad textured disks. (see Fig. 2)

Take-off (landing) velocities (TOV) determined from the clearance measurements clearly correlate to disk surface roughness. A rougher surface is expected to have a higher TOV than that of a smoother surface. This is precisely what is seen from the test results. Laser textured disks such as disk1, disk2, and disk3 exhibit landing velocities of .8 to 1.0 m/s in the data zone. Landing zone bump heights for these disks are 40.0, 22.5, and 27.0nm respectively. Landing velocities in the landing zone are 3.6, 1.7, and 1.9m/s respectively. TOV measurements for pad textured disks such as disk6, disk7, and disk8 range from 1.2 to 1.7m/s. TOV results for tape textured disks such as disk9 and disk10 range from 1.0 to 1.5m/s. Finally, the TOV results for diamond textured disks such as disk4 and disk 5 range from .8 to 1.0m/s.

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From the TOV data, it is clear that laser and diamond textured disks are most competitive in terms of their generally smooth texturing. Mechanically textured disk surfaces result in noticeably higher TOVs. The head requires more physical distance to clear the roughness upon a spinup, while it touches-down at a higher velocity during a spindown. This behavior strongly correlates to the clearance measurements taken on these disks as well.

The average clearance measurements for the laser textured disks range from 51.4 to 52.8nm, while the average clearance for pad textured disks range from 35.8 to 46.8nm. The average clearance ranges for tape and diamond textured disks are 43.4 to 51.4nm and 44 to 48.2nm, respectively. Average clearance values for the landing zones of the three laser textured disks are 21, 41, and 35nm respectively. (see Fig. 3)

A lower clearance is easily correlated to a rougher surface, while a higher clearance can be attributed to a smoother surface. This is because a rougher texture has less distance between the surface and the flying height at nominal velocity. This is just the opposite for a smoother textured surface.

Particular attention should be paid to the laser textured and diamond textured results. Both exhibit identical TOV behavior, however, their clearance comparison show appreciable differences. This can best be explained by variation in the roughness uniformity across the disk surface. The laser texturing provides for a more even surface uniformity, while the diamond texturing cannot match this. From this theory, it is expected that the R_p values for the diamond textured disks are higher than for the laser textured disks. This is primarily due to the fact for two different disk surfaces with the same TOV, the mean roughness plane for the less uniform surface should be lower than that of the more uniform surface. This is essentially what is seen from the Tencor R_p measurement results. (see Fig. 4)

Clearance variation from track to track for cross hatched surface textures such as that of disk8 is exhibited in the data results. A "roller coaster" up and down behavior is clearly present in a clearance vs. radius profile. As expected, this is also evident in the scattered light measurement of the same disk type. In fact, a pattern can also been seen whereas the higher clearances essentially correlate with lower scattered light intensity, while the lower clearances essentially correlate with higher scattered light intensity. This is also the behavior with the other test disks. (see Fig. 5)

Clearance variation along a single track at a set radius such as that which is exhibited by some additional samples of disk7 and disk8 is clearly evident in the scattered light measurement analysis as well. The scattered light intensity around the radii in question varies significantly. The rotational synchronous sampling makes it possible to trace the higher roughness rotational range to the same location of higher intensity on the scattered light intensity plots. Accordingly, this clearance variation causes a higher sigma value in the clearance data results. Spindown profiles from the 8 sectors of the disk surface varies by more than 20%.

Because of surface variations from disk to disk, flyheight specifications for each head are used, rather than clearance values. Therefore, to verify the clearance values from this experiment, individual flyheight values are calculated based on the experimental clearance data.

To most accurately determine the correct flyheight, a TOH for each individual test disk should be added to the clearance for the respective disk. Because this TOH data is not readily available, the peak height of the disk surface roughness (R_p) as determined by the Tencor P-12 is used instead. TOH is heavily related to the R_p value. There remains a difference between the two primarily due to the small additional air bearing that is, and should be, included in the TOH measurement. However, this is not included in the R_p measurement. The air bearing is representative of the air channeled into the surface grooves trying to escape, therefore pushing upwards resulting in a slightly larger flyheight.

R_p measurements obtained from the radial and tangential sweeps do not show appreciable differences. Comparison tests of both 8 and 16 1mm sweeps also show no noticeable differences from the measurement data. With the exception of the results from disk8, flyheight values range from 59.2 to 68.8nm. This is with the absence of the small upward-pushing air bearing previously discussed. However, it is clear that results are still extremely close to the specification of 65nm at 8.5m/s.

A low flyheight of 54.3nm is obtained from disk8. Results from this disk show one of the highest R_p values (second only to those of disk6), the lowest clearance values, and fairly poor resolution values. RMS roughness (R_q) obtained from the Tencor measurements are also high, again, right behind those of disk6. It is noticed that a large amount of variation is present in the clearance data at each test radii due to the mix of a courser surface combined with the cross hatching texture This causes sigma values which are much larger than those of the other test disks. It is assumed that the poor readback signal resolution complemented by this high clearance variation is the cause for the low experimental flyheight.

Tencor R_q values correlate directly with the clearance values obtained from each spindown. Laser textured disks show the lowest R_q values followed by diamond, tape and pad textured disks in increasing order.

IV. CONCLUSIONS

Clearance measurements from an analysis of the analogue readback signal strongly correlate to disk surface texture. Spindown profiles clearly show the transition points of the head to disk interface. The

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clearance at touchdown represents the first point of head to disk surface contact. The touchdown velocity associated with this point can be matched with a TOH value which, when added to the total clearance value, will yield the true flyheight from the mean roughness plane of the disk to the nominal surface of the head. Because R_p values are strongly related to TOH values, it is feasible to use R_p values in lieu of TOH. However, one must understand that a slight error is presented since the small upward-pushing air bearing due to trapped air in the roughness valleys is not taken into consideration for the R_p measurements.

Rougher surface textures yield a lower clearance value, while smoother surface textures yield a higher clearance value. However, flyheight values remain fairly constant and compare very closely to the true flyheight specifications of the head.

The analogue readback signal resolution is representative of the quality of the write signal. However, uniformity of disk surface texture influences the accuracy of the clearance values more heavily.

Rotational synchronous sampling provides for more accurate clearance and resolution measurements. Clearance variation vs. angle plots clearly show variations in disk surface roughness around a single track. Large sigma values in a spindown curve provide for easy noticing of this characteristic.

Clearance measurements can be easily and efficiently taken from an analysis of the analogue readback signal. Results show that smoother disk surfaces have a lower texture depth than rougher surfaces. This provides for reduced head to disk interaction which may cause poor readback signal resolution, as well as eventual disk drive failure.

REFERENCES

B. Bogy and F. E. Talke, "Laser Doppler Interferometry on Magnetic Recording Systems," *IEEE Trans. Magn.*, MAG-21, 1332 (1985).

G. Bouchard., D. K. Miu, D. B. Bogy and F. E. Talke, "On the Dynamics of Winchester and 3370 Type Sliders Used in Magnetic Recording Disk Files," *Am. Soc. Lubr. Eng.*, SP-16, 85 (1984).

D. K. Miu, G. Bouchard, D. B. Bogy and F. E. Talke, "Dynamic Response of a Winchester-Type Slider Measured by Laser Doppler Interferometry," *IEEE Trans. Magn.*, MAG-20, 927 (1984).

C. D. Mee and E. D. Daniel, *Magnetic Recording*, Vol. 1: Technology, McGraw-Hill, New York, 1987.

M.J. Donovan and D.B. Bogy, "A New Laser Interferometer for the Spacing Measurement of Non-Parallel Slider and Disk Surfaces," Dept. of Mech. Eng., University of California, Berkeley, CA, 1994.

K.B. Klaassen, R.E. Eaton and J.C.L. van Peppen, "Effect of Thin-Film Disk Texture on Magnetic Recording Signals," IBM Research Division, ARC, (1992).

K.B. Klaassen and J.C.L. van Peppen, US Pat. 5,130,866, July 14, 1992.

Fig.1 Illustration of the Slider-Disk Interface With Spacings Pertinent to HDI Measurements

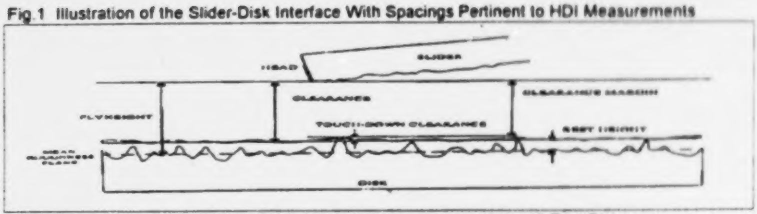


Fig. 2 Average Full Speed Data Zone Resolution Comparison of the 10 Test Disks

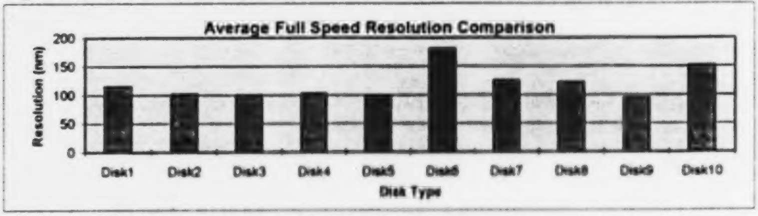


Fig. 3 Average Data Zone Clearance Comparison of the 10 Test Disks

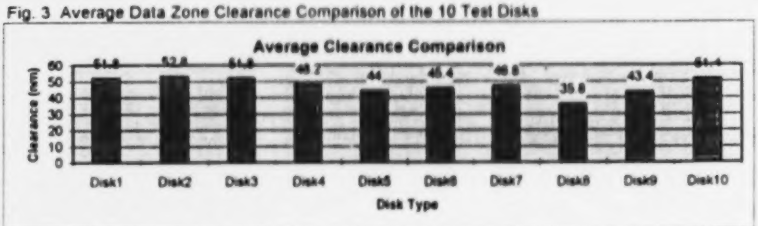
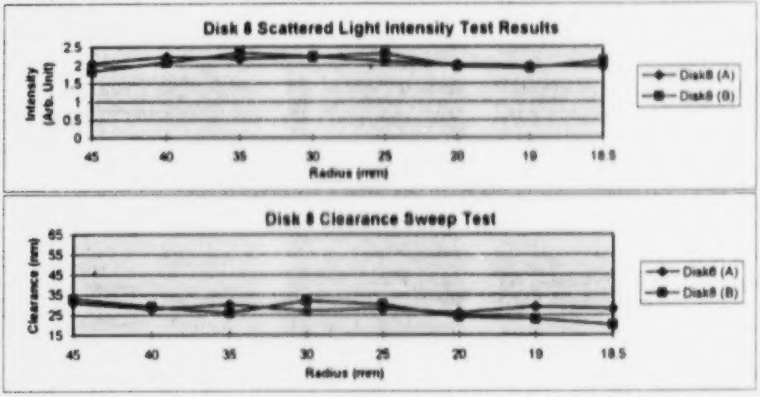


Fig. 4 Tencor Measurement Results and Flyheight Values of the 10 Test Disks

	Disk1	Disk2	Disk3	Disk4	Disk5	Disk6	Disk7	Disk8	Disk9	Disk10
Radial Rp at 30mm (nm)	10.94	9.575	9.855	16.25	18.45	21.35	16.65	18.5	15.8	15.2
Tang. Rp at 30mm (nm)	9.885	9.79	10.27	14.9	15.7	19.85	16.85	18.75	16.95	17.4
Rq (30mm)	2.95	2.88	2.87	5.04	5.93	8.02	5.17	6.21	4.96	5.1
Full Speed Res. (nm)	114	102	99	102.8	99	180.6	124.8	121.6	93.8	151.4
Clearance (nm)	51.8	52.8	51.8	48.2	44	45.4	46.8	35.8	43.4	51.4
Flyheight*	**62.74**	**62.38**	**61.66**	**64.45**	**62.45**	**66.75**	**63.45**	**54.3**	**59.2**	**68.8**

* FH=Rp+Clearance

Fig. 5 Comparison of Scattered Light Measurement Radial Sweep Test Results with Clearance Sweep Test



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A Self-Evaluation Tool for Life-Cycle Cost Analysis

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The lack of use of Life-Cycle Engineering (LCE) technique in the design of production facilities has led to the design and development of the "Self-Evaluation Tool" (SET). The SET is a component of a software system called "Life-Cycle Advisor" that will help project managers to become aware of, and comprehend, all the factors that affect the Life-Cycle Cost of a production facility. For example, the SET will help project managers treat the Life-stages of a building as parts of a complete evaluation.

The SET program was developed with the Visual Basic v3.0 programming language due to the friendly environment characteristics. The SET program consists of windows that display multiple choice questions that cover a variety of project areas. It attempts to establish the scope of the LCE program for a particular structural firm. Buttons with captions of 'Backward', 'Forward', 'Quit' and 'End' appear in each window. The 'Forward' button allows the user to move forward through the program and the backward button does the opposite. The 'Quit' and 'End' buttons will enable the user to conclude the questionnaire whenever he/she wants. As a result of the 'End' command button in window with question twenty-three, the proceeding window will be used to display the users' responses. Menus appear in the last two windows. The menus enable the user to save, print, copy and edit the existing file. Message boxes such as 'Save As' and 'Print' boxes give a more professional look to the SET software system. Overall the SET program will help owners save money by pointing out that designers should consider many factors in both cost and performance throughout the planning horizon of a facility.

BACKGROUND

The Construction Industry Institute (CII) research team #122 believes that there are several reasons for the lack of Life-Cycle Engineering (LCE) of production facilities. One of these reasons points to managers who make their decisions in an unstructured and data-limited environment during the initial planning phase. Another reason for the misuse of LCE analysis is based on the idea that project managers do not understand the relationship between LCE factors. Managers do not consider factors such as the investment of design, construction, maintenance, renewal and decommission of production facilities as part of a combined process of evaluation. Finally, there is a belief that miscommunication between members also becomes part of the problem. A vast majority of the decisions made by individuals at multiple companies do not share common sets of information or methodologies with respect to project life-cycle goals. With these problems in mind, the CII initiated a project that will help project managers and designers do two things. First, the CII intends to help project managers and designers understand the relations between all the factors that affect the LCC of production facilities. Second, the CII intends to improve the decision of those who have the power to affect the LCC of production facilities. The "Self-Evaluation Tool" is one of the elements of the "Life-Cycle Advisor" project that was developed as a software system to help designers and project managers use LCE techniques more efficiently.

PROCEDURES FOR DEVELOPMENT AND IMPLEMENTATION

The overall project was divided and distributed to different members of the research team. The main goal of this project consisted of the creation and automation of the "Self-Evaluation Tool." The SET has been developed and implemented with the utilization of the Visual Basic v3.0 (VB) programming language. One of the goals of the SET program was to provide a Graphical User Interface (GUI) to the user. The SET provides four characteristics similar to any 'MS-Windows' program. First, the SET provides command buttons in every window that control the display of twenty-three multiple choice questions. The twenty-three windows containing the multiple choice questions are able to store the selected choices. Later, the chosen answers will be summarized in order as Figure 7 in the Appendix shows. Second, it contains instructions on how the user can mail or email the selected file. Third, visible menus give the user the ability to edit the file as he/she wishes by saving, cutting, pasting, exiting or returning to the beginning of the program. Fourth, message boxes for a more professional look appear during different situation. These message boxes have two purposes. First, they provide messages restricting the user from proceeding upon an invalid operation. Second, it provides the user customary boxes such as 'Print' and 'Save As' that are familiar to any person who has used a computer before. These boxes give the user several options just like the options that 'Microsoft-Windows' gives.

To accomplish these tasks Visual Basic v3.0 was learned. VB is an object oriented computer programming language. The programmer became familiarized with programming environment by reading a book called VB in 12 Lessons. The book VB in 12 Lessons takes the programmer through "mini-programs" that simulate the way bigger programs should behave. The skills learned were improved by reading a book called Visual Basic3 for Windows. Finally all the knowledge was applied into Visual Basic v3.0 for the implementation of the "Self-Evaluation Tool." Two methods for the creation of the GUI were approached.

Method#1

The first method (method#1) that was approached displayed the 23 questions using a master window. The captions of 'Labels' that displayed the question headings were controlled with 'Forward' and 'Backward' command buttons. These buttons were coded with 'If Then' statements. Method#1 reduced the execution time of the program since there was no need for opening new windows every time a new question was to be displayed. The execution of this method did not easily allow the storage of selected choices for individual questions. For example, when a particular choice was selected for a particular question, the same choice for the next question automatically became selected. For this reason, a second method was attempted using individual windows for each question.

Method#2

Method#2 was successful because there was no difficulty storing the selected answers as the user made a choice. For example, if the user selected choice#1 for a window titled Question#1, choice#1 of window titled Question#2 did not become selected if the user did not check the choice. This was accomplished because the codes for each window are unique and separate to that particular window. This method slowed the program because there was a need for opening and closing new windows every time the next question was requested. The 'Loading' commands for all the files in the beginning of the program compensated for the slowness of the execution. The window titled 'Answers' contains the users' answers to all the questions. The purpose of this window is so that the user can mail it to the CII by selecting the options on the menu. Upon receiving the mailed answers, the CII will be able to improve the quality and quantity of life-cycle engineering techniques by commenting on the user's answers. The CII will grade this questionnaire and provide advisement to the user of the SET program.

The menus play a big role in the implementation of the SET. The menu in the 'Answers' window contains 'Print', 'Exit', 'Back to Questions' and 'Edit' options. The 'Edit' option automatically opens up a new window with new menu. This new window contains 'Save As', 'Display Answers', and 'Help' options. The 'Save As' option will save the edited file same as a normal 'Save As' command does in other programs such as 'Microsoft Word'. The 'Save As' command provides message boxes in case the user mistakenly tries to overwrite an existing file or cancel the 'Save As' command. Method#2 was very useful to advance the development of the SET program.

The goal of developing a program that attempts to make the user more aware of Life-Cycle Engineering Techniques was successfully accomplished. The characteristics of the SET program are as follows; It automates the questionnaire, stores the choices in the check boxes for individual questions, prints, calls the stored answers and displays them in a window titled 'Answers'. All of these characteristics are accomplish with a simple clicking of the mouse. Finally the SET program gives the user the ability to copy the selected options so that she/he can paste them on an email window.

RESULTS OF GRAPHICAL USER INTERFACE

The GUI contains titled windows that will let the user know where and how far he/she is in the program. Figure 2 shows instructions of what to do to run control the program. The windows provide a question along with a set of 'Check boxes' and captions for each factor to be considered by the user. Three buttons were placed at the middle of the screen. These buttons are labeled 'Backward', 'Forward' and 'Quit'.(See Figures 3-5 in Appendix for view of the windows and command buttons.)These are accessed with a simple click of the mouse. They can also be accessed by tabbing until the focus is set to the desired button and pressing the space bar. All the windows that display questions contain the same format. For the benefit of the user, after choosing 'Quit', a 'Frame box' appears requesting the user for a yes or no answer. This is a check to make sure that the user wants to quit. At the end of the questionnaire the 'Quit' button changes to the word 'End'. When the user clicks the 'End' button and accept to finish the questionnaire, an instruction window appears so that the user knows what to do next.(See Figure 6 in Appendix.)The program brings the last window up with a command button 'Enter' in the middle of the screen. Finally, the answers will appear when the programmer clicks the 'Enter' command.(See Figure 7 in Appendix.)These tools will serve two purposes. First, the SET will make it possible for the CII to advise the user upon receiving the mailed answers. Second, the SET will help the user become aware of all the different factors that could possibly affect the Life-Cycle Cost of production facilities.

ANALYSIS

Even though the SET program was developed and implemented, the consideration of a master window for all questions will minimize the amount of memory needed to run the program. It is possible for all the questions to be combined in one window using 'If Then' statements in the code. More time must put into the logic of the coding if less memory is critical for the execution.

For this project, there were two questions asked. First "Will the program be able to compile successfully?" The program had to be done in a certain amount of time. Therefore, method#2 was chosen. The second question was "Is the GUI of the SET user friendly?" This requirement was satisfied when the SET was experimented on several people such as Martin, Adriana, Lüi, Hugo, Amy and many others. These people had no knowledge of the project but had previous experience with other programs written in C++ and FORTRAN. Their feed back pointed out that the running the SET was very simple. Although saving memory was not a priority, it should be taken into consideration for future versions of the program. Other factors were kept in mind, but the finish product and user friendliness of the product were of higher priority. Therefor the use of Visual Basic v3.0 programming language was most appropriate for the implementation of the SET.

CONCLUSIONS

The SET program compiles successfully. With the use of the SET, the designers will be able to mail their data to the CII. The CII research team #122 will be able to advise project managers and designers how they can improve the use of LCE techniques. The SET program will attempt to help owners save money once the designer considers factors in both cost and performance throughout the planning of a new facility.

FUTURE RESEARCH AND RECOMMENDATIONS

It is suggested that future work be done on the SET project. A window at the beginning of the questionnaire allowing the user to open and modify the already existing data files should be implemented. This window could appear after the first window that the user sees when the SET is run. Figure 1 is the title window. This can be done with the usage of menus similar to those in the 'Answers' window shown in Figure 7 of Appendix. The file menu should contain 'New' and 'Open' options. The 'New' menu command will let the user start a new file.

The 'Open' option will allow the user to call a file that was saved in a separate folder. The execution of the SET should have ways to link to the selected file. This linkage should enable the menu commands in the 'Edit Mode' window. If this linkage is accomplished, the 'Edit Mode' window will allow the user to move back and forth throughout the program without the need of further coding. Finally, the program could be upgraded to Visual Basic v4.0 the Windows95 edition.

ACKNOWLEDGMENTS

The author wishes to express it most sincere appreciation to Dr. John Wilson, and Matt Rowe for their inspiration and advisement. Dr. Bavarian, Dr. Dijulio, Dr. Shively for the opportunity of be part of the GD research team. The National Science Foundation for monetary support. Nevertheless, my family for all the encouragement and understanding.

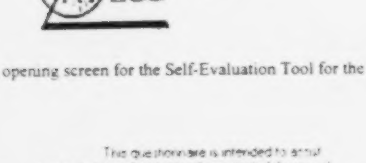
REFERENCES

CII Research Team#122, Life-Cycle Engineering, Introduction to a User's Guide, A paper for the Life-Cycle Engineering, Austin Texas 1996.
Cornell, Gary,The Visual Basic3 for Windows, Osborne McGraw Hill, Berkeley, California 1993
Dabbani, Isam Ali. "Decision Support Life Cycle Analysis System In Building Design" University of Colorado, Boulder 1993.
Monson, Bradley Alan "Prioritization of Highway Projects Using Life-Cycle Cost Analysis" North Dakota State University of Agriculture and Applied Science, North Dakota 1995
Perry Gray, The Visual Basic 2 in 12 Lessons. Osborne McGraw-Hill, Berkely, California 1990.

Appendix

Self-Evaluation Tool
PROTOTYPE V1.0
ATLSS
CII

Figure1 This is the opening screen for the Self-Evaluation Tool for the Advisor program



This questionnaire is intended to assist management in determining the extent of the use of Life-Cycle Cost Analysis in their organization.
Place an "X" in the appropriate response boxes by clicking the mouse or by tabing for the selected choice and pressing the space bar

Figure 2 Gives instructions to the user on how to control the SET.

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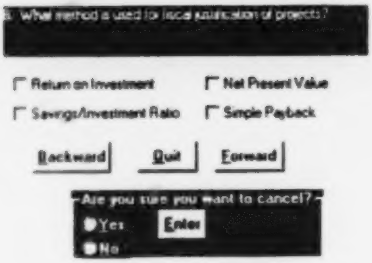


What method is used for fiscal justification of projects?

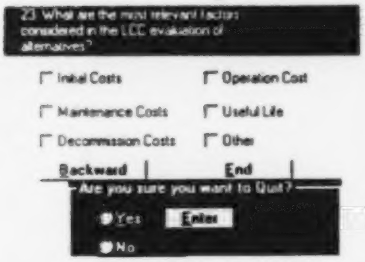
☐ Return on Investment ☐ Net Present Value
☐ Savings/Investment Ratio ☐ Simple Payback

Backward
Quit
Forward

Are you sure you want to cancel?
○ Yes
○ No

Enter

Figure 3 The user becomes aware of the factors that affect the LCC of a facility by reading the available choices in every screen.



23. What are the most relevant factors considered in the LCC evaluation of alternatives?

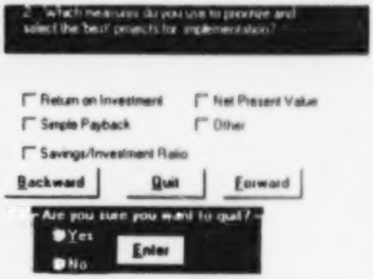
☐ Initial Costs ☐ Operation Cost
☐ Maintenance Costs ☐ Useful Life
☐ Decommission Costs ☐ Other

Backward
End

Are you sure you want to Quit?
○ Yes
○ No

Enter

Figure 4 This is the last question the user will answer. He has a choice of finish running the program or to go back to change any answers in any of the questions.



2. Which measures do you use to prioritize and select the 'best' projects for implementation?

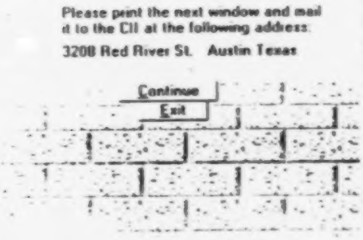
☐ Return on Investment ☐ Net Present Value
☐ Simple Payback ☐ Other
☐ Savings/Investment Ratio

Backward
Quit
Forward

Are you sure you want to quit?
○ Yes
○ No

Enter

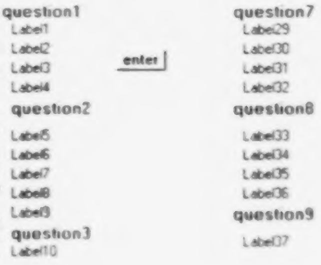
Figure 5 This is the 2nd multiple choice question that will appear if the user decides to choose 'No' for an answer in question 23.



Please print the next window and mail it to the CII at the following address:
3208 Red River St. Austin Texas

Continue
Exit

Figure 6 If the user chooses to finish the program, then he/she will see this figure with the 'Continue' command button. The 'Exit' button will appear only after he/she has printed or saved the final work.



question1
Label1
Label2
Label3
Label4
question2
Label5
Label6
Label7
Label8
Label9
question3
Label10
enter
question7
Label29
Label30
Label31
Label32
question8
Label33
Label34
Label35
Label36
question9
Label37

Figure 7 This screen will provide the user with a summary of the choices selected per question.

1109

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Proceedings — NCUR XI (1997)

Excessive Noise Levels Enhance
Special Effects, Are You Aware?

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Entertainment special effects has been greatly enhanced by audio technology. Increasing sound levels and frequencies without a loss of clarity is now an effective tool for evoking audience response. Although the public may be aware of the hazards associated with power equipment and firearms, it rarely considers music or multi-media events as potentially hazardous. A recently released action film containing special effects with excessive noise levels was selected for investigation. Sixty-four percent of the variation approval rating could be explained by noise level. Although 70% of the subjects could recall specific scenes containing excessive levels, only 34% could recall quiet scenes. Appeal may be associated with the basic "flight or fight" instinct, thus audiences may accept excessive noise levels in an entertainment environment that otherwise might be unacceptable.

INTRODUCTION

Since the public is frequently unaware of hearing damage until it is acute, hazardous noise levels associated with leisure activities is of growing concern. Although the public may be aware of the risks associated with power equipment, concerts and firearms, it does not consider activities associated with amusement parks, such as simulation, or theater multi-media presentation as potentially hazardous. Previous investigations by Brown and Yearout [1991] and Gray, Swaby and Schulze [1995] showed that, with the exception of rock concerts, participants give very little thought to excessive leisure noise level exposure. These observations included professionals who were fully aware of the risks associated extended exposure but elected not to alter their behavior.

Meloni and Kruger [1996] found that the annoyance of impulsive noise stemming from machine gun fire, was less than the annoyance of automatic cannon shots at a military training range. Subjects were exposed to both machine gun and cannon fire simulations in a home setting. Higher disapproval of the cannon volleys can be attributed to the type of environment relative to the expected noise tolerance. In the home, subjects do not accept the unexpected annoying sound of either weapon. This study illustrates a lower approval rating and less tolerance for the annoying noise if it is foreign to the environment. Bubb [1996] demonstrated recall and response effects in relationship to expected noise levels. Subjects responded to noise levels associated with a given task. Perceived acceleration of an automobile's motor and noise level of the motor were directly related. Brown and Yearout [1991] illustrated that loudness equates to perceived power. This phenomena appears to be just as prevalent in film and amusement park activities such as racing simulation.

Misconceptions or lack of awareness concerning hearing loss risk creates an ethical issue for producers and promoters who are aware of the hazard. Producers and promoters should ensure that noise level data for popular amusement activities are obtained. This management responsibility also should include disclosure of not only the noise levels of an activity, but it's associated risk as well.

EXPERIMENTAL PROTOCOL

Introduction. This paper focuses on whether or not a subject's recall and response to a multi-media event, specifically film, has a relationship with excessive and or unacceptable noise levels. Also examined was the ability of the subject to discern a specific event's noise level. Several recently released films were monitored. Of the potential candidates, films that contained special effects and excessive noise levels (dBA) greater than

SLOW MAX(105), PEAK(115) and 3 dB SEL(115), a recently released science fiction action film was selected. This film when viewed at a local sound enhanced theater registered the following noise levels: SLOW MAX (109 dBA), PEAK (120 dBA) and 3dB SEL (119 dBA). The film then was observed to locate several scenes that contained significant noise and scenes that contained noise levels that were within the acceptable range. Data collected by using a specially designed multi-item semantic differential scales.

Subjects. Sixty-five volunteer subjects (27 male, 38 female) were recruited from the University community. These were randomly assigned (based upon individual schedules) into four groups. Subjects' median age was between 20 to 25 years.

Laboratory. UNCA's multi-media classroom was chosen for the experiment. Although the noise levels could not exactly duplicate those of a typical theater, this high technology classroom had the capability to control noise levels within +/- 2 dBA. Speakers and screens were positioned to simulate an environment that was quite comparable to a contemporary multi-theater complex auditorium.

Experimental Design. The four selected groups were then randomly assigned to one of the following two conditions, loud (PEAK dBA > 100 dBA) and not loud (PEAK dBA < 90 dBA). Average exposure time was 2.3 hours. Immediately after the conclusion of the film, subjects were administered the semantic differential scale survey.

RESULTS

Analytical techniques. To insure that the data was homogeneous, Levine's Test for Homogeneity of Variances was performed at the 0.05 significance level. When conditions for normality were met, Analysis of Variances (Type III Sums of Squares) and Least Significance Differences (LSD) Tests were applied. Where data was determined to be non-parametric, Satterthwaite's Approximation with Bonferroni's Adjustment were used in lieu of the Analysis of Variances [Johnson and Milliken, 1984]. Frequency tables were applied to determine significant variables for potential correlations. Once a variable was determined to be significant, further analysis which included correlation, General Linear Model (GLM) and regression analysis procedures were applied where appropriate.

Results. Preliminary analysis determined that there were no significant interrelationships between the two "loud" groups and the two "not loud" groups. Thus the investigator was permitted to pool the four groups into two groups, "loud" and "not loud". Significant statistics for pooled data groups are in Table 1.

Table 1. Pooled Data for Significant Variables/Conditions

Loud Group (sample size = 30)			Not Loud Group (sample size = 35)		
Variable	Mean or Rating	sd	Variable	Mean or Rating	sd
PEAK	114 dBA	12	PEAK	87 dBA	3
SMAX	104 dBA	10	SMAX	80 dBA	3
3 db SEL	123 dBA	4	3 db SEL	110 dBA	4

Other Variables/Perceptions	Other Variables/Perceptions
Film Approval Rating: 88% on a 100% scale	Film Approval Rating: 69% on a 100% scale
Median Perceived Noise Level: 105-110 dBA	Median Perceived Noise Level: 85-90 dBA

ANALYSIS

General. There were no significant age or gender effects. The two group means for all selected variables were statically significantly different at the 0.05 significance level. Variables of interest to the research question are addressed the following sub-paragraphs.

Recall. Subjects were queried to identify the loudest scene, next loudest scene and third loudest scene in the film. Seventy-seven percent of the subjects identified the previously selected scenes in order of loudness (Figure 1). When subjects were asked to identify quiet scenes, 34% could not recall any scene as being quiet. Of those that could recall a quiet event, no more than 6% identified the same scene. One specific scene that combined excessive noise with surprise was recalled by over 90% of the subjects. Though this scene was not the film's loudest, it does typify the effective use of technology to evoke response through visual and audio stimulation.

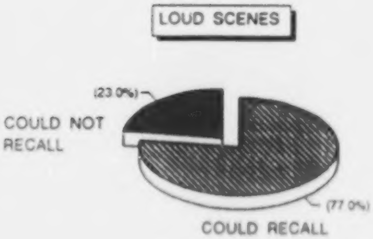

Figure 1 Film Recall Relationship with Noise Level

Slow Maximum (LSMAX) Levels. Permissable noise exposures by OSHA maintain that a sound level slow response of 105 dBA should not exceed one hour in the workplace on any given day If sound levels exceed the established exposure limits, OSHA requires the employer to either reduce noise levels or provide personal protection equipment to employees [Gray, Swaby, & Schulze, 1996] Although Federal guidelines do not apply to noise exposure from leisure activities, one needs to realize that the loud group, whose noise level exposure slow max reached 104 dBA for 2.3 hours, is more than double allowable limits

Discomfort Perceived noise levels for the complete film were estimated by comfort/discomfort votes on a semantic differential scale much like the Borg Vote Scale may be used to estimate heart rate Votes for all responses are illustrated by percentage in Table 2 and Figure 2

Table 2 Estimate Film Noise Levels Based on Discomfort

vote (%)	(1)	(2)	(4)	(7)	(29)	(5)	(36)	(9)	(7)
	not loud		somewhat loud		loud		very loud		too loud
noise (dBA)	75		85		95		105		>115
discomfort	none		not noticeable		some discomfort		ears ringing		hurt my ears

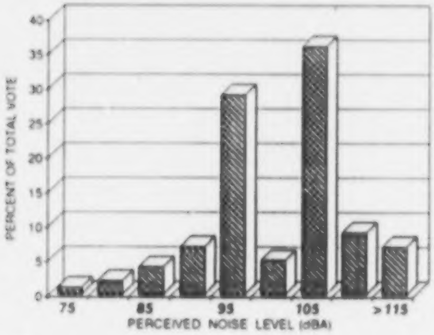

Figure 2 Discomfort Level Percentages

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Approval Ratings. There was a significant correlation (0.801) between film approval ratings and perceived noise level. A regression model, 0.01 significance level and multiple correlation coefficient of 0.64, will predict that 64% of the variation in the approval rating could be explained by perceived noise levels. Figure 3 illustrates this relationship between acceptance ratings and perceived noise levels.

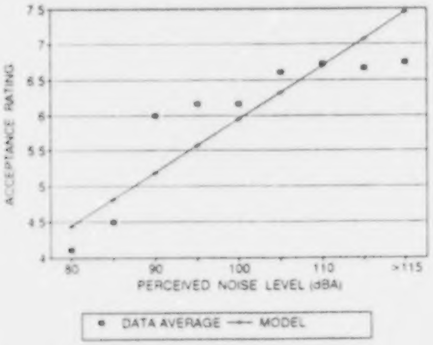

Figure 3. Film Approval Relationship with Noise Level

CONCLUSIONS AND RECOMMENDATIONS

Conclusion. Based upon this exploratory research, it appears that film producers may be taking advantage of current technology to enhance special effects through noise levels that would be unacceptable in the workplace. The louder the special effects, the higher the film rating may be a motivator for film producers to increase noise level. An example is the just released "Star Wars" trilogy that touts an enhanced sound experience. Although audiences are aware of the discomfort from excessive noise, this type of entertainment receives high acceptance. This appeal may be due to the basic "flight or fight" instinct, thus audiences accept these noise levels that under other circumstances might be unacceptable.

Recommendations. Currently, noise level warnings provided by film producers do not exist, and do not adequately explain the potential hazard of current sound technology through enhanced louder noise levels without significant distortion. Film producers should accept more responsibility in educating the public that excessive noise levels in films is hazardous. At the very minimum, films that exceed OSHA standards should include warning of the potential damage to hearing when exposed to loud volumes for extended periods of time. Furthermore, OSHA guidelines for noise exposures should be stated prior to the start of the film, and a statement of the noise level audiences can expect to experience in the film as well. An ideal goal for film producers to meet, ethically, involves a warning at the end of televised commercials for the film, and an opportunity prior to film viewing for patrons to either receive their money back if they choose not to risk hearing loss, or have access to personal protection equipment that the endorsing theater should provide at no additional cost.

REFERENCES

P. Brown and R. Yearout, Impacts of Leisure Activity Noise Levels on Safety Procedures and Policy in the Industrial Environment, International Journal of Industrial Ergonomics, Vol. 7, Elsevier Science Publishers, Amsterdam, (1991) 341-346

H. Bubb, Experiments to the Contradiction, Noise as Strain or Noise as Feedback, Advances in Occupational Ergonomics and Safety I, Vol. 2, International Society for Occupational Ergonomics and Safety, Cincinnati, (1996) 650-659

D. Gray, M. Swaby and L. Schulze, The Use of Personal Stereo Equipment (PSE) in the Professional Engineering Office Environment, Advances in Industrial Ergonomics and Safety VII, Tylor and Francis, London, (1995) 259-264

J. Howe and R. Yearout. Music Style, Age and gender Relationships to Preferred Noise Levels for Headset Cassette Players. Advances in Industrial Ergonomics and Safety IV. Taylor and Francis, London, (1992) 1335-1340.

I. Meloni and H. Krueger. Annoyance of Impulsive Noise Measured in the Laboratory. Advances in Occupational Ergonomics and Safety I, Vol. 2, International Society for Occupational Ergonomics and Safety, Cincinnati, (1996) 645-649

G. Milliken and D. Johnson. Analysis of Mess Data, Volume I: Designed Experiments. Lifetime Learning, 1984

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Surface Estimation Of Machined Parts

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ABSTRACT

Regression analysis is a highly useful tool in experimental designs which target a desired response from machining This design involves (1) the identification of key factors of a milling process, (2) the selection of a quantitative model relating these factors, and (3) an assessment of the model's accuracy in predicting the response This article presents a technique for estimating the surface of machined parts using computer programs for multiple linear regression analysis The goal is to develop response surfaces using mathematical models that (1) accurately predict the response of varying machining parameters and (2) are based on the most significant machining parameters By adjusting the key parameters to specific settings, a targeted response can be realized assuring the functionality of the machined part

INTRODUCTION

Improving safety, reliability, and service life have been the motivation behind research of surface conditions produced by various manufacturing methods Since these surface conditions ultimately affect component performance once in service, component cost and producibility are also affected The emphasis on quality assurance and product reliability increases the importance of recognizing the impact that manufacturing processes have on material properties (Machine Data Center's Handbook, 1983)

Component reliability, therefore, represents the driving force behind this research The ability to predict the surface effects ultimately enables designers to predict component performance As can be seen from the Figure 1 below, the surface effects play a pivotal role in overall component reliability

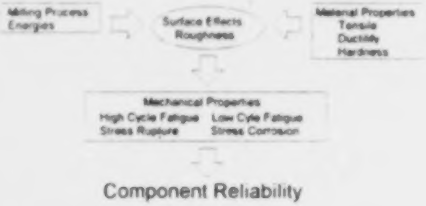


Figure 1 Interaction of processes with materials Machining Data Center's Handbook (1983)

This paper presents a mathematical model for the surface finish generated on steel specimens Data was collected using the Mitutoyo Surftest 402 series 178, utilizing stylus model 178-319 The model's ability to account for changes in the operating conditions while maintaining its success as a prognostic tool is the ultimate goal in the attempt made to model the machining method This test was used to measure and compute roughness average (Ra) values which represent the response variable used in developing the mathematical model

Current work in response surface modeling One of the most significant contributions to statistical methodology in recent years has been the development of systematic procedures for determining, experimentally, those levels of the factors under investigation which produce an optimum response (Ziesel, 1985) Response surface modeling has been successfully applied to many areas of research Surface modeling has been effectively applied to the development of a mathematical model for cutting forces in end milling Inconel 718 (Aluaddin, El Baradie, and Hashmi, 1996) Their model, which was developed in terms of cutting speed and axial depth of cut, was subjected to ANOVA test and was found to be adequate. Khun and Andre (1996) describe a procedure for establishing operating conditions that result in a predicted response close to some target value. The authors included are actively paving the way in response surface modeling and discovering their usefulness as prognostic tools.

Previous work in regression modeling. The diversity and effectiveness of regression modeling has made it widely applicable to many environments. Fields such as crop forecasting, analysis of supply and demand, the study of consumption, market analysis, all have been noble areas for the application of the techniques of regression (Griffin, 1962). Regression analysis is a powerful tool when used for the purpose of predicting (Ziesel, 1995). Regression analysis has been applied in the analysis of the temperature distribution of two dimensional surface buoyant jets (Subramanyan *et al.*, 1995). In addition, these researchers stress the importance of supplementing mathematical models by laboratory and field experiments in order to improve the model's predictive capabilities. In this manner, causal inferences can be made about the effect of certain variables since data comes from experiments (Ziesel, 1995).

Summary of literature in response surface and regression modeling. It is evident that regression modeling is complimentary to response surface modeling since the former stands as a powerful tool in the effectiveness of the latter. Unfortunately, the application of a flexible model able to explain diverse milling situations is as of yet nonexistent. This is largely due to the extreme unique nature of individual machining methods. Experimentally obtained constants can vary widely from one milling situation to another, which in turn, significantly restricts their usefulness as predictive tools for process design (Kulkarni, Chandra, and Jaddale, 1996). However, it is quite evident that if a flexible model is to someday be achieved, it will culminate only as a result of observing and understanding individual phenomenon compiled from the uniqueness amassed from a variety of machining situations. In this light, continued research in the area is well justified and encouraged.

RESEARCH GOAL

The goal is to develop response surfaces using mathematical models that (1) accurately predict the response of varying machining parameters and (2) are based on the most significant machining parameters. By adjusting the key parameters to specific settings, a targeted response can be realized assuring the functionality of the machined part.

The steel specimens were machined according to the parameters illustrated in Figure 2.

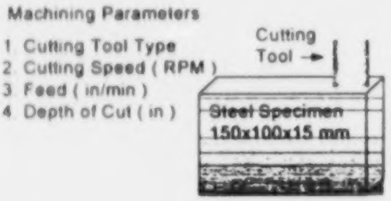


Figure 2. Machining Parameters

Figure 3 below illustrates the manner in which the data was collected and categorized.

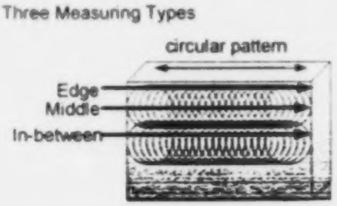


Figure 3. Measuring Types

The circular pattern generated was then tested for uniformity of the response variable, the roughness average.

In order to model the Ra as a function of the key factors affecting the surface, collected Ra values were initially plotted from a single face and visual analysis of the data hinted at a trend as illustrated below in Figure 4

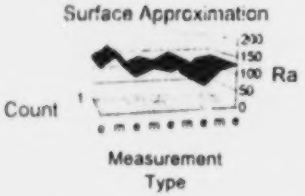


Figure 4 Surface Approximation

From a practical perspective, E measurements were expected to be smoother since the edge of the circular pattern is where an overlap existed between subsequent runs of the cutting tool After conducting an ANOVA of the E and M measuring types, an experimental F value of 9.1 was realized over an expected F value of 9.02., providing evidence that the means of the two measuring types are significantly different Furthermore, a Duncan Multiple Range test at an alpha level of .05 categorized the measurements as being significantly different

Since the trend in Ra values was due to the effect of the cutting tool, face comparisons were achieved by the introduction of blocking By adhering to consistency in the arbitrary selection and use of a single measurement type, Ra variability was effectively diminished

THREE FACTOR FIXED EFFECTS MODEL

This design was developed to study the effects of the three varying factors as shown below in Figure 5 It is well known however, that the cutting forces which are directly related with surface roughness, can generally be considered independent of cutting speeds within practical speed ranges (Reid, 1991)

Test#2 Three Factor Fixed Effects Model

3 Control Variables

Cutting Tool Type (A)	Depth of Cut (B)	Tool Speed (C)
- 1/2" Endmill	- .001"	- High
- 1" Endmill	- .005"	- Low
- 2.94 Side Cutter		

Response Variable Ra

Figure 5 Fixed Effects Model

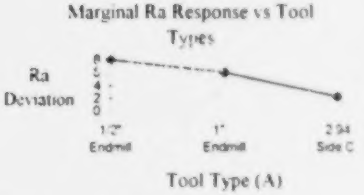
While different cutting tools require different low and high settings, the low and high cutting speed levels were held constant for individual cutting tools In an effort to simplify the calculations necessary, the data presented in Table 1 was coded by dividing through by the smallest Ra value

Table 1 ANOVA of 3 Factor Fixed Effects Model

Analysis of Variance for the 3-Factor Fixed Effects Model

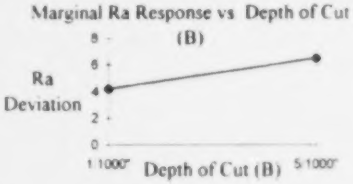
Sources of Variation	Sum of Squares	DF	Mean Square	Fo
Tool Type (A)	136.173	2	68.087	**324222.4**
D. of Cut (B)	31.97	1	31.97	**15223.81**
Tool-Spd. (C)	0.4	1	0.4	190.476
Error	0.0246	12	0.0021	
Total	172.446	23		

~~To assist in the practical~~ interpretation of this experiment, the next figures present plots of the three main effects



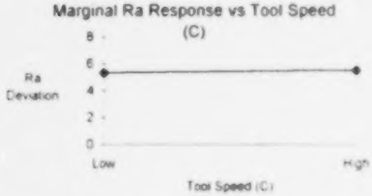
Graph 1 Marginal Ra Response vs Tool Types

From Graph 1, the marginal Ra response due to the tool type used was very significant as supported by the analysis of variance Different tool types yield distinctively different Ra values



Graph 2 Marginal Ra Response vs Depth of Cut

From Graph 2, the marginal Ra deviation increased slighlty as factor B increased This is readily expected since more frictional forces are involved with an increased depth, thus, yielding increased Ra values



Graph 3 Marginal Ra Response vs Tool Speed

The marginal Ra response is relatively unaffected by local changes in tool speed as illustrated in Graph 3 above

Since factor A was overwhelmingly significant, the cutting tool stands as the most important factor yielding the corresponding Ra values Therefore, separate response curves are needed for each tool type In addition, 20 or more observations are recommended so that residual analysis may be done more effectively

REGRESSION ANALYSIS AND EQUATIONS INVOLVED

Due to the fact that this research is on-going and dependent on future experimentation, a run through is provided for the analysis of the data to be attained In addition, most research is of the continuing variety and therefore, sequential (Ostle, 1964)

A multiple regression model was fitted to the ½" Endmill data The final regression model was

$$\hat{y} = 198.775 + 105(x_1 - 200) + 16187.5(x_2 - 003) + e \tag{1}$$

CONCLUSION

In this research, a technique has been illustrated for the development of response curves for a milling operation The cutting tool was determined to be the most significant factor affecting the surface roughness resulting from a milling operation Speed and feed were shown to be secondary factors that affect the surface roughness This was verified and confirmed by conducting an analysis of variance of the roughness data The preliminary research also shows that their exist a linear relationship between the speed and feed in a milling operation By conducting more experiments at different settings of speed and depth of cut, a response surface may be achieved by the illustrated method In addition, the response curve will be fitted using the method of Least Squares, confidence and prediction interval planes constructed, and the model will be tested for lack of fit using the F-ratio

While it is understood that cutting tools represent the single most important factor affecting surface roughness, it should be noted that metals of the same type will not always behave in the same manner when subjected to machining While metals may quite often be of the same type, the microstructures may vary immensely among similar metals, this in turn has enormous effects on the physical properties of the material (Reid, 1991) These consideration have not been addressed which in all likelihood play an important role in component performance

ACKNOWLEDGEMENTS

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REFERENCES

Aluaddin, El Baradie, Hashmi "Modelling of cutting force in end milling Inconel 718", Journal of Materials Processing Technology, Vol 50, 1996, pp 100-108

ANSI/ASME B46 1 - 1985 Surface Texture (Surface Roughness, Waviness, and Lay), The American Society of Mechanical Engineers, pg 18

Griffin, John I Statistics Methods and Applications, Holt, Rinebart, and Winston New York 1962, 223—224, 228

Khuri, Andre I , "Response surface models with mixed effects", Journal of Quality Control, Vol 28 (1996) University of Florida, Gainsville FL pp 177-186

Kulkarni, Chandra, Jagdale, "Dynamic model for end milling using single point cutting theory", Journal of Manufacturing Science and Engineering, Vol 118, May 1996, pp 272-274

Machinability Data Center Machining Data Center's Handbook, 3rd ed , Metcet Research Associates Inc 1983, pg 18-4

Maier, Mark H The Data Game, M E Sharpe Inc Armonk, New York 1995, pg 239

Montgomery, Douglas C Design of Experiments, 3rd ed , John Wiley & Sons New York 1991

Ostle, Bernard Statistics in Research, 2nd ed , Iowa State University Press Ames, IA 1964, 159—160, 424—425

Reid, David T Fundamentals of Tool Type, 3rd ed , Society of Metallurgical Engineers , 1991

Subramanyan, Sivanandam, Rudramoorthy, "Linear regression model for temperature distribution of two dimensional surface buoyant jets ", Modeling, Measurement, and Control 1996, pp 31-41

Zeisel, Hans Say it with Figures, 6th ed , Harper and Row, Publishers Inc New York 1985, 137

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The Use of the GRAFCET Approach to Automation of PLC Programming & Control

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GRAFCET is a high-level graphics-based programming language which uses the Sequential Function Charts (SFC) concept and the top-down design approach to develop the control algorithm for high-end PLCs. In this project an integrated control program development software package named CADEPA (developed by Famic) was utilized. CADEPA can be used to write control programs for PLCs in the GRAFCET language, translate the control programs into executable code for various PLCs, and generate fully documented reports including ladder logic diagrams. In a preliminary study, computer simulation was performed to test the feasibility of the GRAFCET approach to PLC programming. In this phase two study, a local waste water treatment plant is simulated to investigate the suitability of this approach to more complex applications. Experimental study is performed by using an IBM-compatible 486-DX PC and Modicon 984 Compact Programmable Controller.

INTRODUCTION

Programmable Logic Controllers (PLC) are widely used for industrial processes. In general, the hardware includes: a central processing unit (CPU), digital and analog I/O modules, and program recorder/memory for data and program storage. PLCs can carry out different types of control functions at various levels of complexity. Size and memory requirements are contingent upon the scale of the operation. Several PLCs, controlled by a centralized computer, may be used for large processes. Because it is more durable than the PC, the PLC fits well in industrial environments where noise, dust, vibration, and heat are prevalent.

Traditionally, PLC programming has been done using ladder logic. However, with more elaborate processes, ladder logic becomes lengthy and cumbersome. GRAFCET is a high-level graphics-based language that can be utilized to write control programs. GRAFCET uses the Sequential Function Charts (SFC) concept and the top-down design approach to develop the control algorithm, which is "controller independent", for high-end PLCs (How to Use GRAFCET Part I, p. 47). To write control programs for PLCs in the GRAFCET language, an integrated control program development environment named CADEPA (developed by Famic) is used. In addition, it can translate the control programs into executable code for various PLCs and generate fully documented reports including ladder logic diagrams.

The purpose of this study is to use the CADEPA control program development package to evaluate the feasibility and compatibility of the GRAFCET approach to PLC programming. By using this approach, we hope to shorten the control programming process.

METHODOLOGY

The basic GRAFCET GRAPH consists of two graphic elements: "steps" and "transitions". Steps are units which represent physical operations. When a step is activated, the controller performs the action associated with that step. Transitions are conditions which are evaluated to make decisions on whether to activate or deactivate the next step. A transition always link two steps (How to Use GRAFCET Part 1, p.12). As shown in Figure 1, an "application" combines all GRAPHs that make up the complete control process. Similar to subroutines, GRAPHs can also be shared with other applications.

Rules, referred to as the GRAFCET evolution, define how the GRAPH elements follow their sequence (CADEPA, Vol. I, 1986, A-17). They can be summarized as:

Initial steps are unconditionally activated when the program is started or reinitialized;

1) A transition is armed when the preceding step is activated. When the associated condition becomes true, the transition is fired;
2) When a transition is fired, the previous step is deactivated and the step following is activated;
3) More than one transition can be fired simultaneously when the "AND" element is used in a GRAPH.

Once all GRAPHs are created and analyzed separately for syntax errors, the GRAPHs needed are selected to create the application. Now, the GRAPHs must be translated into ladder logic before they can be used on a PLC. PLC hardware configuration, I/O assignments and memory mapping are essential steps in translation. The PLC configurator is utilized to specify the number and type of I/Os, registers and communication ports. Mnemonics are assigned to steps, transitions, I/O and internal variables used in a GRAPH. A specific memory address in the PLC is allocated for each of these mnemonics. Memory mapping defines and partitions the memory for variables used in the program. The CADEPA on-line mode is used to generate the ladder logic and download it to the target PLC where switches and indicators are used to simulate inputs and outputs of the control process. The control process can now be monitored via PLC and personal computer.

In a preliminary study, a simple control system for water neutralization (Figure 2) was successfully programmed in GRAFCET and simulated using an IBM compatible 486-DX2 and Modicon 984 PLC. Our target PLC had 4 kilobytes of memory and used MODBUS communication. In the control system simulated, a sensor is activated in the first basin and pH is tested. A certain amount of acid or base is added depending on the pH value. The mixture is agitated then emptied into a second basin if the pH is between 6 and 8. The water is left for settling before being pumped out. In the GRAPH, the pH sensor is represented by a step. Conditions used in the pH test are represented by a transition. Ten steps and ten transitions were used in the GRAPH to program the water neutralization control system.

In the second phase, a local waste water treatment facility as shown in Figure 3, was the object of our simulation study to investigate the suitability of this approach to more complex processes. This CADEPA "application" contains three GRAPHs: a main program, a pH control sub-program and a clarification sub-program. The main program, which is shown in Figure 4, contains six steps and five transitions. A total of 24 steps (actions), 23 transitions (conditions), and nine variables were used to simulate the actual process. Memory was partitioned for timers, I/O variables, logical and numerical variables, steps, and transitions. During actual simulation of the programs, we traced the operation via computer to locate errors in the CADEPA application and correct them.

CONCLUSION

From our initial study, we concluded GRAFCET programs were easy to write and modify. In phase two, we verified that GRAFCET programs can be successfully used to control complex continuous processes. An emergency sequence should be added to complete the process control. For future study, we recommend the use of the CADEPA for hydraulic and pneumatic applications. Furthermore, study can be done on the efficiency of the ladder logic generated by CADEPA versus conventional ladder logic.

REFERENCES

Bateson, Robert N. Introduction to Control System Technology. (1989). Ohio: Merrill Publishing Company.

CADEPA Volume I. (1993). Quebec: Famic.

Diebold, John. Automation. (1983). New York: Amacon.

Dorf, Richard C. Modern Control Systems. (1992). Massachusetts: Addison- Wesley.
Hale, Francis J. Introduction to Control System Analysis and Design. (1988). New Jersey: Prentice Hall.
How to GRAFCET (SFC) for Industrial Control. (1993). Quebec: Famic.
Ogata, Katsuhiko. Modern Control Engineering. (1990). New Jersey: Prentice Hall.
Webb, John W. Programmable Logic Controllers. (1988). New York: Merrill.

APPENDIX

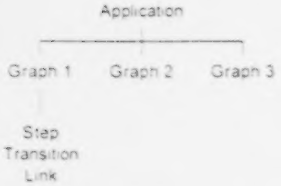
Application
Graph 1
Graph 2
Graph 3
Step
Transition
Link

Figure 1: CADEPA Application

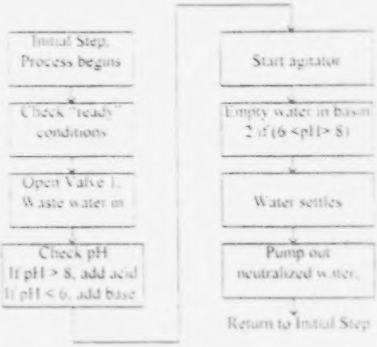
Initial Step, Process begins
Check "ready" conditions
Open Valve 1, Waste water in
Check pH
If pH > 8, add acid
If pH < 6, add base
Start agitator
Empty water in basin 2 if (6 <pH> 8)
Water settles
Pump out neutralized water,
Return to Initial Step

Figure 2: Water Neutralization Process

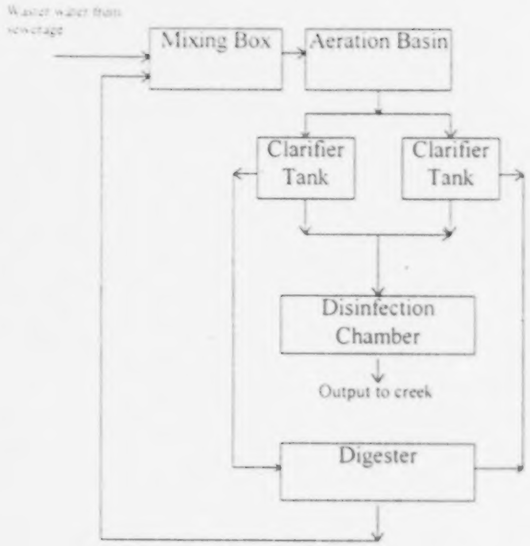
Waste water from sewerage
Mixing Box
Aeration Basin
Clarifier Tank
Clarifier Tank
Disinfection Chamber
Output to creek
Digester

Figure 3: Waste Water Treatment Process

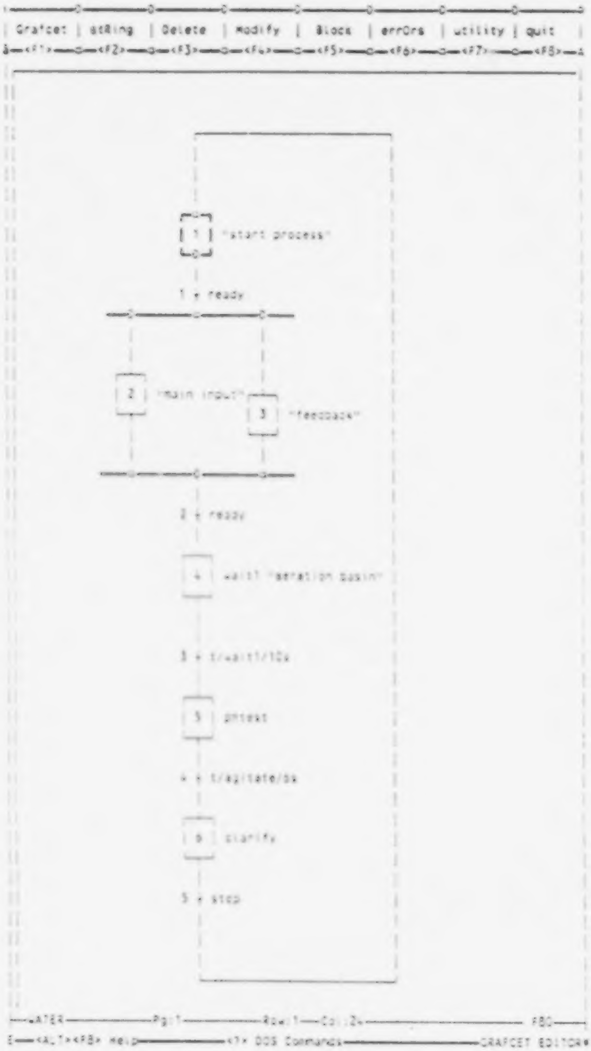
Grafcet
stRing
Delete
modify
Block
errOrs
utility
quit
<F1>
<F2>
<F3>
<F4>
<F5>
<F6>
<F7>
<F8>
1
"start process"
1 + ready
2
"main input"
3
"feedback"
2 + ready
4
wait1 "aeration basin"
3 + t/wait1/10s
5
phtest
4 + t/agitate/5s
6
clarify
5 + stop
WATER
Pg:1
Row:1
Col:2
F80
<ALT><F8> Help
<?> DOS Commands
GRAFCET EDITOR

Figure 4: GRAFCET Program of Waste Water Treatment Process

Counting Arrangements of 2's and -1's

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INTRODUCTION

In this paper, we discuss our findings concerning the number of sequences with non-negative partial sums that can be formed from n 2's and k -1's. In particular, we give a recursive formula for computing the number of such sequences. We also derive a closed formula for the number of such sequences with $k = 2n$ and present some other findings for $2 \le k < 2n$.
Since these numbers which count our sequences can be evaluated in a manner similar to that of binomial coefficients, we will use a symbolism similar to that which is standard notation for the binomial coefficients.

Definition. Let $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$ denote the number of arrangements $a_1 a_2 \ldots a_{n+k}$ of n 2's and k -1's so that $a_1 + a_2 + \cdots + a_i \ge 0$ for all $1 \le i \le n+k$.
Example. Let us count the number of sequences with non-negative partial sums which can be formed from two 2's and four -1's. Clearly, we must begin with a 2. It is also clear that this initial 2 can be followed by no more than 2 -1's. Thus, there are 3 possible arrangments as shown below, and $\left\{\begin{matrix} 2 \\ 4 \end{matrix}\right\} = 3$.
#1 --- 2 2 -1 -1 -1 -1
#2 --- 2 -1 2 -1 -1 -1
#3 --- 2 -1 -1 2 -1 -1

PRINCIPAL RESULTS

Theorem 1.
(i) $\left\{\begin{matrix} n \\ 0 \end{matrix}\right\} = 1$ for $n \ge 1$.

(ii) $\left\{\begin{matrix} n \\ 1 \end{matrix}\right\} = n$ for $n \ge 1$.

(iii) $\left\{\begin{matrix} n+1 \\ k \end{matrix}\right\} = \left\{\begin{matrix} n+1 \\ k-1 \end{matrix}\right\} + \left\{\begin{matrix} n \\ k \end{matrix}\right\}$ for $1 < k < 2n+1$.

(iv) $\left\{\begin{matrix} n+1 \\ 2n+2 \end{matrix}\right\} = \left\{\begin{matrix} n+1 \\ 2n+1 \end{matrix}\right\} = \left\{\begin{matrix} n+1 \\ 2n \end{matrix}\right\}$ for $n \ge 0$.

Proof. Statement (i) is obvious by inspection. For statement (ii), notice that an arrangement of n 2's and a single -1 will occupy $n+1$ positions. But by the definition of the sequence, the fist position cannot be occupied by the -1. Thus, there are n such arrangements.

For statement (iii), imagine an arrangement of $n+1$ 2's and k -1's with $2 \le k < 2n+1$. The last element (a_{n+k+1}) is either a 2 or a -1. If it is a 2, then the remaining positions are filled with n 2's and k -1's. Hence, these positions can be filled in $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$ ways. On the other hand, if the last element is a -1, then the remaining positions are filled with $n+1$ 2's and k-1 -1's. This can be done in $\left\{\begin{matrix} n+1 \\ k-1 \end{matrix}\right\}$ ways. Thus, statement (iii) is established.

To establish statement (iv), we need to consider an arrangement of $n+1$ 2's and $2n+2$ -1's. Note that the last two elements in the arrangement must be -1's. Indeed, if either of these elements is a 2, then since $a_1 + a_2 + \cdots + a_{3n+1} + a_{3n+2} + a_{3n+3} = 0$ it must be the case that $a_1 + a_2 + \cdots + a_{3n+1} < 0$ which is contrary to our requirement. Hence, the first $3n+1$ positions are filled with $n+1$ 2's and $2n$ -1's. Thus the assertion of statement (iv) is valid.

Using the results of Theroem 1 we can construct a pseudo-triangular array containing the numbers $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$ in somewhat the same manner as the Pascal triangle is constructed. In particular, the nth row and the kth column will contain $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$. Each row begins with a 1 in the 0th column by part (i) of Theorem 1. The next entry (column 1) in the nth row will be n for $n \geq 1$ by part (ii). After that, part (iii) says that an element is determined by adding the element directly to the left and directly above until there are no elements directly above. (That is until we reach the $(2n-1)$th column of row n.) The final two entries of the row are obtained, by part (iv), by repeating the element immediately to the left.

Table 1: An Array Through Row 5

k=	0	1	2	3	4	5	6	7	8	9	10
n=1	1	1	1								
n=2	1	2	3	3	3						
n=3	1	3	6	9	12	12	12				
n=4	1	4	10	19	31	43	55	55	55		
n=5	1	5	15	34	65	108	163	218	273	273	273

We would like to produce a closed form for $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$ but have been able to do so only in certain special cases. One interesting case is $k=2n$. First, we need a preliminary definition and result.

Definition: A ternary tree is a finite set of elements that is either empty or partitioned into four disjoint subsets. The first subset is called the root, and the other three subsets are the left, middle, and right subtrees of the original tree. A left, middle, or right subtree can be empty. Each element of the ternary tree is called a node of the tree. [3]

It has been determined [2] that the number of different ternary trees that can be formed from n nodes is

$$\frac{1}{2n+1}\binom{3n}{n}. \tag{1}$$

Theorem 2.

There is a one-to-one correspondence between the sequences of n 2's and $2n$ -1's with non-negative partial sums and the ternary trees that can be constructed with n nodes. Thus,

$$\left\{\begin{matrix} n \\ 2n \end{matrix}\right\} = \frac{1}{2n+1}\binom{3n}{n}. \tag{2}$$

Proof. Before we begin to establish this correspondence, we need to expand a bit on the definition above. A ternary tree is constructed of nodes. There must always be at least one node, the root node. Each node can have at most three children but may have 0, 1, or 2. We let the nodes represent the positioning of the 2's in the sequence of 2's and -1's. That is, every non-empty node will represent a 2 and every empty node position will represent a -1. To translate from a ternary tree to a sequence, we start at the root node which represents a 2. Then we go to the next level. We read across the level from left to right. For every position possible stemming from the nodes in the previous level, there is either a node or an empty position. If there is a node in the position, we translate that to a 2; if the position is empty, we translate that to a -1. We read across the entire level before going to the next level. Once all the 2's have been accounted for (we have translated all the non-empty nodes), we add as many -1's as necessary to fill the sequence.

Now we translate from a sequence to a ternary tree as follows. We know that the first number in our sequence must be a 2 and this represents the root node of the ternary tree. Each node can have up to 3 child nodes. If the next number in the sequence is a 2, we put a node in the next child node position. Otherwise, we put an empty node in the next child node position. This continues across each level completely from left to right across all possible child nodes at that level before progressing to the next level. By constructing the ternary tree in this fashion until we run out of 2's in the sequence, we arrive at a ternary tree that is uniquely determined by the sequence.

As an example, let us consider $n=2$. We can see from the Table 1, that $\left\{\begin{matrix} 2 \\ 4 \end{matrix}\right\}=3$. The three results are presented in Figure 1.

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All Ternary Trees with 2 Nodes

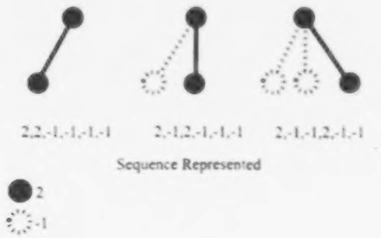

Figure 1

Here are some other examples of ternary trees and the corresponding sequences:

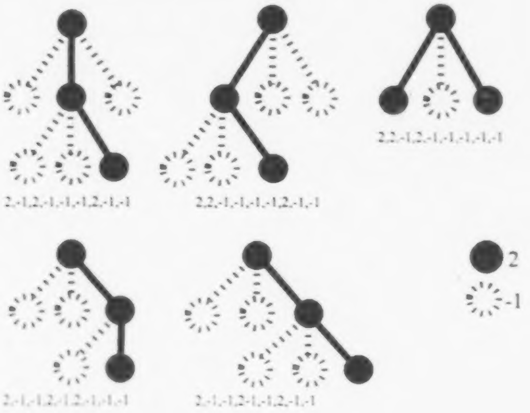

Figure 2

OBSERVATIONS
While we did not succeed in finding a closed form for $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$, we did make some interesting observations and derivations.

Lemma 1.

$$\left\{\begin{matrix} n \\ k \end{matrix}\right\} = \sum_{m=\left\lceil \frac{(k+1)}{2} \right\rceil}^{n} \left\{\begin{matrix} m \\ k-1 \end{matrix}\right\}. \qquad (3)$$

Proof. We will prove this lemma by induction on n.
Case 1: Suppose $k=2t+1$. Then the smallest value of n for which $\left\{\begin{matrix} n \\ k \end{matrix}\right\}$ is defined is $n=t+1$. Thus, our assertion is $\left\{\begin{matrix} t+1 \\ 2t+1 \end{matrix}\right\} = \sum_{m=\left\lceil \frac{(2t+2)}{2} \right\rceil}^{t+1} \left\{\begin{matrix} m \\ 2t \end{matrix}\right\}$. But this is simply $\left\{\begin{matrix} t+1 \\ 2t+1 \end{matrix}\right\} = \left\{\begin{matrix} t+1 \\ 2t \end{matrix}\right\}$ which we know to be true. So assume the result for some fixed $n>t+1$ and consider

$$\left\{\begin{matrix} n+1 \\ 2t+1 \end{matrix}\right\} = \left\{\begin{matrix} n+1 \\ 2t \end{matrix}\right\} + \left\{\begin{matrix} n \\ 2t+1 \end{matrix}\right\} = \left\{\begin{matrix} n+1 \\ 2t \end{matrix}\right\} + \sum_{m=\left\lceil \frac{(2t+2)}{2} \right\rceil}^{n} \left\{\begin{matrix} m \\ 2t \end{matrix}\right\} = \sum_{m=\left\lceil \frac{(2t+2)}{2} \right\rceil}^{n+1} \left\{\begin{matrix} m \\ 2t \end{matrix}\right\}.$$

Thus, the inductive step is complete and the result established.
Case 2: If $k=2t$, the argument is similar, and we do not present the details here.

For example, $\left\{{9 \atop 5}\right\}$ is the sum of all the terms in column 4 in rows 3 through 9.

Table 2: Lemma 1 Results

$$\left\{{n \atop 1}\right\} = \binom{n}{1}$$

$$\left\{{n \atop 2}\right\} = \binom{n+1}{2}$$

$$\left\{{n \atop 3}\right\} = \binom{n+2}{3} - \binom{n}{0}$$

$$\left\{{n \atop 4}\right\} = \binom{n+3}{4} - \binom{n}{1}$$

$$\left\{{n \atop 5}\right\} = \binom{n+4}{5} - \binom{n+1}{2} - 3\binom{n}{0}$$

$$\left\{{n \atop 6}\right\} = \binom{n+5}{6} - \binom{n+2}{3} - 3\binom{n}{1} + 3\binom{n}{0}$$

$$\left\{{n \atop 7}\right\} = \binom{n+6}{7} - \binom{n+3}{4} - 3\binom{n+1}{2} + 3\binom{n}{1} - 12\binom{n}{0}$$

$$\left\{{n \atop 8}\right\} = \binom{n+7}{8} - \binom{n+4}{5} - 3\binom{n+2}{3} + 3\binom{n+1}{2} - 12\binom{n}{1} + 24\binom{n}{0}$$

$$\left\{{n \atop 9}\right\} = \binom{n+8}{9} - \binom{n+5}{6} - 3\binom{n+3}{4} + 3\binom{n+2}{3} - 12\binom{n+1}{2} + 24\binom{n}{1} - 67\binom{n}{0}$$

$$\left\{{n \atop 10}\right\} = \binom{n+9}{10} - \binom{n+6}{7} - 3\binom{n+4}{5} + 3\binom{n+3}{4} - 12\binom{n+2}{3} + 24\binom{n+1}{2} - 67\binom{n}{1} + 165\binom{n}{0}$$

$$\left\{{n \atop 11}\right\} = \binom{n+10}{11} - \binom{n+7}{8} - 3\binom{n+5}{6} + 3\binom{n+4}{5} - 12\binom{n+3}{4} + 24\binom{n+2}{3} - 67\binom{n+1}{2} + 165\binom{n}{1} - 438\binom{n}{0}$$

$$\left\{{n \atop 12}\right\} = \binom{n+11}{12} - \binom{n+8}{9} - 3\binom{n+6}{7} + 3\binom{n+5}{6} - 12\binom{n+4}{5} + 24\binom{n+3}{4} - 67\binom{n+2}{3} + 165\binom{n+1}{2} - 438n + 1147$$

As an example of these derivations, let us derive the formula above for $\left\{{n \atop 3}\right\}$:

$$\left\{{n \atop 3}\right\} = \sum_{k=1}^{n} \left\{{k \atop 2}\right\} = \sum_{k=1}^{n} \frac{k(k+1)}{2} = \frac{1}{2}\sum_{k=2}^{n} (k^2+k) = \frac{1}{2}\left[\sum_{k=1}^{n} (k^2+k) - 2\right] = \tag{4}$$

$$\frac{1}{2}\left[\frac{n(n+1)(2n+1)}{6} + \frac{n(n+1)}{2} - 2\right] = \frac{n(n+1)(n+2)}{6} - 1 = \binom{n+2}{3} - \binom{n}{0}$$

It is clear that there is a great deal of structure in the arrary above. One immediately sees that

$$\left\{{n \atop k}\right\} = \binom{n+k-1}{k} - \binom{n+k-4}{k-3} + \sum_{i=1}^{k-3} a_i \binom{n+k-4-i}{k-3-i} \tag{5}$$

It is also clear that the sequence of a's begins -3,3,-12,24,-67,165,-438,1147,...
What is not clear is how one generates this sequence of a's.

FURTHER OBSERVATIONS

We know each of the diagonal entries, and we know that each entry is the difference of the term immediately to the right and the term immediately above and to the right. This observation can be used to compute $\left\{{n \atop k}\right\}$ in several special cases. In particular, we have:

Table 3: Some Results

$$\left\{ {n \atop 2n} \right\} = \left\{ {n \atop 2n-1} \right\} = \left\{ {n \atop 2n-2} \right\} = \frac{1}{2n+1}\binom{3n}{n}$$

$$\left\{ {n \atop 2n-3} \right\} = \binom{3n-3}{n-1}\frac{23n^2-29n+6}{(2n+1)(2n)(2n-1)}$$

$$\left\{ {n \atop 2n-4} \right\} = \binom{3n-3}{n-1}\frac{19n^2-31n+6}{(2n+1)(2n)(2n-1)}$$

$$\left\{ {n \atop 2n-5} \right\} = \binom{3n-3}{n-1}\frac{15n^2-33n+6}{(2n+1)(2n)(2n-1)}$$

$$\left\{ {n \atop 2n-6} \right\} = \binom{3n-6}{n-2}\frac{313n^4-1852n^3+3653n^2-2582n+360}{(2n+1)(2n)(2n-1)(2n-2)(2n-3)}$$

$$\left\{ {n \atop 2n-7} \right\} = \binom{3n-6}{n-2}\frac{237n^4-1614n^3+3567n^2-2694n+360}{(2n+1)(2n)(2n-1)(2n-2)(2n-3)}$$

$$\left\{ {n \atop 2n-8} \right\} = \binom{3n-6}{n-2}\frac{177n^4-1392n^3+3477n^2-2802n+360}{(2n+1)(2n)(2n-1)(2n-2)(2n-3)}$$

As an example of these derivations, let us derive the formula above for $\left\{ {n \atop 2n-3} \right\}$:

$$\left\{ {n \atop 2n-3} \right\} = \left\{ {n \atop 2n-2} \right\} - \left\{ {n-1 \atop 2n-2} \right\} = \left\{ {n \atop 2n} \right\} - \left\{ {n-1 \atop 2n-2} \right\} = \frac{1}{2n+1}\binom{3n}{n} - \frac{1}{2n-1}\binom{3(n-1)}{n-1} =$$

$$\frac{1}{2n+1}\frac{(3n)!}{n!(2n)!} - \frac{1}{2n-1}\frac{(3n-3)!}{(n-1)!(2n-2)!} = \frac{(3n-3)!}{(n-1)!(2n-2)!}\left[\frac{1}{2n+1}\frac{(3n)(3n-1)(3n-2)}{n(2n-1)(2n)} - \frac{1}{2n-1}\right] =$$

$$\frac{1}{2n-1}\binom{3n-3}{n-1}\left[\frac{3(9n^2-9n+2)-(2n)(2n+1)}{2n(2n+1)}\right] = \binom{3n-3}{n-1}\frac{23n^2-29n+6}{(2n+1)(2n)(2n-1)} \tag{6}$$

CONJECTURE

Technically, we have let $\left\{ {n \atop k} \right\}$ really represent $\left\{ {n \atop k} \right\}_2$. Based on the results found here and the previous research done on 1's and -1's by Bailey [1], we present the following conjecture for $\left\{ {n \atop mn} \right\}_m$, the number of sequences with non-negative parital sums formed from n m's and mn -1's where m is any positive integer:

$$\left\{ {n \atop mn} \right\}_m = \frac{1}{mn+1}\binom{(m+1)n}{n} \tag{7}$$

References

[1] Bailey, D.F., "Counting Arrangements of 1's and -1's", *Mathematics Magazine*, Vol. 69, No. 2, (1996), pp. 128-131.

[2] Karlitz, L., "Enumeration of 2-line arrays.", *Fibonacci Quarterly*, Vol. 11, (1973), pp. 113-130.

[3] Tenenbaum, Aaron M., Yedidyah Langsam, and Moshe J. Augenstein., Data Structures Using C., New Jersey: Prentice Hall, (1990), p. 231.

Magic Squares as Matrices

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A magic square is an n x n array of integers in which the entries in each row, column, and diagonal sum to the same number. We call a magic square traditional if the n^2 entries are simply the numbers 1, 2, ..., n^2. A magic square can be regarded as a matrix, and so we may examine its linear algebraic properties. We originally conjectured that an n x n traditional magic square is singular if n is even. Although we were able to establish this result for certain special cases, the conjecture is false in general.

SOME PRELIMINARY RESULTS

There are some previously established properties of magic squares that we will use (cf. Andrews). The first of these properties concerns the common sum of the rows, columns, and diagonals. This number is called the magic number of the square and will be denoted by S. In the case of the traditional magic square, we can arrive at a formula for S. The sum of all the entries in the traditional magic square is

$$\sum_{i=1}^{n^2} i = \frac{n^2(n^2+1)}{2}$$

This sum must be distributed equally across the n rows of the square, so we have that, in the traditional magic square,

$$S = \frac{n^2(n^2+1)}{2n} = \frac{n(n^2+1)}{2}$$

Second, viewing a magic square as an n x n matrix, we see that S is an eigenvalue of the square corresponding to the eigenvector $(1, 1, ..., 1)^T$. The magic square has n (not necessarily distinct) eigenvalues, and the next result states some properties of the eigenvalues different from S and their corresponding eigenvectors.

Theorem 1: If $\lambda \neq S$ is an eigenvalue of a magic square A with corresponding eigenvector $(x_1, x_2, \ldots, x_n)^T$, then $\sum_{i=1}^{n} x_i = 0$.

Proof: Let

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

Since λ is an eigenvalue of A corresponding to $(x_1, x_2, \ldots, x_n)^T$, we have that

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n &= \lambda x_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n &= \lambda x_2 \\ &\ldots \\ a_{n1}x_1 + a_{n2}x_2 + \ldots + a_{nn}x_n &= \lambda x_n \end{aligned}$$

Adding these equations, we find

$$(a_{11} + a_{21} + \ldots + a_{n1})x_1 + (a_{12} + a_{22} + \ldots + a_{n2})x_2 + \ldots + (a_{1n} + a_{2n} + \ldots + a_{nn})x_n = \lambda(x_1 + x_2 + \ldots + x_n) \Rightarrow$$
$$Sx_1 + Sx_2 + \ldots + Sx_n = \lambda(x_1 + x_2 + \ldots + x_n) \Rightarrow (S - \lambda)(x_1 + x_2 + \ldots + x_n) = 0$$

Since $S \neq \lambda$, $x_1 + x_2 + \ldots + x_n = 0$. □

REGULAR MAGIC SQUARES

A regular magic square is a magic square in which entries diametrically opposite the center sum to $\frac{2}{n}S$ (cf. Andrews 1). For example,

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ & & & \\ a_{n1} & a_{n2} & & a_{nn} \end{bmatrix}$$

is an n x n regular magic square if and only if $a_{11} + a_{nn} = a_{21} + a_{n-1,n} = \ldots = a_{ij} + a_{n-i+1,n-j+1} = \frac{2}{n}S$. As a concrete example,

$$\begin{bmatrix} 1 & 12 & 14 & 7 \\ 8 & 13 & 11 & 2 \\ 15 & 6 & 4 & 9 \\ 10 & 3 & 5 & 16 \end{bmatrix}$$

is a 4 x 4 regular magic square, since $a_{11} + a_{44} = a_{12} + a_{43} = \ldots = 17$.

In attempting to prove our conjecture, we first examined this special type of magic square, and arrived at the following result.

Theorem 2: If A is an n x n regular magic square and $\lambda \neq S$ is an eigenvalue of A corresponding to the eigenvector $(x_1, x_2, x_3, \ldots, x_n)^T$, then $-\lambda$ is an eigenvalue of A corresponding to the eigenvector $(x_n, \ldots, x_3, x_2, x_1)^T$.

Proof: Let

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

be an n x n regular magic square. By Theorem 1, $x_1 + x_2 + x_3 + \ldots + x_n = 0$, so certainly $\frac{2}{n}S(x_1 + x_2 + x_3 + \ldots + x_n) = 0$. This implies that $(a_{11} + a_{nn})x_1 + (a_{12} + a_{n,n-1})x_2 + \ldots + (a_{1n} + a_{n1})x_n = 0$ which in turn implies that $a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = -(a_{nn}x_1 + a_{n,n-1}x_2 + \ldots + a_{n1}x_n)$. Since $(x_1, x_2, x_3, \ldots, x_n)^T$ is an eigenvector of A, $a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n = -(a_{nn}x_1 + a_{n,n-1}x_2 + \ldots + a_{n1}x_n) = \lambda x_1$. Thus $a_{n1}x_n + \ldots + a_{n,n-1}x_2 + a_{nn}x_1 = -\lambda x_1$. In a similar manner, one can show that

$$a_{n-1,1}x_n + \ldots + a_{n-1,n-1}x_2 + a_{n-1,n}x_1 = -\lambda x_2$$

$$\ldots$$

$$a_{11}x_n + \ldots + a_{1,n-1}x_2 + a_{1n}x_1 = -\lambda x_n$$

Equivalently, $-\lambda$ is an eigenvalue of A corresponding to $(x_n, \ldots, x_3, x_2, x_1)^T$. □

Corollary: A 4 x 4 regular magic square is singular.

Proof: Let

$$A = \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix}$$

be a 4 x 4 regular magic square. A has four (not necessarily distinct) eigenvalues. Call these eigenvalues λ_1, λ_2, λ_3, and λ_4. We may assume that $\lambda_1 = S$. Also, from linear algebra, we know that $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 = \text{trace}(A) = a + f + k + p = S$ (cf. Leon). Therefore, $\lambda_2 + \lambda_3 + \lambda_4 = 0$. This implies that at least one of λ_2, λ_3, $\lambda_4 \neq S$; assume $\lambda_2 \neq S$. If $\lambda_2 = 0$, we have proved the result, since a matrix with a zero eigenvalue is singular. So assume $\lambda_2 \neq 0$. Then, by Theorem 2, $-\lambda_2$ is an eigenvalue of A; let $\lambda_3 = -\lambda_2$. So $\lambda_2 + \lambda_3 = 0$, which implies that $\lambda_4 = 0$. Therefore, A must have a zero eigenvalue; hence A is singular. □

SYMMETRIC MAGIC SQUARES

The next special case we consider is the symmetric magic square. This is a square in which the pairs of numbers summing to $\frac{2}{n}S$ "are arranged symmetrically in relation to a perpendicular line through the center of the square" (cf. Frierson 140). So,

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

is an n x n symmetric magic square if and only if
$a_{11} + a_{1n} = a_{12} + a_{1,n-1} = \ldots = a_{ij} + a_{i,n-j+1} = \frac{2}{n}S$. As an example,

$$A = \begin{bmatrix} 1 & 11 & 6 & 16 \\ 14 & 3 & 4 & 3 \\ 7 & 2 & 15 & 10 \\ 12 & 8 & 9 & 5 \end{bmatrix}$$

is a 4 x 4 symmetric magic square. Notice that a symmetric magic square cannot be regular.

It is easy to see that such a square must be singular. Consider the 4 x 4 case; the eigenvector $(1, -1, -1, 1)^T$ will correspond to a zero eigenvalue.

In fact, the condition of symmetry may be relaxed somewhat and the magic square will remain singular; it is only necessary that the pairs of numbers summing to $\frac{2}{n}S$ be consistently arranged over each row in the square. For example, any 4 x 4 traditional magic square in which the "17-pairs" (i.e. 1 and 16, 3 and 14, etc.) are arranged in the same pattern in each row will necessarily be singular:

$$\begin{bmatrix} a & 17-a & b & 17-b \\ c & 17-c & d & 17-d \\ e & 17-e & f & 17-f \\ g & 17-g & h & 17-h \end{bmatrix} \quad (1, 1, -1, -1)^T \text{ corresponds to } \lambda = 0$$

$$\begin{bmatrix} a & b & 17-a & 17-b \\ c & d & 17-c & 17-d \\ e & f & 17-e & 17-f \\ g & h & 17-g & 17-h \end{bmatrix} \quad (1, -1, 1, -1)^T \text{ corresponds to } \lambda = 0$$

This reasoning can be generalized to establish

Theorem 3: An n x n magic square in which the "$\frac{2}{n}S$ pairs" are arranged in a consistent pattern over each row is singular.

For example,

$$A = \begin{bmatrix} 16 & 1 & 4 & 13 \\ 10 & 7 & 6 & 11 \\ 5 & 12 & 9 & 8 \\ 3 & 14 & 15 & 2 \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} 16 & 13 & 1 & 4 \\ 3 & 2 & 14 & 15 \\ 10 & 11 & 7 & 6 \\ 5 & 8 & 12 & 9 \end{bmatrix}$$

are both singular matrices. Also, since in general $\det(A) = \det(A^T)$, the occurrence of any of the above patterns in the columns of the square guarantees singularity.

By looking for variations in the patterns of the "17-pairs," we were able to resolve the conjecture for the 4 x 4 case. For example, what happens if every entry occurs in the same row as its "17-complement," but there is no consistent arrangement of these pairs over every row? Consider

$$A = \begin{bmatrix} 1 & 16 & 13 & 4 \\ 6 & 9 & 8 & 11 \\ 12 & 7 & 10 & 5 \\ 15 & 2 & 3 & 14 \end{bmatrix}$$

which has determinant 3264, thus disproving the conjecture.

CONCLUSIONS

Our original conjecture is not true in the 4 x 4 case; therefore it seems reasonable to believe that an arbitrary n x n magic square is not necessarily singular when n is even. However, we speculate that a regular magic square of any even dimension is singular. Certainly Theorem 2 holds; the only problem to resolve is the multiplicity of the eigenvalues, i.e. if λ and $-\lambda$ are eigenvalues of the square, it is not clear that they must have the same multiplicity. If they do not, the n eigenvalues could possibly sum to S while none of the eigenvalues is zero.

REFERENCES

Andrews, W. S., 1960, Magic Squares and Cubes, (New York: Dover Publications, Inc.)

Frierson, L. S., 1960, "A Mathematical Study of Magic Squares", Magic Squares and Cubes, (New York: Dover Publications, Inc.)

Leon, Steven J., 1994, Linear Algebra With Applications, (New York: MacMillan College Publishing Company)

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The Structural Design and Electronic Control System for a Large Segmented Space Reflector Test-bed

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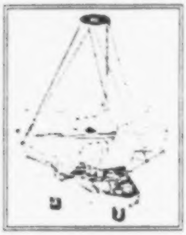

The segmented reflector test-bed is an experimental apparatus that is designed and developed at the Control and Structures Research Laboratory (CSRL) at California State University, Los Angeles. The test-bed is capable of performing experiments that simulate the complex dynamic of a large segmented optical system. It is a generic experimental facility that can address in an integrated way the problems associated with Control and Structure Interaction (CSI), distributed control of multi-input multi-output systems, optics, electronics, actuator and sensor design, and digital implementation. It is specifically designed to demonstrate, in a unique way, the advantages of decentralized control approach to large scale systems.

BACKGROUND

Future astronomical space missions will require high-performance optical systems. Such optical systems will necessarily have large apertures for high-precision performance making the size of the reflectors very large. Due to practical considerations such as time, cost and complexity of fabricating large-apertures telescopes, as well launch vehicle size, weight and power constrains, future telescopes will be made of precision-segmented reflectors. A segmented mirror reflector consists of mirror panels which, when formed together, become a parabolic primary mirror that magnify the images from space. These mirror panels are easily manufactured, and deployable in space.

With the advantages of the segmented reflector telescopes, shortcoming are also presented. The large size of these telescopes make the structure flexible to external forces such as thermal fluctuations and solar disturbances. It becomes apparent that development of control concepts and extensive performance evaluation via simulation in an environment characterized by various dynamic disturbances is a necessity. The control design challenge is to make the segmented reflector perform as a monolithic reflector. This is done via high-precision figure control which would maintain the surface of the reflector to within a specified tolerance of the calibrated reference position.

THE STRUCTURE AND COMPONENTS DESIGN

Overall Structure And Components design

The C.S.R.L. test-bed consists of several major components actuator platforms, mirror segments, truss members, fittings and joint flexures.

SEGMENTED PRIMARY MIRROR

The CSRL primary mirror is designed to emulate the critical properties of a real segmented mirror. These properties include segmentation geometry, inter-segment spacing, segment mass, inertia and stiffness, and optical focal ratio (H.Boussalis, M. Mirmirani and Z. Wei, 1995). The seven segment primary mirror consists of a ring of six actively controlled hexagonal segments surrounding a fixed center segment that acts as a reference. Because the test-bed is control-system oriented, and because of difficulty and added expense of fabrication of actual optical-quality segments made from glass, the segments will be fabricated from flat honeycomb aluminum plates. The active segments are attached to segment-positioning actuators with special three-degree-of-freedom flexures. These flexures permit individual segments to have two rotational degree of freedom (tilt) and one transitional degree of freedom (piston). Each segments is controlled by three actuators and the entire primary has a total of 18 actuators. Figure 1 illustrates the isometric view of a flexure and a schematic diagram of the special arrangements of three flexures to a mirror segment, resulting in three degrees of freedom motion. The relative displacement between the edges of adjacent segment is measure by an ensemble of 24 edge sensors. The edge sensors provide information about a segment's relative displacement as well as absolute displacements from the fixed center reference segment.

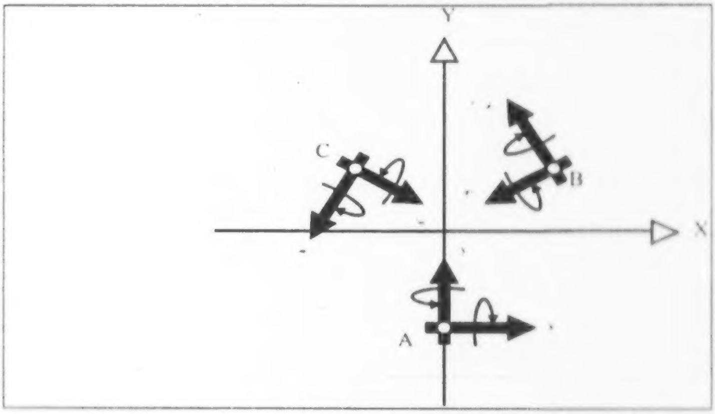

Figure 1: Orientation of Joint Flexure with Respect to Panel

STRUCTURE

One of the most fundamental design goals has been a strong, light-weight truss structure whose structural-dynamic characteristics are representative of a large, flexible space-borne system. These include low frequency modes, high modal density and global mode shapes that properly reflect the coupling of the sub-elements of the structure. therefore, the requirements for the design of the truss, in addition to the dimensional constrains, has been a careful trade-off between the need for the structure to support itself in the 1-g laboratory environment versus the need to keep the frequency of the first mode as low as possible. We employed multi-criteria optimization technique based on Pareto-optimality concept to accomplish this objective (Guyan, W.B.,1990). We used CADKEY and AUTOCAD software to create a baseline primary truss structure. The baseline design consists exclusively of tetrahedrons with 60 elements and 21 nodes as shown in Figure 2.

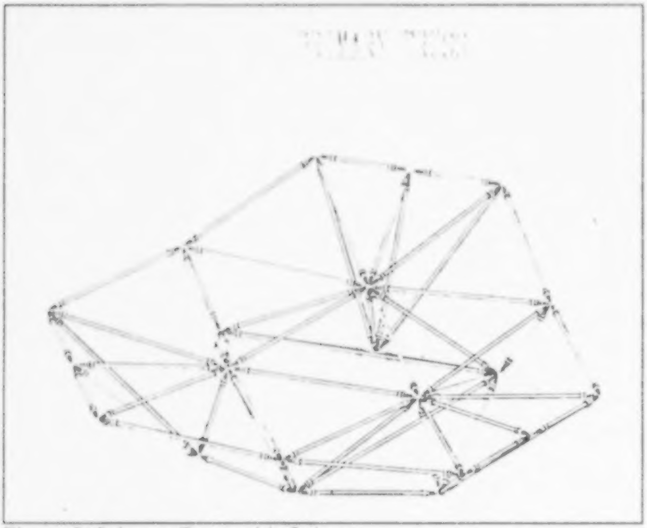

Figure 2: Primary Truss with fittings

THE ELECTRONIC AND COMPUTER ARCHITECTURE

Overall Electronic and Computer Architecture

The drive electronics used in the C.S.R.L. testbed is for the purpose of processing the analog output of sensors and interfacing with the segment position actuators. The drive electronics is in charge of real-time processing and data acquisition. The computer and graphic set up includes a DSP, a PC and two SUN stations. The Digital Signal Processor is the main computational unit and it is responsible for real-time control processing, signal generation, and real-time directory memory. The DSP and the SUN stations are used to monitor the C.S.R.L. experiments via the graphical display of the Kaman sensor reading, the actuator commands, and the mirror segments piston. The input/output unit is composed of two 32-channels 16-bit analog-to-digital converters.

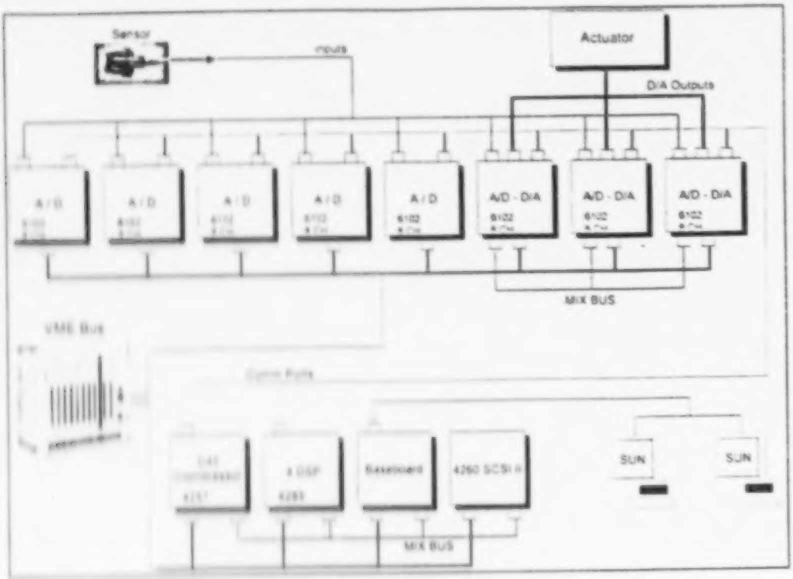

Figure 3: Block Diagram of Electronic and Computer Architecture

Sensors

The primary mirror of the Segmented Reflector Telescope consists of seven hexagonal panels with the center one fixed. A total of 24 edge sensors are distributed on the 12 adjacent edges between panels (2 for each edge). Each sensor is able to detect displacement or misalignment of adjacent panels when the telescope is subjected to any disturbance (Carrier, 1990). The sensors interface with the analog-to-digital converter, so that the output of the sensor can be transmitted to the controlling unit digitally. The sensors are the only components of the electronic system involved in the measurement, conversion, and transmission of data back to the controllers. Sensors must be used to measure the position of the segments with respect to some unique, stable reference rather than with respect to the underlying structure. This is accomplished by the edge sensors, whose output will guide the controllers to re-align the panels to attain a parabolic shape. A control fixed segment is chosen as a reference for the whole system and the position on individual segments are obtained by a special algorithm that applies to proper geometric transformation to the ensemble of sensor signal. With a 100,000 dynamic range, a resolution of 1 μm, an accuracy of 1 micron, and a voltage range of +/- 10 volts, the linear inductive proximity sensors (model 6U1) are one of the fastest and more accurate types of sensors, which will be used for panel displacement monitoring.

A/D and D/A Converters

The purpose of the analog-to-digital converters is to receive an analog voltage, producing a corresponding binary output which is proportional to the analog input. Such an input in our case is the analog output voltage of the edge position sensors. A 64-channel A/D converter with 16-bit resolution, differential amplifier inputs, voltage range of +/10 volts, and a minimum sampling rate (for aliasing prevention) of 320 KHz is required for proper sensor output sampling and conversion. These requirements also apply for the digital to analog converter, whose purpose is to convert the processed signal back into an analog

113

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voltage for use in actuator triggering.

The DSP Board

Once an analog signal has been converted to digital form, operations can be performed on the data in the Digital Signal Processor by means of a programmable set of instructions. The DSP acts as the brain of the electronics control unit, using high-speed CPUs to analyze and process the incoming digital data, and process a digital output code that will be used (after D/A conversion) to correct panel positions. A 40 MFLOP (million of floating-point math operations per second) DSP, with direct memory access, and VME Bus compatibility is used in the C.S.R.L. electronics control systems.

The VME Bus

The transferring of data within the electronic control system is provided by the VME Bus (Versa Module Eurocard Bus). It is a standard chassis consisting of one or more master and slave modules. The master modules are employed for processor boards, while slave modules are memory and I/O boards (Peterson 1992). The VME Bus is used for the transfer of data within components at speeds of up to 80 Mbytes per second.

CONCLUSION

The test-bed has being designed to perform the essential functions needed for the various system missions. Performance of the test-bed is expected to be of comparable quality to that of an actual optical system. All these has been achieved through the design of the several mechanical components, the electronic control system, decentralized control algorithms

REFERENCES

Hahn, M., Mirmirani, M., Boussalis H., Optimal Design of a Truss Structure for Segmented Reflector, ASME Conference, Boston, 1995.

Carrier, A. C., Modeling and Shape Control of a Segmented-Mirror Telescope, Department of Aeronautics and Astronautics, Stanford University, March 1990.

Gary, W. B., 1990, Submilimeter Moderated Mission Option Study, Jet Propulsion Laboratory Report D-7071, Pasadena, CA.

Guyan, R. J., Reduction of Stiffness and Mass Matrices, AIAA, Vol. 3, No. 2, 1964

Wade D. Peterson. The VME Bus Handbook, Third Edition 1992.

H. Ryaciotaki-Boussalis, Z. Wei, M. Mirmirani, Decentralized and PID Controller Design for Large Space Borne Telescopes. IASTED Conference on Modeling and Simulation, Pittsburgh 1995.

H. Boussalis, M. Mirmirani and Z. Wei, Decentralization and PID Controller Design for Large-Spaceborn Telescopes, IASTED International Conference on Applied Modeling Simulation and Optimization, Pittsburgh, 1995.

H. Boussalis, C. Szeto, and M. Mirmirani, The use of Neural Networks to Control a Segmented Reflector Telescope, IASTED International Conference on Applied Modeling, Simulation and optimization, Pittsburgh, 1995.

1133

The Effects of Stretching and Aging on the Tensile Properties of Al-Cu-Li (2195) Alloy

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In recent years, aluminum copper lithium alloys have been used in high performance commercial and military aircraft due to its improved strength, high stiffness, low density, high modulus, and high temperature capability. In this experiment, tests were conducted on specimens of Al-Cu-Li (2195) alloy to observe changes in the tensile properties of the alloy due to the combined stretching and aging processes. After being solution-treated at 510 °C for one hour, the alloys were immediately quenched and stretched parallel to rolling direction of the plate to approximately 5%, 10%, and 15% plastic strain, followed by aging at 180 °C for 24 hours. The plates were cut into tensile specimens according to ASTM specifications for testing on the MTS 810 System with Teststar Software to determine the effect of stretching on the tensile properties of the Al-Cu-Li (2195) alloy.

INTRODUCTION

The 2195 alloy is planned to be primarily used for the external liquid-fuel tank in the space shuttle due to its excellent cryogenic mechanical properties (Frazier, Lee, Donnelian, and Thompson, 1989). Other important properties of the 2195 alloy are its low density, high modulus of elasticity, and fatigue toughness properties. The Al-Li alloy was selected over conventional high strength alloys because of its high temperature capabilities, and resistance to fatigue crack propagation (Lee and Frazier, 1988). The 2195 alloy offers improved density and strength over the 2219 (Al-Cu-Mn) alloy with comparable strength and weldabiltiy.

Aluminum lithium alloys containing copper need to be stretched prior to aging in order to obtain optimal strength and fracture toughness (Lee and Frazier, 1988). Al-Li alloys having 2wt % Cu and T_1 precipitates are significantly affected by stretching. The formation of the precipitates increases the amount of dislocations thus increasing the strength of the alloy.

Aluminum alloys including Al-Cu-Li alloy are strengthened by age hardening (precipitate hardening). The strengthening effect is due to the formation of coherent precipitates which act as the strengthening phase. In the process of solution treatment at 510 °C, all precipitates are dissolved. After the alloy is changed from two phases to one phase (Al solid solution α), the alloy is immediately quenched in water to prevent the formation of coarse precipitates. After quenching, the alloy is aged at 180 °C. During the aging process, fine precipitates nucleate and grow from the supersaturated α phase. These fine coherent precipitates strengthen the Al alloy (Flinn and Trojan, 1990). In the current study, the pre-stretching and age hardening processes are demonstrated using Al-Cu-Li (2195) alloy.

EXPERIMENTAL PROCEDURE

The Al-Cu-Li (2195) alloy plate used in this study was supplied by Lockheed-Martin in New Orleans, Louisiana. Placing the plates in the Sybron Thermolyne Furnace with Furnatrol III Type 19300 Automatic Controller, the plates were solution-treated at 510 °C for 1 hour followed by quenching in water as shown in Figure 1. Using the Material Testing System 810 with Teststar software (MTS 810), the plates were then stretched uniaxially 5%, 10%, and 15% in the rolling directions. The plates were placed in furnace at 180 °C to heat for 24 hours to evaluate the effects of artificially aging. Using the International Electronics Co., Ltd. TensilKut with Type 33 electronic motor control, tensile specimens were cut in the rolling and transverse directions The tensile specimens were prepared in accordance with ASTM standards with a gage length of 2.0 inches, width of 0.5 inches and nominal thickness of 0.25 inches Using the MTS 810, the specimens were tested to determine changes in the tensile properties such as yield strength, and ultimate tensile strength The results of the test were recorded and compared with previous test to examine significant change in the properties

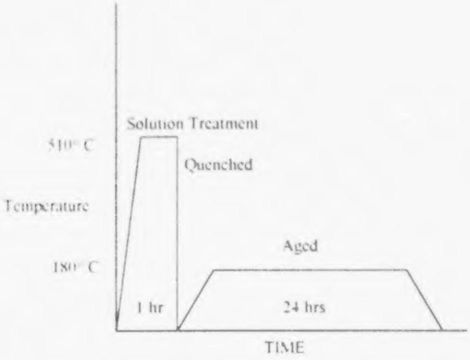

Figure 1 Procedures for age hardening heat treatment

DISCUSSIONS AND RESULTS

When Al-Cu-Li alloy is stretched, the yield strength and ultimate tensile strength increase The change in strength is dependent upon the amount of stretching and orientation of the specimen to grain upon cutting The yield strength and ultimate tensile strength in the 90° stretched 6% exceeds 80 ksi and 85 ksi, respectively in all orientations (Es-Said and Lee, 1995)

In this experiment, the Al-Cu-Li alloy plates were stretched various percentages along the rolling direction To evaluate the best direction to apply, specimens were tested in the rolling and transverse (90°) direction The yield strength and ultimate tensile strenght for each specimen was determined from the stress-strain curves and data tables with the average value being taken as the result In the rolling direction, the yield strength and ultimate tensile strength exceed 76 ksi and 82 ksi respectively for 5% stretching, 81 ksi and 87 ksi respectively for 10% stretching, and 82 ksi and 88 ksi respectively for 15% stretching In the transverse direction, the yield strength and ultimate tensile strength exceed 76 ksi and 81 ksi respectively for 5% stretching, 79 ksi and 84 ksi respectively for 10% stretching, and 78 ksi and 83 ksi respectively for 15% stretching The comparison plots in figure 2 indicates the maximum value for yield strength and ultimate tensile strength for the alloy cut in transverse and rolling directions The rolling direction yield strength and ultimate tensile strength exceeded thoses in the transverse direction The 15% stretching exceeded the 5% and 10% stretching The best process for the application of the alloy is 15% stretched rolling direction artificially aged

TABLE 1 Average Yield Strength and Ultimate Tensile Strength Of Al-Cu-Li (2195) Alloy In Artificially Aged Condition Cut In Rolling and Transverse Direction With Stretching In the Rolling Direction

Stretching	Rolling	Transverse	Rolling	Transverse
(%)	Yield Strength (psi)		Ultimate Tensile Strenght (psi)	
5	76241.5	76070.8	82677.0	81745.3
10	81395.0	79466.4	87526.0	84044.5
15	82967.5	78069.5	88649.0	83323.5

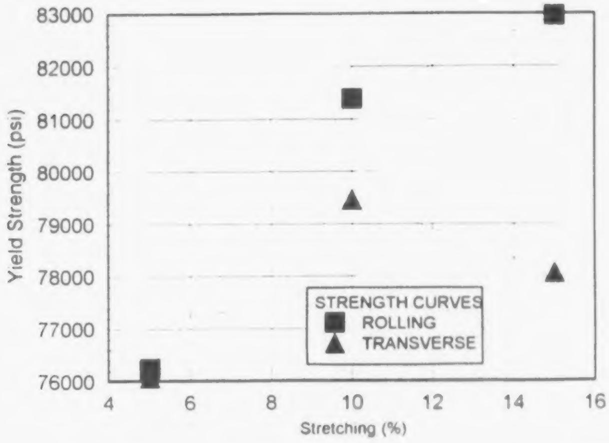

Figure 2. YIELD STRENGTH AS A FUNCTION OF STRETCHING PRIOR TO AGING

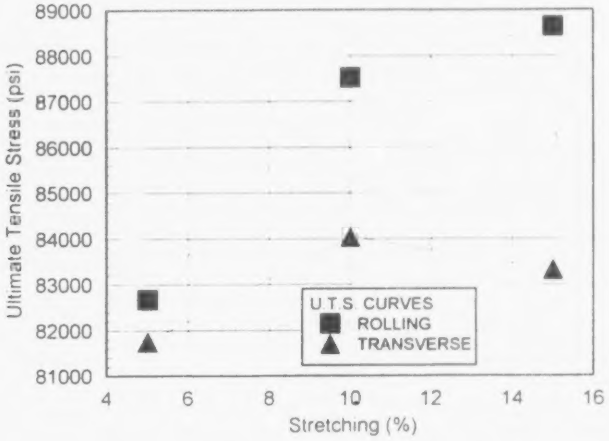

Figure 3. ULTIMATE TENSILE STRENGTH AS A FUNCTION OF STRETCHING PRIOR TO AGING

1141

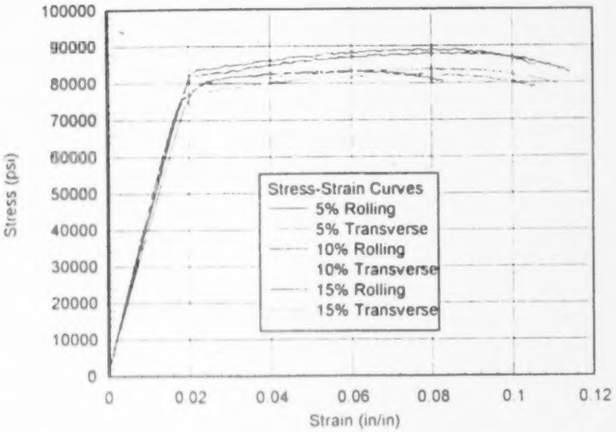

Figure 4. Pre-stretched Artificially Aged Specimens Stress-Strain Curves

CONCLUSIONS

1. The degree of stretching and direction has an effect on the yield strength and ultimate tensile strength.
2. The maximum yield strength and ultimate tensile strength for a 15% rolling direction stretched artificially aged specimen is 82 ksi and 88 ksi respectively.

ACKNOWLEDGMENTS

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REFERENCES

Es-Said, O. S., and E.W. Lee, "The Effect of Stretch Orientation (and Rolling Mode) on the tensile behavior of 2095 Aluminum Lithium Alloy", Light Weight Alloys for Aerospace Applicatin III, The Minerals, Metals, & Materials Society, 1995.

Frazier, Williams, Eui Lee, Mary Donnelian, and James Thompson, "Advanced Lightweight Alloys for Aerospace Applications", JOM, May 1989, pp. 22-24.

Flinn, R. A., and P. K. Trojan, Engineering Materials and Their Applications, 4th edition, 1990, pp. 244-248.

Lee,W. and W. E. Frazier, "The Effect of Stretch on the Microstructure and Mechanical Properties of 2090 Al-Li", Metallurgica, Vol. 22, 1988, p 53.

Resolvents of m-Accretive Operators in Banach spaces

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In this paper, a "resolvent identity" for the m-accretive operator T is developed. A number of theorems concerning these resolvents are proven and in particular, their uniform convergence to the identity operator is demonstrated.

INTRODUCTION

Accretive operators were first introduced in 1962 by George Minty [8] and have since been extensively studied by Barbu [1], Browder [2], Deimling [3], Kartsatos [5], Lakshmikantham and Leela [7]. These operators have achieved some noteriety in applications involving solutions to partial-differential equations as well as to ordinary differential equations and integro-differential equations.

In this paper, accretive operators are explored from an abstract point of view. First, a result will be proven to establish the equivalency of two well-known definitions of "m-accretiveness". These definitions were initially proposed by George Minty and by Tosio Kato [6] respectively.

Some properties of the "resolvent operators" will be developed and it will be proven that not only do the resolvents converge pointwise to the identity, but that this convergence is uniform. In proving this last result a variation of a "resolvent identity" which was initially developed by Guan and Kartsatos [4] will be established.

ACCRETIVE OPERATORS

The operator T: $D(T) \subset X \rightarrow X$, where X is a Banach space, is accretive if $\forall\, n \in N$ and $\forall\, x, y \in D(T)$ the following inequality holds:

$$\|x - y\| \leq \|x - y + \frac{1}{n}(T(x) - T(y))\| \qquad (1)$$

An accretive operator T is said to be m-accretive if

$$R(T + \frac{1}{n}I) = X \quad \forall\, n \in N \qquad (2)$$

Some examples of accretive operators are:

1. Any increasing function from $R \rightarrow R$
2. Any positive definate matrix in R^n.
3. Negative the Laplacian $\left(-\frac{\partial^2}{\partial x^2} - \frac{\partial^2}{\partial y^2}\right)$

The definitions of accretive and m-accretive, equations (1) and (2), were established by Tosio Kato in 1967. Five years earlier, George Minty defined an accretive operator to be m-accretive if $R(I + T) = X$, which is similar to Kato's definition with $n \equiv 1$. The following theorem demonstrates that Minty's definition implies Kato's.

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Theorem 1: Let $T: D(T) \subset X \to X$ be an accretive operator.
If $R(I + T) = X$ then $R(I + nT) = X \ \forall n \in N$.

Proof: Suppose that T is accretive with $R(I + T) = X$. Let $y \in X$ and $n \in N$. Then the equation $(I + nT)x = y$ is equivalent to the equation,

$$x = (I + T)^{-1}\left(\frac{y}{n} + \left(1 - \frac{1}{n}\right)x\right). \tag{3}$$

To see this, consider

$$\begin{aligned}
(I + nT)x &= y \\
\left(\frac{1}{n} I + T\right)x &= \frac{y}{n} \\
T(x) &= \frac{y}{n} - \frac{1}{n}x \\
x + T(x) &= \frac{y}{n} + x - \frac{1}{n}x \\
(I + T)x &= \frac{y}{n} + \left(1 - \frac{1}{n}\right)x \\
x &= (I + T)^{-1}\left[\frac{y}{n} + \left(1 - \frac{1}{n}\right)x\right].
\end{aligned}$$

As will be shown in the next section, the operator $(I + T)^{-1}$ is non-expansive, so the operator $(I + T)^{-1}\left(\frac{y}{n} + \left(1 - \frac{1}{n}\right)x\right)$ is Lipschitz continuous. Indeed,

$$\begin{aligned}
&\left\|(I + T)^{-1}\left(\frac{y}{n} + \left(1 - \frac{1}{n}\right)x_1\right) - (I + T)^{-1}\left(\frac{y}{n} + \left(1 - \frac{1}{n}\right)x_2\right)\right\| \\
&\leq \left\|\left(\frac{y}{n} + \left(1 - \frac{1}{n}\right)x_1 - \left(\frac{y}{n} + \left(1 - \frac{1}{n}\right)x_2\right)\right\| \\
&\leq \left\|\left(1 - \frac{1}{n}\right)x_1 - \left(1 - \frac{1}{n}\right)x_2\right\| \\
&= \left|1 - \frac{1}{n}\right| \, \|x_1 - x_2\|.
\end{aligned}$$

Therefore, the Lipschitz constant is $\left|1 - \frac{1}{n}\right|$ and by the fixed point contraction theorem, equation (3) has a unique solution. This result implies that $(I + nT)x = y$ has a solution, which implies that $R(I + nT) = X$ since y was an arbitrary element of X.

Clearly, $R(I + nT) = X$ implies that the operator $n(T + \frac{1}{n}I)$ is onto.

Thus, $R(T + \frac{1}{n}I) = X$.

RESOLVENTS OF m-ACCRETIVE OPERATORS

T accretive implies $\left\|x - y + \frac{1}{n}(T(x) - T(y))\right\| \geq \|x - y\|$ which implies $\left\|(x + \frac{1}{n}T(x)) - (y + \frac{1}{n}T(y))\right\| \geq \|x - y\|$ so if $(I + \frac{1}{n}T)(x) = (I + \frac{1}{n}T)(y)$ then $x = y$. Thus $(I + \frac{1}{n}T)$ is one-to-one, which implies $(I + \frac{1}{n}T)^{-1}$ exists. Now let $u = x + \frac{1}{n}T(x)$ and $v = y + \frac{1}{n}T(y)$ for some $x, y \in D(T)$ and $n \in N$,

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then

$$\begin{aligned}\|u - v\| &= \|x + \frac{1}{n}T(x) - (y + \frac{1}{n}T(y))\| \\ &= \|x - y + \frac{1}{n}(T(x) - T(y))\| \\ &\geq \|x - y\| \\ &= \|(I + \frac{1}{n}T)^{-1}u - (I + \frac{1}{n}T)^{-1}v\|.\end{aligned}$$

Therefore, the operator $(I + \frac{1}{n}T)^{-1}$ is non-expansive for every $n \in N$.

Thus, associated with every accretive operator is another operator called the "resolvent" of T. This operator is denoted by J_n, maps X into D(T) and is defined by $J_n = (I + \frac{1}{n}T)^{-1}$. Moreover, $\|J_n(x) - J_n(y)\| \leq \|x - y\| \ \forall x, y \in X$. The following inequality relates resolvents to the initial accretive operator T:

$$n\|x - J_n(x)\| \leq \|T(x)\| \ \forall x \in D(T)$$

Indeed,

$$n(x - J_n(x)) = n(J_n(x + \frac{1}{n}T(x)) - J_n(x))$$

$$\begin{aligned}n\|x - J_n(x)\| &\leq n\|(J_n(x + \frac{1}{n}T(x)) - J_n(x))\| \\ &\leq n\|(x + \frac{1}{n}T(x)) - x\| \\ &\leq n\|\frac{1}{n}T(x)\| \\ &= \|T(x)\|.\end{aligned}$$

This result may now be used to prove that the J_n's converge pointwise to the identity operator on X.

Theorem 2: $J_n(x) \to x$ as $n \to \infty$.

Proof: For $x \in D(T) \cap R(I + nT)$, then

$$\begin{aligned}\|J_n(x) - x\| &= \|x - J_n(x)\| \\ &= \frac{1}{n}n\|x - J_n(x)\| \\ &\leq \frac{1}{n}\|T(x)\|\end{aligned}$$

which converges to 0 as $n \to \infty$. Therefore, $\lim_{n \to \infty} J_n(x) = x$.

Theorem 4, will further show that this convergence is uniform. For an example, the interested reader is encouraged to graph, on the same set of axes, a sequence of resolvents $J_n(x) = \frac{-n}{2} + \frac{n}{2}\sqrt{1 + \frac{4}{n}x}$ for the accretive operator $T(x) = x^2, x \geq 0$.

The proof of Theorem 4 involves a "resolvent identity" which establishes connections between each J_n. In particular, this resolvent identity shows that if one J_n satisfies a certain property (compactness, uniformly continuity) they all do. The main results are contained in the next two theorems.

Theorem 3 (Resolvent Identity):

$$J_n(x) = J_k\left[\frac{n}{k}x + \frac{k-n}{k}(J_n(x))\right] \tag{4}$$

where $J_n(x) = (I + \frac{1}{n}T)^{-1}(x)\ \forall\, n \in N$.

Proof: First, consider

$$J_n(x) = (I + \frac{1}{n}T)^{-1}(x)$$

$$(I + \frac{1}{n}T)J_n(x) = x$$

$$J_n(x) + \frac{1}{n}T(J_n(x)) = x$$

$$\frac{1}{n}T(J_n(x)) = (I - J_n)(x).$$

Now, consider

$$J_k\left[\frac{n}{k}x + \frac{k-n}{k}J_n(x)\right] = J_k[J_n(x) + \frac{n}{k}(I - J_n)(x)]$$

$$= J_k[J_n(x) + \frac{n}{k}(\frac{1}{n}T(J_n(x)))]$$

$$= J_k[J_n(x) + (\frac{1}{k}T(J_n(x)))]$$

$$= J_k[I + \frac{1}{k}T]J_n(x)$$

$$= (I + \frac{1}{k}T)^{-1}[I + \frac{1}{k}T]J_n(x), \text{ since } J_k(x) = (I + \frac{1}{k}T)^{-1}(x)$$

$$= J_n(x).$$

Theorem 4: J_n's are uniformly convergent on X.

Proof: It was previously established that $J_n(x) = (I + \frac{1}{n}T)^{-1}(x)$ with $\|J_n(x) - J_n(y)\| \leq \|x - y\|$. Furthermore, the resolvent identity established in Theorem 3 says

$$J_n(x) = J_k[\frac{n}{k}x + \frac{k-n}{k}J_n(x)],$$

so consider $\|J_n(x) - J_k(x)\|$ for $x \in X$.

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Then

$$
\begin{aligned}
\|J_n(x) - J_k(x)\| &= \|J_k[\frac{n}{k}x + \frac{k-n}{k}J_n(x)] - J_k(x)\| \\
&\leq \|\frac{n}{k}x + \frac{k-n}{k}J_n(x) - x\| \\
&= \|\frac{k-n}{k}J_n(x) + (\frac{n}{k} - 1)x\| \\
&= \|\frac{k-n}{k}J_n(x) + \frac{n-k}{k}x\| \\
&= \frac{1}{k}\|(k-n)J_n(x) + (n-k)x\| \\
&= \frac{1}{k}\left|(k-n)\right| \|J_n(x) - x\|.
\end{aligned}
$$

Since $\lim_{n \to \infty} J_n(x) = x$, $\|J_n(x) - J_k(x)\| \to 0$ as $n, k \to \infty$.

This result implies that the "J_n's" satisfy the so called "Cauchy criterion for uniform convergence" and thus converge uniformly to the identity.

CONCLUSION

A sequence of non-expansive operators can be associated with each accretive operator T and that these "resolvents" converge uniformly to the identity. Future work could entail a detailed study of the resolvent identity and its relationship to "compact displacements" of the identity.

REFERENCES

1. Barbu, V., "Nonlinear Semigroups and Differential Equations in Banach Spaces", Noordhoff Int. Publ., Leyden (The Netherlands), 1975.
2. Browder, F., "Nonlinear Operators and Nonlinear Equations of Evolution in Banach Spaces", Proc. Symp., Pure Appl. Math., 18 Part 2, Amer. Math Soc., Providence, 1976.
3. Deimling, K., "Nonlinear Functional Analysis", Springer-Verlag, New York, 1985.
4. Guan, Z., Kartsatos, A. G., "Solvability of Nonlinear Equations With Coercivity Generated by Compact Perturbations of m-Accretive Operators in Banach Spaces", Houston J. Math. (1995), 149 - 188.
5. Kartsatos, A. G., "Recent Results Involving Compact Perturbations and Compact Resolvents of Accretive Operators in Banach Spaces", Proceedings of the First World Congress of Nonlinear Analysts, Tampa, Florida, 1992, Walter DeGruyter, New York, (1995), pp. 2197 - 2222.
6. Kato, T., Nonlinear semi-groups and evolution equations, J. Math Soc., Japan 19 (1967), 508 - 520.
7. Lakshmikantham, V., Leela, S., "Nonlinear Differential Equations in Abstract Spaces", Pergamon Press, Oxford, 1981.
8. Minty, G. J., Monotone (nonlinear) operators in Hilbert space, Duke Math J. 29 (1962), 341 - 346.

NUMERICAL MODEL FOR ICE MELTING IN A RECTANGULAR ENCLOSURE WITH DENSITY EXTREMUM EFFECTS

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Phase change phenomena are common, both in nature and in industry. The liquid phase can experience strong convection currents which can have a significant effect on the overall solidification process. Furthermore, water is unique in that it has a density maximum at 4 °C. Numerous studies have been published on ice melting and on convection of water around the density extremum. But very few studies have addressed both problems at the same time. The present paper applies a recently developed numerical model to simulate this problem, including the flow equations inside the liquid phase.

INTRODUCTION

The importance and complexity of melting and solidification processes has resulted in large numbers of investigations, both analytical and experimental. In nature, this situation arises during the freezing of seawater over large areas of the globe, and inside the earth during the cooling and solidification of magma bodies. In industry, examples include solidification of alloys, crystal growth, and freezing of food stuffs.

Natural convection has been shown to have a great influence on the solidification/melting process. This topic has been extensively studied in the last few decades. Generally speaking, it is an accepted fact that natural convection enhances heat transfer rate during melting but retards it during solidification (Kim, 1993). Because of convection, the interface between the liquid and the solid can be irregularly shaped and difficult to track in numerical models. Recently developed one-region models solve this problem by applying one single set of equations to the whole domain (Bennon, 1987). The goal of this study is to contribute to the general knowledge in this area by considering freezing of water in a rectangular enclosure in a situation where density inversion effects are important. The present paper numerically models this situation and the results are presented and explained.

DESCRIPTION OF THE PROBLEM

This study focused on a rectangular enclosure filled with cold water. The left vertical boundary is kept at a constant temperature of 263K, while the right side vertical boundary is at a constant temperature of 276K in the first case, 279K in the second case, and 281K in the last case. In all three cases the top and bottom boundaries are thermally insulated. These boundary conditions have been set to investigate what happens to the water circulation and the freezing of water before and after a density inversion is introduced. Unlike normal fluids, pure water exhibits a nonlinear variation of its density with temperature, with density increasing with temperature up to 4 °C and decreasing thereafter.

MATHEMATICAL FORMULATION

Momentum conservation in the x-Direction:

$$\frac{\partial(\rho u)}{\partial t} + \rho\ V\cdot\nabla u = \nabla\cdot(\mu_l\ \frac{\rho}{\rho_l}\ \nabla u) - \frac{\partial p}{\partial x}$$

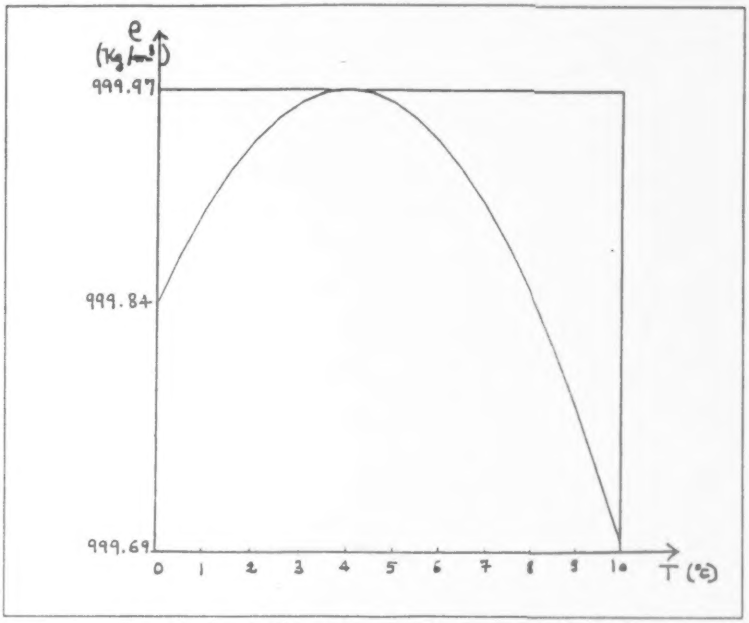

Figure 1. Density-Temperature Relation for Water Near 4 °C

Momentum conservation in the y-Direction:

$$\frac{\partial(\rho v)}{\partial t} + \rho\, V\cdot\nabla v = \nabla\cdot\left(\mu_l \frac{\rho}{\rho_l} \nabla v\right) - \frac{\partial p}{\partial z} + \rho g[\, \beta_T\, (T-T_r)]$$

where μ_l is the dynamic viscosity of the liquid phase.

Energy Conservation:

The energy equation is written in terms of the enthalpy h.

$$\frac{\partial h}{\partial t} + \nabla\cdot(Vh) = \nabla\cdot\left(\frac{k}{\rho c_s} \nabla h\right) + \nabla\cdot\left(\frac{k}{\rho c_s}\nabla\,(h_s-h)\right) - \nabla\cdot\left((h_l-h)\, V\right)$$

Where the subscripts "s" and "l" refer to the solid and liquid phases, respectively. When a given control volume is undergoing phase change, the percentage of latent heat released (or absorbed) will determine the liquid fraction in it. A liquid fraction of zero means that a control volume is entirely solid, whereas a liquid fraction of one means that it is entirely liquid. The locations where it is between zero and one then simply represent the interface. At any given time, the value of the enthalpy within each control volume is known. This in turn allows for the liquid fraction distribution to be calculated.

NUMERICAL ANALYSIS

The conservation equations are solved using SIMPLER (Semi-Implicit Method for Pressure-Linked Equations Revised), which was introduced by Patankar (1980). This method solves the x- and y-momentum equations given above directly for velocities. It uses a scheme that corrects the pressures at each time-step. The pressure corrections are then used to find an improved velocity field. Once a converged velocity field has been found,

other equations, such as energy and species are solved for using the Tridiagonal-matrix algorithm (TDMA).
Dimensionless variables are defined as follows:

$$r' = \frac{r}{H} \quad , \quad z' = \frac{z}{H} \quad , \quad t' = \frac{t\alpha_l}{H^2} \quad , \quad u' = \frac{uH}{\alpha_l} \quad , \quad v' = \frac{vH}{\alpha_l}$$

where the primed quantities are dimensionless, α represents the thermal diffusivity, ν the viscosity, and *H* is the height of the domain of study, which is equal 10 cm in this study.

RESULTS

The results shown are for several real time values ranging from 5000 to 15000 time steps. This range was important because it shows the important steps leading to the formation of uniform and nonuniform flow circulation. The temperature increases from the left to the right. The left wall is assumed to be at a constant temperature of -14 °C, while the right wall is kept at a higher temperature (3, 6, and 8 °C, depending on the case).

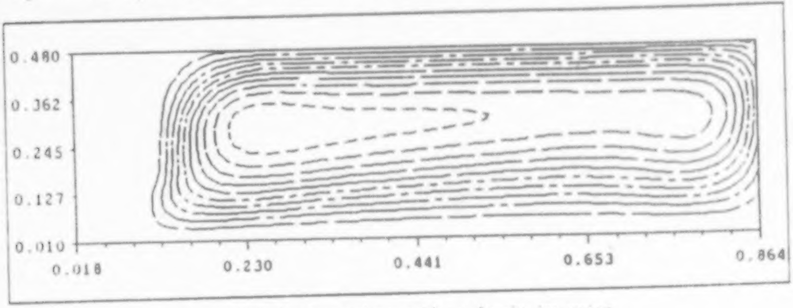

FIGURE 2. Streamlines with no density inversion
T(left) = -14 °C, T(right) = 3 °C, time = 5,000 Δt

The results are presented in Figures 2 through 8. At this point, it will be stressed that the results presented are more qualitative than they are quantitative.

Figure 2 shows freezing when there is no density inversion. It shows one circulation cell inside the liquid phase, with fluid flow up at the ice-water interface. This is in accordance with the density graph, which shows that between 0 °C and 4 °C, the colder the water, the less dense it is.

The next set of figures (3-5) represent the flow when density inversion is present. The circulation pattern inside the enclosure now consists of two counter-rotating cells. The clockwise cell on the left side is the dominant one since the temperature range below the maximum is twice the temperature range above it. The fact that the small cell on the right does not extend all the way to the top is due to viscous effects.

The last set of figures (6-8) corresponds to a more balanced thermal boundary condition inside the liquid phase. The left boundary is simply the ice-water interface which is at 0 °C, and the right boundary is at 8 °C. This provides for a certain level of symmetry which can be seen in Figures 6-8. The two counter-rotating cells are still of approximately equal size after 5000 time steps. After 10,000 time steps (Figure 7), however, the cell on the right is now confined to the lower right corner. The loss of symmetry in the flow pattern can be explained by the fact that the isotherms are no longer vertical. This is due to the effect of fluid flow on enthalpy, and therefore on the temperature field. This is even more pronounced after 15,000 time steps, as can be seen in Figure 8.

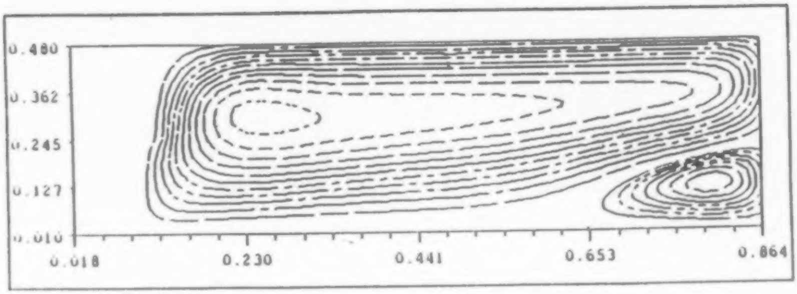

FIGURE 3 Streamlines with density inversion.
T(left) = -14 °C, T(right) = 6 °C, time = 5,000 Δt

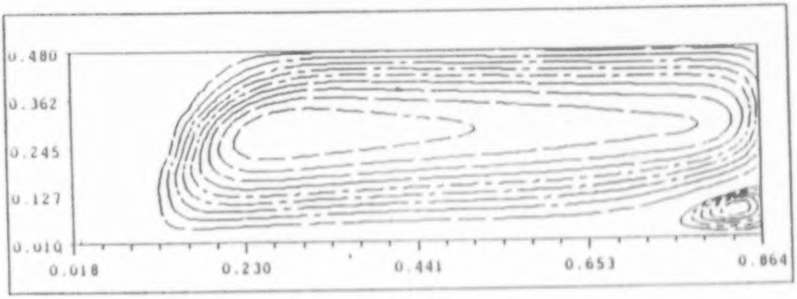

FIGURE 4. Streamlines with density inversion.
T(left) = -14 °C, T(right) = 6 °C, time = 10,000 Δt

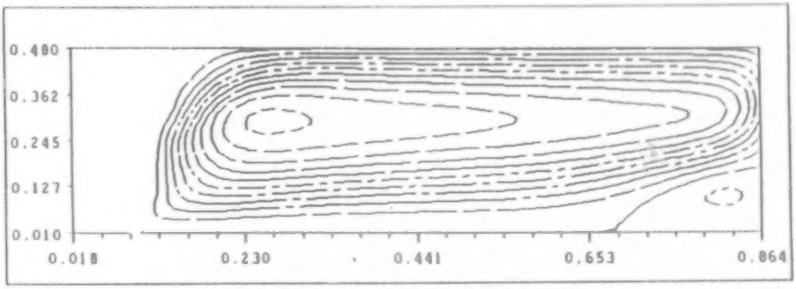

FIGURE 5. Streamlines with density inversion.
T(left) = -14 °C, T(right) = 6 °C, time = 15,000 Δt

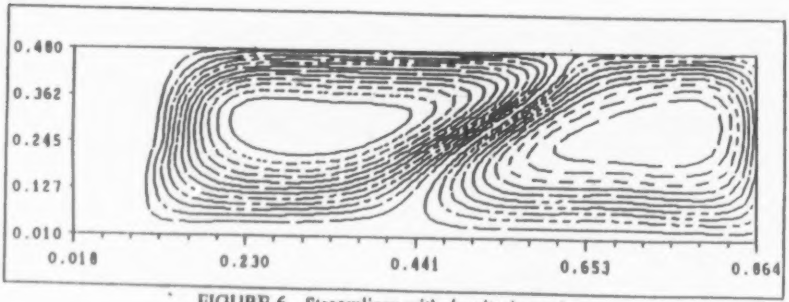

FIGURE 6. Streamlines with density inversion.
T(left) = -14 °C, T(right) = 8 °C, time = 5,000 Δt

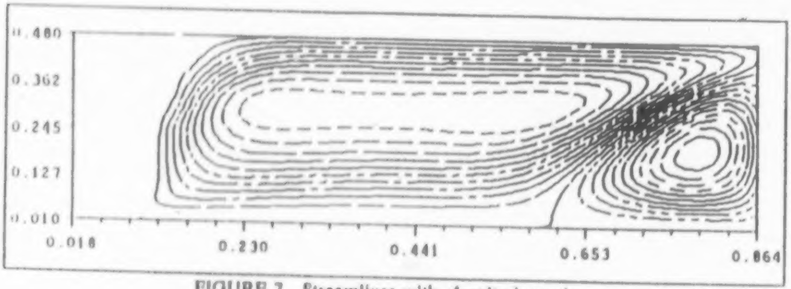

FIGURE 7. Streamlines with density inversion.
T(left) = -14 °C, T(right) = 8 °C, time = 10,000 Δt

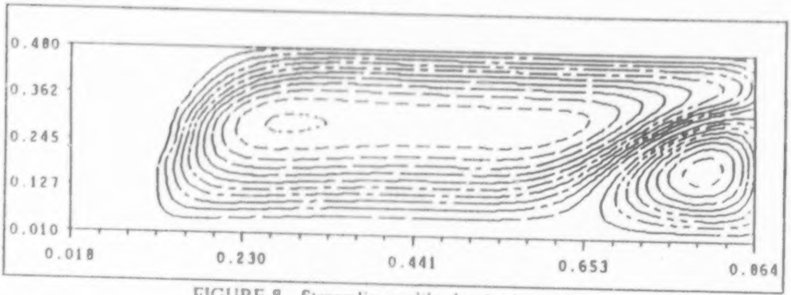

FIGURE 8. Streamlines with density inversion.
T(left) = -14 °C, T(right) = 8 °C, time = 15,000 Δt

REFERENCES

Bennon, W.D., and Incropera, F.P., A Continuum Model for Momentum, Heat and Species Transport in Binary Solid-Liquid Phase Change Systems, Int. J. Heat Mass Transfer, Vol. 13, 277-296 (1988).

Kim, C.J., et al., Two-Dimensional Freezing of Water Filled Between Vertical Concentric Tubes Involving Density Anomaly and Volume Expansion, Int. J. Heat Mass Transfer, Vol. 36, 2647-2656 (1993).

Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publ. Corp.(1980).

Nanofabrication and Resistance Testing of Metal Coated Silicon Microcontact Arrays

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It has been proposed that an array of pointed tips on one side of an electrical interface will reduce the load required to obtain sufficiently low resistance for microchip testing contacts. The purpose of this project was to fabricate an array of pointed silicon columns, coat them with a layer of tungsten metal, and test the resistance across the contact with a metal probe. Data revealed that the electrical contact through the pointed surface achieved low test resistances at lower loads than the contact through a flat surface.

BACKGROUND

Semiconductor research is always directed at making computers smaller, faster, and more powerful. One of the next possible advances in computer technology will come in the form of modules and nanotechnology. Modules are bundles of pre-packaged microchips hardwired together to minimize the distance for an electrical impulse to travel. Researchers who work in the area of nanotechnology are searching for lithography techniques and procedures that will provide increasingly small features on the chip circuitry. But with both of these innovations, the current method of chip testing has become obsolete. Modern testing uses small probes that press down on contact pads and test the voltage across the circuits. But with the smaller features requiring more testing contacts and the need for pre-packaged testing, the load increases while the area decreases. The resultant pressure will cause the chip to fail. It is believed that an array of pointed tips that could be fabricated onto the testing probes or onto the microchip contacts could reduce the load required to make an adequate testing contact. These pointed tips would provide a reproducible low impedance contact by minimizing the asperitic effects, and piercing any oxide or contaminant layer on the surface of the probe. This report will describe the tip fabrication process and document the results of the resistance testing.

EXPERIMENTAL METHODS AND MATERIALS

The arrays of tips were fabricated using photolithography, selective ion etch and metal deposition techniques. All fabrication steps were conducted at the Cornell Nanofabrication Facility (CNF). Silicon wafers were obtained that had an 800 Å oxide layer. The wafers were hexamethyl disilane vapor primed in the YES oven for 34 minutes. Shipley 1813 was then spun onto the wafers at 4000 RPM for 60 seconds. After spinning, the wafers were baked at 115° C for 60 seconds. The wafers were then exposed for 0.6 seconds on the HTG contact aligner using a chrome on glass mask. The mask had two areas that were two dimensional clear field arrays of dots with different periodicities, and a third area was a two dimensional dark field array of holes. After exposure, the wafers underwent a post-exposure bake and were developed in MF 312. After developing, the two clear field arrays generated dots of resist while the dark field array generated holes.

The pattern of dots of resist on the wafer was used in a selective etch process to etch the oxide layer, which was then used to selectively etch the silicon substrate. A Plasma-Therm 72 reactive ion etcher was used for these processes. The wafer was descummed using an oxygen plasma, then the oxide layer was etched using tri flouro methane and oxygen. The oxide etch removes oxide at 325 Å per minute. After etching the oxide, the resist was completely removed in an oxygen plasma. Lastly, the silicon was etched using a sulfur hexaflouride and oxygen etch recipe. This etch is anisotropic and etches silicon versus oxide in a 6.5 : 1 ratio. Therefore, the etch undercuts the oxide layer, forming pillars with sloped sidewalls. By varying the gas concentrations and the etch times, varying shapes and heights of columns were produced. A higher oxygen percentage causes the plasma to etch downward more than sideways, producing

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steeper sidewalls and a higher aspect ratio between height and width. After the etch was completed, the wafers were dipped in hydroflouric acid to remove the rest of the oxide layer.

Metal deposition was conducted in a CVC sputtering chamber. This was the chosen method because chemical vapor deposition of tungsten requires a very high temperature, and was not possible at the CNF. Tungsten metal was chosen to be the surface metal due to its hardness and low resistance. The wafers were placed in the vacuum chamber, ion beam cleaned, and coated with approximately 350 nm of tungsten. The wafers were then removed, the contact pads painted over with resist, then placed back in the sputtering chamber to be ion beamed and coated with copper. This copper coating adhered to the tungsten and allowed wires to be soldered to the area around the contact pads. Then the resist was removed and the tungsten on the tips was exposed. An SEM micrograph of the finished tip array is shown in Figure 1.

The contact arrays were tested on a contact resistance tester in the Cornell University Materials Science department. Gold hemispherical probes were fabricated by melting the end of a gold wire with an acetylene torch and allowing the end to ball up due to surface tension. These probe tips would prevent error due to misoriented contact. The resistance tester places a voltage across the contact, and measures the current as a function of increasing load.

ANALYSIS

The data from the contact resistance tests on the fabricated array was compared with a similar resistance test on a flat surface. (Figure 2) It can be seen that the load required to obtain a particular resistance is lower for the contact array than for the flat surface, or equivalently, the resistance is lower for the tip array than for the flat surface at the same load.

A second series of wafers have been fabricated with sharper points to try and further reduce the resistance of the contact. It is hoped that an optimum size and dimension for an array of pointed tips can be found that will bring the load and resistance to a minimum.

CONCLUSION

In order to test smaller, more closely packed electronic chip features, a method of reducing the load required to achieve sufficient electrical contact must be found. It has been demonstrated that a fabricated array of pointed tips on one of the surfaces reduces the resistance across the contact. Arrays were fabricated that attained a low resistance at lower forces compared to a flat surface. Research is currently being conducted to try and find the optimum size and dimension of pillars that will achieve the lowest resistance for low loads.

ACKNOWLEDGMENTS

This research was made possible by a grant from the National Science Foundation, and was conducted at the Cornell Nanofabrication Facility and the Cornell University Materials Science Center.

REFERENCES

Hill, J., "Isolated Contact Physics on an Area-Array Flex Circuit Connector," Master's Thesis, Cornell University, 1993

Ongchin, S., "Contact Physics of Pressure Engaged Separable Interconnects for Wafer Level Testing," REU report, Cornell University, 1995

Ortiz, A., "Optimal Dimensions of Metallic Arrays for Low Impedance Contact Pads," REU Final Report, Cornell University, 1995

Van Der Heide, M., Ongchin, S., Zhou, C., Korhonen, M., Li, C.Y., "Tungsten Coated Microcontacts," Contract Review, Cornell University, 1996

Yap, J., "Fabrication and Testing of Tungsten Coated Silicon Columnar Arrays for Low Impedance Electronic Chip Testing," REU report, Cornell University, 1996

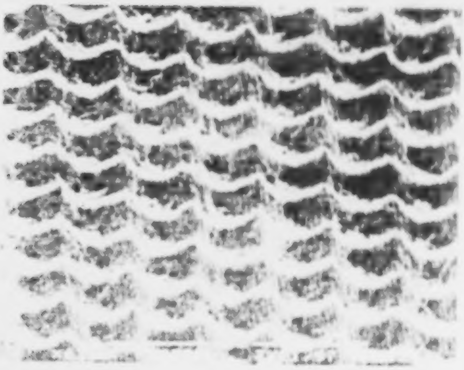

Figure 1: SEM micrograph of Tip Array. 4 microns spacing between tips.

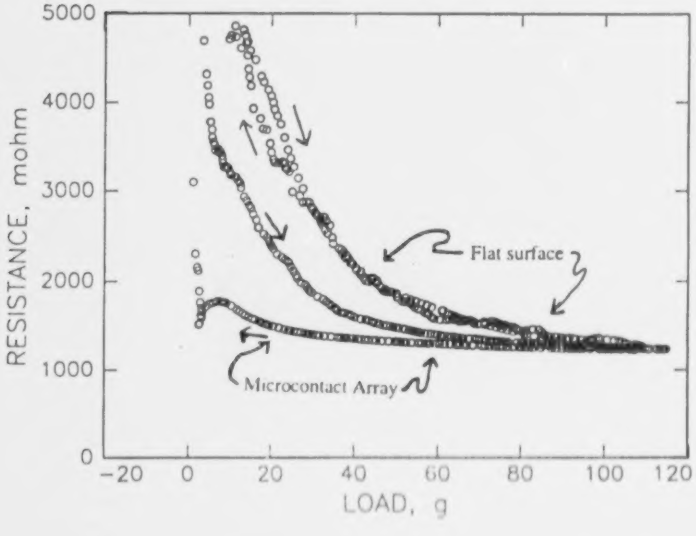

Figure 2: Resistance versus Load Plot for Contact Resistance Tests
Arrows indicate the direction of loading

The Effect of Razor Notching Techniques on the Fracture Toughness of Polymeric Materials

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The objective of this research is to find the effects of different razor notching techniques on the fracture toughness values of brittle and ductile polymers. Three brittle polymers are tested, polycarbonate, PMMA, and Lexan. PVC is the only ductile polymer being tested to date. A modified razor blade with teeth (thus resembling a saw) is being used to induce a stress free crack tip as opposed to the use of a regular razor blade suggested in the ASTM 5045-91A standard. Photo-elastic observations show that the crack tips of polycarbonate are virtually stress free when the modified blades are used. Also, it can be observed that using the modified blade gives more conservative fracture toughness values for PMMA, and it also reduces the variability in the results. The effect of the modified blade on PVC is being studied.

INTRODUCTION

Fracture toughness is the ability of a material to resist crack growth when it is loaded in tensile mode. In ductile polymers this material property is equivalent to the J-integral. Currently, the ASTM D5045-91A standard is used to evaluate this material property in brittle polymers. However, no standard exists to evaluate the J-integral in ductile polymers since, due to the viscoelastic behavior of these materials, it is very difficult to determine when the crack growth starts. Due to the notching method described in the ASTM D5045-91A standard (in the case of the brittle polymers) it is suspected that some error is introduced before testing that results in values that are either too high or too low. Therefore, the objective of this research is to test new notching methods that will induce crack tips resembling as much as possible a natural crack which in turn will reduce the error in the fracture toughness values found. For brittle polymers fracture toughness is calculated with the following formula:

$$K_{IC}=(P_Q/B)\cdot W^{1/2}\cdot f(x) \qquad (1)$$

P_Q = maximum tensile load W = width of specimen
B = specimen thickness $f(x)$ = function of a (the initial crack length)

For ductile metals the J-integral is calculated in the following way:

$$J = A\cdot n/B_n\cdot b_0 \qquad (2)$$

A = Area $n = 2+0.522\cdot(b_0/W)$
B = Specimen thickness b_0 = uncracked ligament

NOTCHING METHOD

The notching method proposed is a modification to the one described in the ASTM 5045-91A. It consists of using a serrated blade as shown in Figure 1, and creating the final notch with the use of a shaper machine. The use of the shaper machine creates the final notch in a sawing motion at a constant rate, and it controls the length of the final notch on all specimens. The idea behind using a serrated blade was to try to minimize the stresses created around the crack tip radius as well as decreasing the crack tip radius. This method was applied to all brittle and ductile polymers tested.

TESTING PROCEDURE

Compact test specimens were used with the dimensions shown in Figure 2. Three sets of ten specimens were tested for each brittle and ductile material. Five specimens were notched using the modified blade, and the other five using the regular blade for comparison purposes. The final crack tip which is 0.025 in. was created using a shaper machine. The shaper machine created this final crack at a constant rate and allowed to control the length in all specimens. Polycarbonate samples were viewed under a polariscope. The polycarbonate, polymethyl-methylacrylite, and Lexan specimens were loaded to failure in order to calculate the fracture toughness value. The polyvinylchloride samples were tested using the multiple specimen techniques.

CONCLUSION

Polycarbonate was the first material tested due to its photo-elastic properties. Using the modified razor blade on polycarbonate revealed that virtually no residual stresses were present after the notching whereas the regular blade produced highly visible stresses around the crack tip (see Fig. 4). In addition, an analysis with a scanning electron microscope (SEM) revealed that the crack tip radius was smaller for the modified blade compared to the regular blade. From Table 1 it can be seen that in the case of PMMA the fracture toughness values and the standard deviation are lower when the specimens are notched with the modified razor blade than with the regular blade. In the case of Lexan, there is not much variation in the fracture toughness and standard deviation values. These results suggest that every polymer is affected differently depending on the notching method used. In the case of PVC the J-integral values vs. crack growth reveal very similar trends when either the serrated of regular blade is used. However, more testing has to be done on PVC to settle the issue.

REFERENCES

ASTM Standard D5045 -91 A

Plain Strain Fracture Toughness and Strain Energy Release of Plastic Materials

ASTM Standard E813-89

Standard Test Method for J1c, a Measure of Fracture Toughness

Hertzberg, Richard W. Deformation and Fracture of Engineering Materials. 3rd Ed. New York.: McGraw Hill,1990.

Figure 1. Modified Razor Blade

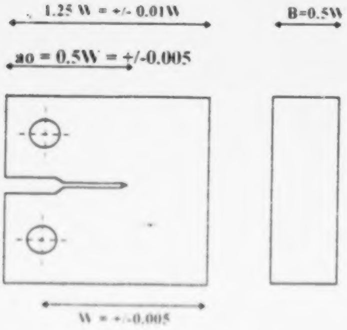

Figure 2 Compact Test Specimen

Table 1 Fracture Toughness Values and Standard Deviation for PMMA and Lexan
*T-notch refers to modified serrated blade

K1c MPa*m$^{1/2}$				
MATERIAL	PMMA	STD	LEXAN	STD
R-NOTCH	3.491	1.0228	3.886	0.3823
T-NOTCH	2.992	0.8164	3.832	0.3832

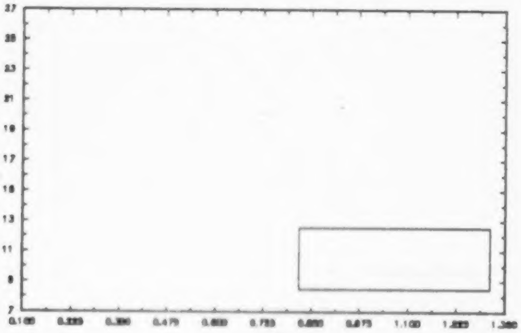

Figure 3 J-integral vs Increment of crack growth for PVC

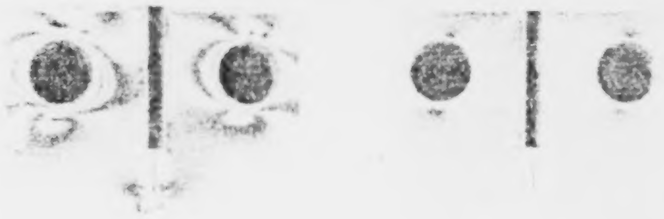

Figure 4. Photo-elastic observations for the crack tip of polycarbonate (left: regular blade, right: modified blade)

Assessment of In-Plane Strength of Carbon/Epoxy Laminates

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Structural laminated composites are being identified for implementation into new generation launch vehicles. There is an increased need to fully understand and predict the failure criteria of these materials, as it is crucial to the success of NASA's current and future goals. There now exists many computer programs which predict the failure of these materials using the finite element technique. However, assumptions about the in-plane strength of composite laminates cause tremendous error in the computer-produced predictions. The objective of this project is to show the errors in these assumptions, proving that the lamination theory is incapable of correctly predicting the failure of composite laminates.

INTRODUCTION

The need for safe, lightweight, less expensive, and more reliable launch vehicle components is being driven by the competitiveness of the commercial launch market. The United States has lost two thirds of the commercial launch market to Europe. As low cost Russian and Chinese vehicles become available, the United States market share could be reduced even further. Additionally, reliable and inexpensive transport to the international spacestation during construction and operation will be critical to its success. This international climate is driving the NASA Reusable Launch Vehicle (RLV) Program. The objective of this program is to make routine transportation to and from space with a totally reusable launch vehicle that has aircraft-like operation designed to reduce the cost per launch by a factor of 10. Achieving this objective will require more efficient uses of materials.

Continuous fiber reinforced plastic (CFRP) composite materials can provide the NASA RLV Program with the material and structural efficiencies needed to stay competitive in the international launch market place. Composite materials offer high specific properties (material property/density) that can significantly reduce the weight associated with launch vehicles. This reduction leads to increases in payload capacity, and reductions in propellant requirements.

In satellite systems, the high specific properties, design flexibility, improved corrosion and wear resistance, increased fatigue life, and low coefficient of thermal expansion that are characteristic of CFRP composite materials can all be used to improve the overall satellite performance. Some of the satellites that may be able to take advantage of composite materials are the Tethered Satellite Systems (TOSCIFER, AIRSEDS, TSS2, SEDS1, AND SEDS2), AXAF, GRO, and the next generation Hubble Space Telescope.

The advantages of CFRP composites material are seldom fully realized because of their inherent complexity and the limited understanding of their fundamental behavior. As a result most composite structures are over-designed, a luxury that the RLV program can not afford.

There now exists many computer program which attempt to predict the failure of composite materials. These programs are based on the classical lamination theory which uses a series of matrix manipulations to determine the failure of a composite laminate. However, this method fails to consider the rich three-dimensional stress states of a multi-ply composite, constraint of adjacent plies, and the statistical nature of the material. L.J.Hart-Smith points out that the current methods of failure prediction are not based on physical phenomenon and fail to consider the micromechanics of composite materials. Many of computer programs now available are being used without concern to their validity. Experimental observation revealed that the computer programs fail to take into account the micromechanics and ply-interaction activities within the composite and therefore, error is present in the prediction of failure criteria.

The remainder of this paper shows that current composite programs are incapable of correctly predicting failure in composite laminates. First, the methodology for this investigation is explained which is followed by a summary of the results gathered from both experimental and theoretical means. Results are then discussed and conclusions stated.

METHODOLOGY

This project used prepreg tape with IM7 fibers embedded in 977-2 epoxy matrix at a volume fraction of 0.6. 12" by 12" square sheets of prepreg material were hand laid up and hot pressed cured. The plates were then cut into 1.5" wide by 12" long specimens. End pieces were not used.

The preliminary specimens consisted of eight individual layers of the carbon fiber/epoxy resin sheets arranged in unidirectional $[0]_s$, ninety degree $[90]_s$, and $[\pm 45]_s$ lay-ups. These specimens were used to generate material characterization data for input into computer models. Six to eight replicates of the specimens were prepared in order to produce statistically significant values for Poisson's ratio, Modulus of Elasticity, and breaking strength. Table 1 shows the results of the preliminary tensile tests. A second set of specimens were prepared for the purpose of observing an onset of failure and the ultimate laminate strength. Three geometry's were used: quasidirectional 1($[+45/0/-45/90]_s$), quasidirectional 2 ($[-45/0/+45/90]_s$), and bidirectional ($[0/90]_s$). These specimens were also hand-laid up and hot press cured. The width of these specimens were 1.5" and their length was 12".

Table 1: Material Characterization Experimental Results

SPECIMEN	REPITITIONS	ULTIMATE BREAKING STRENGTH (PSI)	MODULUS OF ELASTICITY (MSI)	POISSON'S RATIO
$[0]_s$	8	320,000	26.65	0.3342
$[90]_s$	6	7,360	1.62	0.0246
$[\pm 45]_s$	6	38,200	1.66	-

Experimental materials characterization was performed on a 100 kip Servo hydraulic Instron in stroke control. Biaxial strain gages were placed on the specimens in order to determine values for Poisson's ratio. Strain gages on each face of the specimen were used to check for out-of-plane bending. Failure analysis data was generated using ten specimens of each quasidirectional 1($[+45/0/-45/90]_s$), quasidirectional 2 ($[-45/0/+45/90]_s$), and bidirectional ($[0/90]_s$) composite laminates. Each specimen was taken to failure to determine a statistically significant ultimate breaking strength. Additional laminates were then loaded to 20%, 50%, and 90% of the ultimate breaking strength. The specimens were then unloaded and removed from the load frame and subjected to various non-destructive tests (NDE) techniques in order to determine the mode of damage present. Table 2 is a summary of the failure analysis.

Table 2: Failure Analysis/Experimental Results

SPECIMEN	BREAKING LOAD (ksi)	LOADED TO 90% OF BREAKING STRENGTH
Quasidirectional 1 $[+45/0/-45/90]_s$	122.2	Edge delamination No 90 degree cracking
Quasidirectional 2 $[-45/0/+45/90]_s$	137.9	No edge delamination No 90 degree cracking
Bidirectional $[0/90]_s$	145.6	No edge delamination No 90 degree cracking

Both X-ray analysis and microscopy were used to examine the in-plane layers of the composites for the presence of damage. A zinc iodide solution was placed on the edges of the composite laminate and was allowed time to seep down into the specimen to enhance the visibility of cracks. The specimens were then exposed to X-rays using a HP Faxtron and Kodak type 55 film. This method reveals matrix cracking both in and out of the plane of the laminate. The second method used to examine the failure modes in the composite was microscopy. Each specimen was cut into small pieces and then meticulously polished. The polished edge was then placed under a microscope where any damage could be viewed.

Using the information gathered from the preliminary tensile tests, the Composite Pro® computer program, as well as finite element analysis, was used to predict the failure criteria of a quasidirectional lay-up carbon epoxy laminates. Properties of the carbon IM7 epoxy matrix 977-2 gathered from the preliminary tensile tests were used as input for the program in order to calculate the failure modes of the quasidirectional lay-ups. The computer programs predicted the ultimate breaking strength as well as the load at first failure. Table 3 is a summary of the results from the computer modeling.

Table 3: Results from Computer Modeling

SPECIMEN	FIRST FAILURE PREDICTION (ksi)	BREAKING LOAD (ksi)
Quasidirectional 1 $[+45/0/-45/90]_s$	20	130
Quasidirectional 2 $[-45/0/+45/90]_s$	30	140
Bidirectional $[0/90]_s$	40	150

DISCUSSION

Many current computer codes are not capable of correctly predicting the failure of composite laminates. The failure of carbon fiber IM7, epoxy matrix 977-2 composites were experimentally investigated. Experimental materials characterization was performed on $[0]_s$, $[90]_s$, and $[\pm45]_s$ specimens which laid the foundation for input into the computer programs.

Composite laminates can experience two main modes of failure: Intralaminar damage and/or interlaminar damage. Intralaminar damage occurs within the plane of the specimen and shows up in the form of small cracks running transverse to the fibers within the layers of the composite. Interlaminar failure, on the other hand, consists of debonding between the plies of the specimen (commonly termed delamination).

Intralaminar damage occurs as a result of stress on the composite and shows up as cracking within the layers of the composite. First failure, in the form of transverse cracking, commonly occurs within the ninety degree layers of the specimen due to the weakness of the ninety degree plies. The computer programs predict this cracking to occur at a load of approximately 20% of the breaking strength of the laminate. When pulled to ninety percent of breaking, neither the quasidirectional or bidirectional specimens show evidence of cracking.

Interlaminar damage occurs at the edges of the composite in the form of

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debonding between the plies. This type of failure is evident in the quasidirectional 1 specimen at a load of 90% of failure. However, the computer programs fail to predict the delamination of the composite laminates because it assumes that each layer of the composite is allowed to act freely and individually. Boundary conditions are not accounted for by the computer programs.

Experimental failure analysis was performed on $[+45/0/-45/90]_s$, $[-45/0/+45/90]_s$ and $[0/90]_s$ specimens as shown in Table 2. The experimental failure ranged from 122 ksi to 146 ksi. There were signs of debonding between the plies of the specimen (delamination) at loads above 90% of breaking. However, there were no signs of cracking within the individual layers of the composite laminate for any of the different lay-ups.

Computer modeling of quasidirectional and bidirectional specimens is summarized in Table 2. Shown in this table are predictions of breaking load and first failure. Breaking was determined to occur at loads ranging between 130 and 150 ksi. Evidence of first was failure was predicted to occur at fairly low loads, 16%, 21%, and 26.6% of breaking for quasidirectional 1, quasi 2, and bidirectional specimens respectively.

The three dimensional stress states and intralaminar stress are not being accounted for by the computer programs. Evidence of this failure is seen in the experimental results as debonding occurs at the edges of the composite but are not predicted by the computer programs. Boundary conditions, such as layers upon layers, do not allow for the individual layers of the composite to act freely and individually. The computer programs do not take boundary conditions into consideration which allows for incorrect failure predictions.

CONCLUSIONS

Contrary to the program predictions, failure was not evident in any of the layers within the composites. The failure sequence and mechanisms are shown to be incorrectly predicted by the current computer models. Furthermore, the computer programs fail to take the interaction of boundary layers into consideration and therefore, can not predict the presence of delamination in a composite laminate. In order to achieve optimal failure criteria predictions mircomechanics must be employed into the computer programs.

REFERENCES

L. J. Hart-Smith, "How to Calculate In-Plane Strengths of Fiber-Polymer Composite Laminates," SAMPLE Journal, Vol. 28, No. 6, Nov/Dec 1992.

The Design and Development of a Phantom Model for Hyperthermia Cancer Treatment

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The goal of hyperthermia therapy is to raise the temperature of a tumor above 42°C. One clinical problem resulting from the lack of understanding of the mechanisms of bioheat transfer is the difficulty in determining when the tissue has reached 42°C. Phantom models are tissue-equivalent materials used to study bioheat transfer and the resulting temperature distribution.

Three phantom models were designed for studying the temperature distributions incurred by simulated hyperthermia therapy. One is used to study only conduction through the surrounding tissue; one has a straight tubing array to simulate convection due to arterial vessels; while the third mimics capillary perfusion using a simple tubing network. The temperature distributions in each phantom were measured using liquid crystal thermography. Liquid crystal color patterns were apparent when the model was heated within the active range and were recorded by photography. The results were compared to better understand the effect of blood flow.

BACKGROUND

The goal of hyperthermia cancer treatment is to raise the temperature of a tumor to toxic levels, above approximately 42°C (106°F), while keeping the surrounding healthy tissue at normal temperatures. This treatment is based on the fact that temperatures of 42°C or higher can kill mammalian cells.(1) Hyperthermia therapy is often used in conjunction with radiation or chemotherapy. In fact, hyperthermia has approximately doubled the effectiveness of x-ray therapy against melanoma and breast cancer (Hayashi 1993).

There are three modes of hyperthermia cancer treatment. The first is whole-body hyperthermia where the object is to raise the temperature of the entire body to therapeutic temperatures. The advantage of this method is apparent in systemic cancers where the treatment is not local to a specific tumor (Strohbeln 1986), as with other types of therapies, but system-wide.

The second mode is regional hyperthermia therapy. During this treatment, energy is deposited to the general region of the tumor (Strohbeln 1986). The problem with this modality is sustaining the healthy tissue at normal temperatures while achieving toxic temperatures within the tumor itself.

The final type of hyperthermia therapy is local hyperthermia. Here the energy is deposited in the tumor itself with minimal amounts extending to the surrounding tissue (Strohbeln 1986). The difficulty with this is that the tumor must be extremely localized and its boundary well-defined.

Heat can be applied in several ways. The most common are electromagnetic microwave frequencies of 300-2450 MHz, radio frequencies of <300 MHz and ultrasound at frequencies of 0.3-3 MHz.(1) There are two methods of applying hyperthermia treatment: superficial and interstitial. Superficial hyperthermia treatment heats tissue from zero to five centimeters in depth to a temperature of 42°C using an array of heat applicators set up outside of the body (Hayashi 1993).

The second type is interstitial hyperthermia treatment. The heat is delivered to the tumor site by implanted devices. Early techniques used metallic implanted needles. Now, microwave hyperthermia treatment consists of implanted plastic catheters holding a microwave antennae. Also used for heating are interstitial laser and interstitial conductive devices such as ferromagnetic implant seeds, electrical resistance elements and hot water tubes (Hayashi 1993).

The mechanisms of cellular damage after hyperthermia therapy to both healthy and tumorous cells are multiple, complex and poorly understood (Green 1991) and there is no consensus to the importance of each (Perez et. al. 1987). It has, however, been observed that tumors are more heat sensitive than healthy tissue (Pethig) and this is a testament to the theory behind hyperthermia cancer treatment. However, the most important factor in the heat transfer aspect of hyperthermia is the decrease in the blood flow rate within the tumor. The increased growth rate of the tumor creates pockets of cells, or buds (Report on Research 1987-88). The blood flow through these pockets is not as effective due to the random fusion of elongated, dilated, and twisted blood vessels (Perez et. al. 1987). This makes the pockets less susceptible to blood-borne drugs and radiation and more likely to be damaged by heat (Report on Research 1987-88) because they cannot dissipate the applied heat as efficiently as normal tissue (Lagendijk 1984). However, tissue temperature is extremely sensitive to convection due to blood flow; therefore, any large vessel within the tumor will cause a lowering of the minimum tumor temperature. These locations will be under dosed and the tumor will regrow from there (Lagendijk 1984).

One method used by researchers to study heat transfer and resulting temperature distributions is provided by phantom modeling. Phantoms are electromagnetic tissue-equivalent physical materials with bulk electrical and thermal properties similar to those of human tissue (Baish et. al. 1986), the latter being the more difficult to model due to blood flow heat transfer effects (Perez et.al. 1987). The use of phantom models are well established in hyperthermia research (Baish et.al. 1986). However, their use is restricted by the limited number of blood flow patterns available and the difficulty in simulating live tissue (Lim 1988).

Although phantoms have a flow geometry very different from the microgeometry of tissue, they do provide a well-controlled system for examining some fundamentals of bioheat transfer (Roemer 1991). Some examples of phantom models include: dielectric liquids, sponges soaked in saline, mixtures of "superstuff" (polyethylene powder, salt and water), saline-formaldehyde gels, beef, and live animal tissue. There are two distinct types of phantom models: static and dynamic. Static phantoms account only for conduction heat transfer and not convection by blood flow (Perez et.al. 1987). An example of a dynamic model is a solid matrix of tissue-equivalent electromagnetic material in which parallel tubes are embedded. Water is passed through the tubes to simulate the convective cooling effects due to blood flow. A high flow rate ensures that a constant temperature is kept along the tubes. The difference in the temperatures between the tubes and the simulated tissue represents the difference between artery and tissue temperatures respectively (Baish et.al. 1986). The biggest problem facing phantom modeling is simulating the complex microvasculature of the human body (Pethig).

EXPERIMENTAL SETUP

The purpose of this project was to design and construct a phantom model to study the bioheat transfer mechanism. The temperature field calculated using the bioheat transfer equation will be compared to that measured experimentally in the phantom.

Three phantoms were constructed for laboratory experiments. All three were made from a polyacrylamide gel held in a 10"x8"x3" plexiglas container. The gel was covered during storage and testing to prevent it from drying out. Figure 1 shows a schematic of the phantom model and its layers. Each model was constructed using an approximately one inch thick layer of gel on the bottom of the plexiglas container. Two liquid crystal sheets were placed side by side on top of the gel to obtain readings in both the 35-40 degree Celsius range and the 40-45 degree Celsius range. Another one inch layer of gel was placed on top of the liquid crystal sheets. The heating elements were placed every two and one-half inches down the center of the phantom to simulate interstitial hyperthermia. As the phantom was heated, the resulting temperature pattern on the liquid crystal sheets was recorded through the transparent gel by photography.

The dynamic phantom, which simulated large arterial blood flow, contained two parallel tygon tubes (three inches apart). These were embedded within the bottom layer of the polyacrylamide gel in an attempt to duplicate the perfusion effects of arterial flow. The third model simulates capillary blood flow by embedding a network consisting of branching segments of glass tubing instead of the tygon tubing.

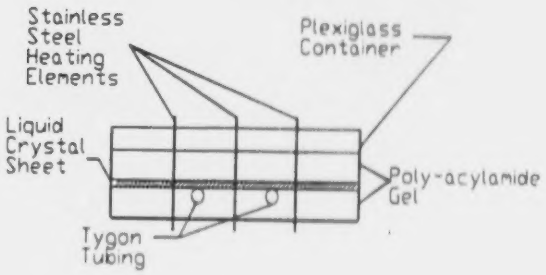

Figure 1: Schematic of Phantom Model

TESTING PROCEDURE

Hyperthermia treatment was simulated by applying a voltage drop across each of the three stainless steel elements implanted into the gel. The current through the wires was 5 Amps while the voltage across each rod was found to be averaged about 0.468 V, resulting in a total voltage of 1.404 V. The total power supplied to the system was approximately 7 Watts, assuming no losses through the lead wires. This power level was determined through trial and error. A higher current burns the polyacrylamide gel, while a lower current will not yield enough energy to reach toxic temperatures.

Tests were run for twelve hours until steady-state was reached. Photographs were taken at distinct time intervals throughout the testing to obtain transient temperature patterns of the liquid crystal sheets. Photographs were also taken once the phantom had reached steady-state. An example of the data obtained is shown in Figure 2.

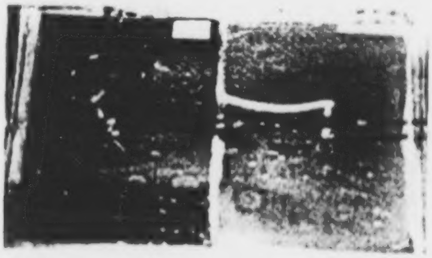

Figure 2: Temperature Distribution Patterns on 35-40 degree Celsius (right) and 40-45 degree Celsius (left) Liquid Crystal Sheets

RESULTS

Figure 3 is a contour graph obtained from the static model. The right side shows the 35-40 degree C liquid crystal sheet; while the left shows the 40-45 degree C liquid crystal sheet. The red start, corresponding to 35°C and 40°C respectively, is indicated by the solid lines; the green start (36,41) is indicated by the dashed lines; and the blue start (40,45) is depicted by the dotted lines. The heat transfer due to conduction alone is shown from (2a) to (2c) as the heat from each heating element begins to interact and spread throughout the gel.

Figure 4 is a contour plot of the dynamic model. The test conditions were the same as they were for the static model. However, water was flowing through the tubes. The figure shows however, a distinct cooling affect due to the "artery" passing through the gel at the locations depicted by the arrows. The convection heat transfer occurring in these locations lowers the temperature of the gel and results in a lower overall temperature reached by the simulated therapy.

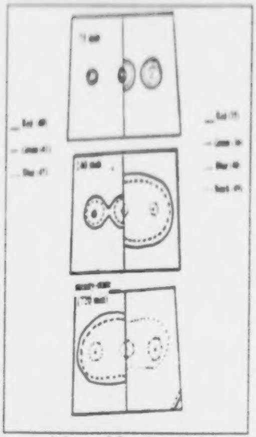

Figure 3: Contour Map of Static Model after (top) 75 min; (middle) 240 min; and (bottom) steady-state.

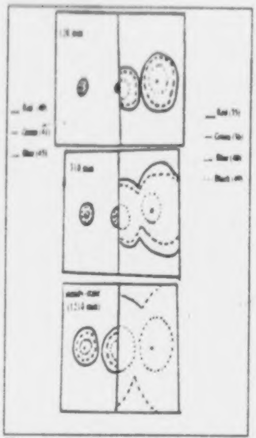

Figure 4: Contour Map of Dynamic Model after (top)120 min; (middle) 310 min; and (bottom) steady-state.

CONCLUSIONS

When comparing Figures 3 and 4, the overall lower temperature resulting from the "artery" running through the tumor is apparent. This, in a clinical situation, could possibly nullify the effect of the treatment since toxic temperatures were not reached throughout the tumor. The tumor can regrow from those cells not damaged and killed during therapy and the disease could spread. This type of analysis is very important is understanding the effect of blood flow in tumors located near large arterial blood vessels and also must be done to understand the effect of capillary perfusion effects in all tissue. Until these bioheat transfer mechanisms are understood, hyperthermia treatment will continue to be theoretically sound but clinically a "trial and error" type of treatment.

ACKNOWLEDGEMENTS

The author wishes to express her appreciation to Professor Mary Carroll for her assistance in preparing the polyacrylamide gel for the each of the three phantom models.

REFERENCES

Hayahsi. "Homing in on cancer cells (Hyperthermia cancer treatment)." *Technology Review* January 1993, V 96 p.12-13.

Strohbeln. "Use of Heat in Cancer Therapy" *IEEE* © 1986

Green. "Hyperthermia Alone or Combined with Chemotherapy for the Treatment of Cancer" *Health Technology Assessment Reports*. Dec 1991

Perez; Emani; Nussbaum; Sapareto. "Hyperthermia" *Principles and Practice of Radiation Oncology*. J.B. Lippincott Co., Philadelphia. © 1987

Pethig. "Phantoms for hyperthermia and Impedance Tomography." *Phys. Med. Biol.*. V 36, No. 12, pp. 1559-63.

Report on Research. "Hyperthermia: Heat-Treatment Research Taps Many Disciplines" Winter 1987-88. V 5, No. 1, pp. 14-17.

Lagendijk. "The influence of blood flow in large vessels on the temperature distribution in hyperthermia." *Cancer Research*. Oct. 1984, V 27, No 1, pp. 17-23. © 1982

Baish; Foster; Ayyaswamy. "Perfused Phantom Models of Microwave Irradiated Tissue" *Journal of Biomedical Engineering*. August 1986. V 108, pp. 239-245.

Lim. "Evaluation of temperature fields in two dynamic phantoms heated by the ferromagnetic implant hyperthermia." University of Arizona. © 1988

Roemer. "Optimal power deposition in hyperthermia. The treatment goal: the ideal temperature distribution: the role of large blood vessels." *Hyperthermia*. 1991 V 7, No. 2, pp.421-430.

International Virtual Design Studio:
Design of a Vehicle Without Wheels or Wheel-like Contact With the Floor

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With the emerging global environment, the requirements of today's engineers are expanding rapidly. Today engineers must be able to collaborate with their colleagues around the world. In response to this new demand, the idea of the International Virtual Design Studio (IVDS) emerged. The IVDS is a joint project between Union College in Schenectady, NY and the Middle East Technical University in Ankara, Turkey. The eight participating students communicated via current internet technologies to design, manufacture, and test a competition vehicle. The project culminated with the Union students traveling to Turkey to submit their vehicle and compete in the day-long class competition. This paper introduces you to the concept of the IVDS (one of the first in the world) and explores both the design process and the design itself, the wheel-less vehicle, in the context of the IVDS.

INTRODUCTION

The last decade has seen an explosion of new technology that has enabled the exchange of information on a world-wide scale. Mirroring this new trend, both large and small engineering firms are increasingly drawing upon the resources of the international community for their expertise and unique perspective. Thus, to prepare future engineers, undergraduate training should have some international component. The objective of this project was two-fold. First, it served as a pilot project to gauge the feasibility of a collaborative design experience between students in remote locations. Second, it gave the students a valuable, international design experience in which they communicated with the students in Turkey to design, construct, and test a vehicle that can successfully compete against other vehicles in the competition.

The idea for the International Virtual Design Studio emerged from a series of three unrelated events. First, an electrical engineering alumnus, returning to Union, explained how his electronics firm had just hired two new engineers, both of whom resided outside of Washington, DC where the firm was located. These new engineers remained in their respective locations and used electronic technologies to communicate with the firm. Second, the idea of a "virtual term abroad" was proposed by a faculty member from Union's East-Asian Studies Program to bring Union College students and students in Asian universities together. Finally, in the spring of 1996, Richard A. Kenyon, Dean of Engineering at Union College, traveled to the Middle East Technical University (METU) in Ankara, Turkey and discussed the possibility of an exchange program between METU and Union College. The idea for the IVDS project was proposed to Dean Platin, Associate Dean of Engineering at METU, who communicated an interest in such a project.

Mechanical engineering students at Union College complete a two-term (20 weeks) capstone design project in their senior year. At the Middle East Technical University, senior mechanical engineering students participate in a similar 16 week-long design competition. The similar project objectives and time frames made a collaborative design project between the two schools feasible. Four Union College students and four METU students were selected. In the spring of 1996, the two students that initially volunteered began to investigate current internet technologies for the project and to design the studio. Their research and work resulted in the pilot design studio shown in Figure 1. The Union College students used this room to communicate with their Turkish partners. Note the large computer screen and curved setup to accompany up to four students. By the beginning of the fall term, the two teams had been formed from the eight students.

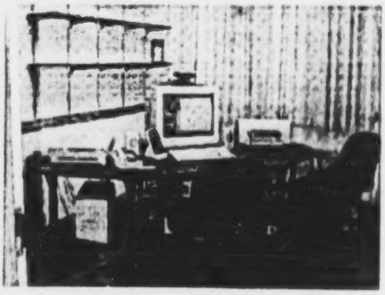

Figure 1: The pilot IVDS room at Union College

The remainder of this paper will discuss the pilot IVDS project. First, the project and competition guidelines is given and then the design and manufacture of the vehicle is discussed. This paper concludes with an overview of the competition.

THE PROJECT

The project assignment was to design a vehicle with no wheels or wheel-like motion to travel down a 30 cm wide path while carrying a minimum payload of 500g. There were two tests during the competition and points were accumulated based on five criteria. In the first test, the objectives were to: (1) maximize the traveling distance in one minute, (2) minimize deviations from predicted values, (3) minimize the energy consumption, and (4) minimize the weight of the machine. In the second test, the objective was to maximize the payload carrying capacity (payload/machine weight). Each side had to manufacture and test their own vehicle and then one machine was be submitted for the competition.

The project was divided into three phases: design, manufacturing, and competition. The first phase involved the design of the vehicle and submission of the design report at the end of the first six weeks. During this phase, the students communicated several times a week over email and through occasional telephone calls. The first step in the design process was brainstorming which was made possible by exchanging pictures of ideas. At this point, all ideas were considered possible design solutions. The students conceived of a hovercraft, an electromagnetically-driven vehicle, a spider-like walking machine, a pushing-motion machine, and a rowing-motion machine. A literature survey was then conducted to investigate past solutions to wheel-less vehicles. Next, a feasibility study was conducted. In this study, each brainstorming idea was critically weighed against the five competition criteria and rated according to how well it could fulfill each criteria. The students also considered the simplicity of each idea, the ability to manufacture, and the availability of standard parts. The pushing-motion machine was chosen for its simple design, reproducible motion, low weight, and its ability to be easily manufactured.

The basis for the pushing-motion machine is a Grashof crank-rocker mechanism that transforms the constant circular motion from the gearbox to a rocking motion. Two legs were used to translate the rocking motion into pushing-motion. Each of the two legs was attached to a foot which would grip the floor and allow the vehicle to be propelled forward. To design the linkage a cardboard model was first constructed to obtain the desired motion and approximate link lengths. Then the link lengths were found analytically. Both the cardboard model and the analytical method resulted in surprisingly similar link lengths. The gearbox was designed to increase the torque and decrease the output speed from the 12V DC motor. The design report consisted of a literature survey, feasibility study, detailed design drawings and calculations, performance values, and was assembled by both the Turkish and American students. Considerable attention was given to the predicted values because points were accumulated based on how well the actual performance values were predicted in the design report.

The next phase in the project was the manufacturing stage. This phase was ten weeks long to ensure sufficient time to obtain supplies and parts, manufacture, test, and make necessary changes. During this time, the students did not correspond as frequently as during the design stage. Communications focused on problems encountered and changes that needed to be made. By the ninth week, the Union vehicle was ready for testing. Several minor modifications were made to optimize the motion and payload carrying-capacity.

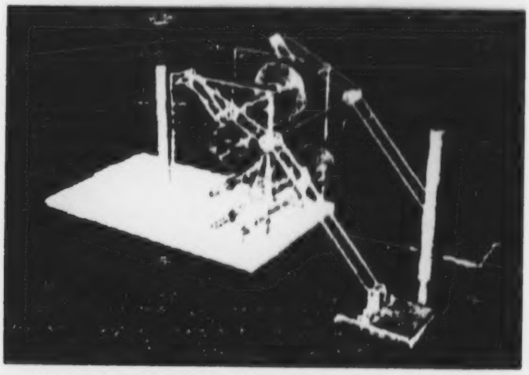

Figure 2: The pushing-motion vehicle with the payload located to the left, the gearbox in the center, and the load-carrying feet at the right.

The final phase of the project took place at the Middle East Technical University from January 27 through January 30, 1997. The four Union students and their advisor, Assistant Professor Ronald Bucinell, arrived in Ankara on Monday, January 27. They were immediately taken to the school where the students met their partners and were given two hours to compare vehicles and decide which one to submit. The author's team chose the U.S. vehicle because it weighed less, traveled faster and farther, and carried more weight. The next day was for a jury presentation. Each team demonstrated and defended their car in front of several professors and graduate students. The teams had to answer questions about why they chose their particular design and they also had to explain differences between the two vehicles.

The competition was held on Thursday January 30, 1997 in an atrium of the mechanical engineering department. Both IVDS teams competed against approximately 17 other teams. Though only the U.S. car competed in the competition, performance values were obtained for both cars.

RESULTS

The table below summarizes the predicted values and performances values for both the U.S. and the Turkish cars.

	Predicted	Turkey vehicle	U.S. vehicle
Weight (gm)	470	820	580
Load carried (kg)	1.25	1.25	1.25
Distance traveled in one minute (cm)	250	220	385
Power (W)	4.11	4	4

DISCUSSION

One of the underlying objectives of this project was for the two groups of students in the United States and in Turkey to design and construct similar vehicles which could indicate the level of collaboration between the two teams. However, to produce two vehicles with the same performance characteristics is a formidable task. The team in the U.S. and the team in Turkey did not have the same access to materials and manufacturing expertise. For instance, in Turkey, many of the teams machined their own gears whereas in the U.S. it was decided they would be purchased from a supplier. Also, the Turkish students had to manufacture their vehicle themselves with limited shop experience and time. However, the U.S. students were not trained nor allowed to use their machine shop. Thus, they relied on professional machinists. Therefore, many of the differences between the vehicles could be attributed to these factors.

The performance values obtained from the two vehicles built by Team 2 can provide some insight into how well the objectives of the project were fulfilled. The similar performance values between the U.S. and the Turkey vehicle indicate that the teams communicated well, particularly during the manufacturing stage when many last-minute changes were made to the vehicle.

The international nature of this project earned it the nickname of the "Virtual Term Abroad." This name may suggest that it is similar to a standard term abroad experience. However, there is an important characteristic that distinguishes a standard term abroad experience from the IVDS project. When a student studies in another country they are experiencing the culture and education firsthand. Since they are immersed in the culture, they can easily gather valuable cues and signals from students and professors regarding expectations, work ethics, and beliefs. However, in a project such as the IVDS, where the students remain in their respective countries for most of the project, the students cannot easily learn the cultural practices and beliefs that may become an important factor in working as a team. Participants should be aware of this missing component so they can still be sensitive to the culture they are working with and make a concerted effort to learn about the culture through other avenues.

CONCLUSION

The IVDS pilot project at Union College offers a unique chance for students to interact with students around the world using current internet technologies. It is a particularly challenging project because though the students remain in their respective countries for most of the project, it requires they make a concerted effort to learn about the other culture. The lessons learned in working with students from other countries can be applied to situations that the engineer will encounter in the academic and industrial workplace. Since the project is academic in nature, it forces the students to draw upon and apply their engineering coursework. Thus, this project gives the students a significant foundational experience in collaborative design from which they can build upon after graduation.

REFERENCES

1 *Engineering Criteria 2000 (For Review and Comment).* Prepared by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET), December, 1995.
2 "International Virtual Design Studio," http://design.me.metu.edu.tr/vds/, September 1996
3 "International Virtual Design Studio," http://tardis.union.edu/me_dept/int_design.html, November 1996

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Heat Transfer Enhancement on a Printed Circuit Board

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A major problem facing engineers today is electronics cooling. Since the 1960s the trend in electronic package design has been towards a reduction of feature size and an increase in the number of electrical components per chip. This has resulted in increased power densities and added difficulty in cooling electronic packages.

This paper presents the design of an air cooling system for one of many components on a high powered, double sided printed circuit card. The new design required optimization of an impingement apparatus which redirects parallel flow to impinge on the component. A computational fluid dynamics model was created using FLOTHERM* which shows that simple cross flow over the components is an insufficient cooling method. The model also shows that impingement cooling increases heat transfer by as much as 17%. A physical model was created to confirm the results of the computer model.

BACKGROUND

A major problem in the design of computers is cooling of the electronic components. The introduction of the integrated circuit (IC) architectures on silicon chips has resulted in a trend of increasing package densities. Since the beginning of the 1960s, this trend has led to a reduction of feature size and an increase in components per chip. This has therefore created a dramatic increase in chip power. In addition, the desire to increase computer speed has motivated engineers to place IC packages closer together. The outcome is the assembly of a great number of chips on a multilayer ceramic module, many of which are placed together on a single board. This results in a power density increase for the chip, module, and system. Therefore, advanced cooling technologies are needed. Otherwise, operating temperatures would be very large which would reduce the reliability of the computer (Incropera, 1987).

There are many methods used in the cooling of electronic components. Each method has significant advantages and disadvantages. One of the most obvious methods is the increase of air flow over the electronic modules. As simple as it may seem, this method comes with several complications. Increasing air flow usually requires a larger air moving device, resulting in less space for the electronic components or a larger electronics package. Another consequence of increasing the flow rate is that a higher pressure drop results. This pressure drop can result in increased noise in the package.

Another simple method of cooling electronics is the application of heat sinks. Heat sinks increase the surface area of the hot electrical components to increase their convective heat transfer. One problem that could arise when using this technique is that the heat sink could cause the air flow to stagnate, depending on the shape of the heat sink, and actually reduce the heat transfer from the component. Therefore, caution should be taken when choosing a heat sink to use.

A third method used often in electronics cooling is the addition of flow barriers which disrupt the flow over the components. These barriers can be designed in various shapes and sizes. They are designed to disrupt the flow over the components by creating vortices. These barriers are sometimes referred to as vortex generators. Experiments have shown that taller barriers provide greater enhancement while also causing a greater pressure drop. The enhancement percentage has been shown to be greater at lower Reynolds numbers (Schmidt, 1991).

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* FLOTHERM is a trademark of Flomerics, Inc.

Impingement cooling is also a successful method of cooling electronics. Impingement cooling refers to heat transfer from solid surfaces using multiple fluid jets. Hollworth et al. (1989) performed an experiment measuring heat transfer and pressure drop for a system of low velocity air jets which imposed forced convection on an array of electrical components on a circuit board. Each component on the surface is cooled by a group of four air jets, and the remaining fluid is vented through drilled holes in the circuit board between components. Therefore the slightly heated fluid can be used to cool components on other boards. The final design created in this experiment, however, did not succeed in using the slightly heated air to cool other components.

This paper presents a new technique for cooling a printed circuit card. The project involves extensive computational and experimental analysis for the determination of the most effective and most feasible cooling method.

PROBLEM SPECIFICATIONS

The particular card to be cooled is shown in Figure 1, which presents a three dimensional view of a mother-daughter card. The larger bottom portion of the card is the mother card and the smaller piece attached to the top of the mother card is the daughter card. The cards are double sided, containing almost all of the same components on each side.

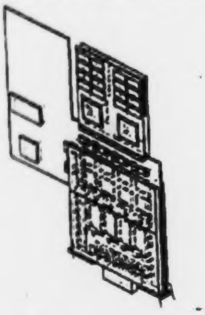

Figure 1: Mother-Daughter Card

The daughter card is approximately 137.50 mm wide and 122.05 mm tall. The main portion of the mother card, that which is directly below the daughter card, is 156.46 mm wide and 206.44 mm tall. Both cards have a thickness of approximately 2.54 mm.

There are many electrical components on each side of the card. The names of the components and their corresponding sizes and power levels can be found in Table 1. The mother-daughter cards are each 2.54 mm thick and are stacked vertically side by side approximately 34.29 mm apart, as seen in Figure 2. Channels exist between the cards through which air flows parallel to the cards.

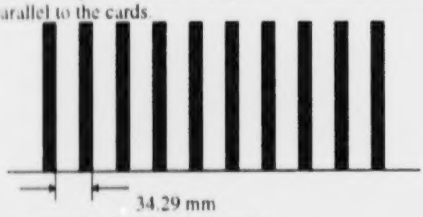

Figure 2: Card Arrangement (10 cards, 9 channels)

Air flows through 38 of these channels at a rate of 400 cubic feet per minute (cfm). Therefore the flow rate in one of these channels is 10.53 cfm. This flow rate corresponds to a flow velocity of 0.45 m/s in one channel.

PROBLEM SIMPLIFICATION

Several simplifications were made on the actual mother daughter card in order to better analyze the system. The system to be investigated would lie within one channel between two mother-daughter cards. Since the mother-daughter card has many components, it was necessary to break the card down into larger components. Figure 3 illustrates the simplified Mother-Daughter card.

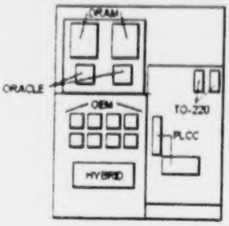

Figure 3: Two Dimensional View of Simplified Mother-Daughter Card

A summary of the changes made to the mother-daughter card can be seen in Table 1.

Table 1: Comparison of Mother-Daughter card and Simplified Version

	Actual Card					Simplified Card			
Module Name	**Power [W]**	**Thickness[mm]**	**Height [mm]**	**Width [mm]**	**Number per side**	**Power [W]**	**Height [mm]**	**Width [mm]**	**Number per side**
DRAM	2.88	16	10.87	20.64	16	23.04	55.41	45.63	2
ORACLE	1.60	2	30.76	30.76	2	1.60	30.76	30.76	2
HYBRID	9.00	4	41.38	25.81	4	36.00	41.38	103.22	1
GEM	3.00	8	22.82	22.82	8	3.00	22.82	22.82	8
PLCC*	0.80	12	14.13	14.13	12	3.20	63.03	14.13	1
PLCC**						6.40	30.43	63.03	1
TO-220*	6.00	2	9.78	16.30	2	6.00	9.78	16.30	2

*only exist on one side of card **second PLCC module on simplified card

Some preliminary calculations indicated that the HYBRID module would be one of the hottest components on the card. For further simplification of the project, the HYBRID module was chosen to be the only component for which a heat transfer enhancement apparatus would be designed.

DESIGN PROCESS

The general design chosen for testing was the insertion of an obstruction within the channel which would redirect the parallel flow perpendicular to the HYBRID module. This was done by inserting an angled plate within the channel. This angled plate contained a hole and a vertical plate which was intended to cause the parallel flow to change direction and impinge onto the component perpendicularly. Figure 4 illustrates the general geometry of this design.

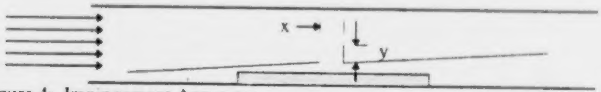

Figure 4: Impingement Apparatus

COMPUTER MODEL

FLOTHERM, by Flomerics, was used to create a computational model to simulate thermal and fluid behavior of the system. FLOTHERM is a commercial CFD (Computational Fluid Dynamics) code which uses a finite control volume technique to break up the problem into a set of non-overlapping, contiguous finite volumes. The conservation equations are solved by iterations for each of these finite volumes. Iterations are performed until the total error falls below a user defined percentage, in this case 1 %. For simulation of turbulence FLOTHERM offers both an algebraic model and a standard k-epsilon model. This project uses the standard k-epsilon turbulence model. A 2-dimensional model was created.

The computer model consists of a simple channel which contains one HYBRID module in the center. Simulations were performed using this simple model without any impingement at various flow velocities between 1 and 10 m/s. The impingement apparatus described was inserted into this simple model and an optimization process was performed to improve the heat transfer on the HYBRID module as much as possible. The optimization of the geometry of the apparatus was performed by varying the size of the opening (x) and the height of the vertical plate(y) as seen in Figure 4. Three sizes of the opening (15,20, and 25 mm) and three sizes of the vertical plate (5, 6.5, and 8 mm) were simulated to determine which geometry would give the best results.

EXPERIMENTAL MODEL

An experimental model was created for comparison with the computational results. The experimental model has the exact dimensions as the FLOTHERM model. The model is constructed of Plexiglas and the HYBRID module is made of aluminum. A foil heater was placed between the Plexiglas and the aluminum component. Three thermocouples were inserted into the component to monitor its temperature. Ambient temperatures and the outside temperature of the Plexiglas underneath the component were also measured with thermocouples. Pressure taps were drilled into the top of the channel for measurement of the pressure drop within the channel with a microtector. Experiments were performed at various power levels and flow velocities between 1 and 10 m/s.

The optimized impingement apparatus from the FLOTHERM model will be built and inserted into the physical model. Experiments will be performed similar to the previous experiments and the results will be compared to the computational results for the impingement apparatus.

RESULTS

The computational and experimental results for the simple parallel flow test agree amazingly well. Plots of Nusselt number vs. Reynolds number and Friction Factor vs. Reynolds number were created to make the comparison, as seen in Figures 5 and 6.

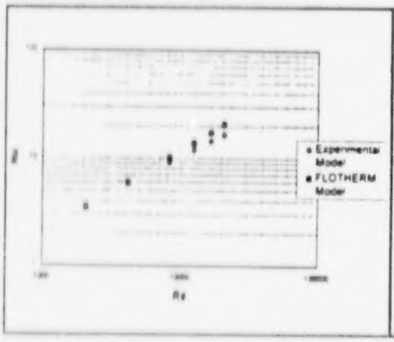

Figure 5: Effect of Velocity on Heat Transfer (Parallel Flow Case)

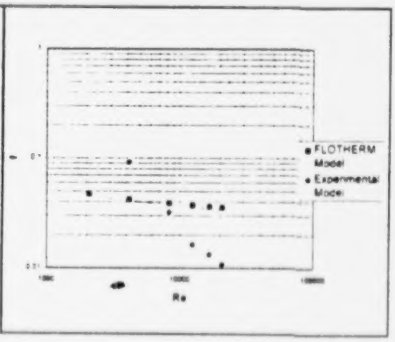

Figure 6: Effect of Flow Velocity on Friction Factor (Parallel Flow Case)

Figure 5 illustrates how FLOTHERM accurately predicted the heat transfer on the component. As flow velocity increases, the difference between the computational and experimental results increases. Figure 6 presents a great difference between the prediction of the friction factor and the actual value determined experimentally. As flow velocity increases, the friction factor decreases in the computational and experimental results. However, FLOTHERM predicts a more gradual decrease in friction factor than the experimental results indicate. This difference is most likely due to the fact that there is a great deal of error associated with the pressure drop measurements. Since the pressure drop measurements are very small in magnitude, the error is a large percentage of the readings.

Experiments have not yet been performed on the new impingement apparatus. However FLOTHERM simulations have been performed to optimize the geometry of the apparatus. The results indicate that the largest size opening (25 mm) and the largest size vertical plate (8 mm) give the best cooling results. This was determined by taking into account both heat transfer enhancement and pressure drop. A plot of the pumping power (Nusselt Number vs. the product of Reynolds Number and Friction Factor raised to the 1/3 power) of the system was used to compare the geometries with each other and the parallel flow case. Figure 7 presents a FLOTHERM drawing of the velocity vectors for the best impingement apparatus. Figure 8 shows the improvement in heat transfer when using the best apparatus.

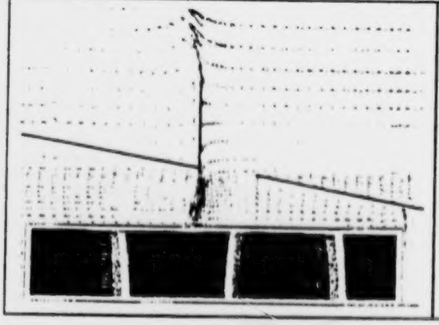

Figure 7: FLOTHERM Velocity Vectors for Best Impingement Case

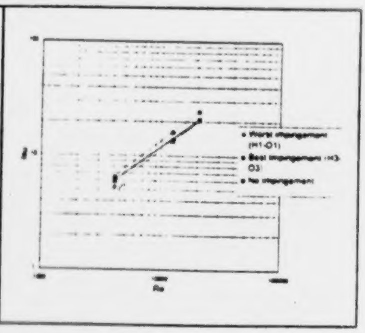

Figure 8: Effect of Flow Velocity on Heat Transfer (Computational Results Only)

Though the heat transfer is much improved using the best impingement apparatus the pressure drop is increased as well. Therefore, the simple flow data points on the plot of pumping power lie above those of the impingement cases. When determining the best and worst impingement geometries, the apparatus with the largest opening and the largest vertical plate gives rise to data which lies above that of the impingement apparatus with the small opening and small vertical plate, on the pumping power plot.

CONCLUSIONS

Impingement has been shown to improve the cooling of at least one component on the mother-daughter card. The best design of the impingement apparatus has an 8 mm high vertical plate and a 25 mm wide opening. Though the impingement apparatus results in a relatively high pressure drop, a 17% increase in heat transfer is achieved at a flow velocity of 10 m/s.

ACKNOWLEDGEMENTS

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REFERENCES

Garimella, S.V., Schlitz, D.J., 1993, "Reducing Inter-Chip Temperature Differences in Computers Using Vortex Generators in Forced Convection," Journal of Electronic Packaging, Vol. 115 No. 4.

Hollworth, B.R., Durbin, M., 1989, "Impingement Cooling of Electronics" Heat Transfer in Electronics, HTD-Vol. 111.

Incropera, F.P., 1987, "Research Needs in Electronic Cooling," Proceedings International Symposium on Cooling Technology for Electronic Equipment.

Lee, Jing, et al., 1991, "Enhancing Heat Transfer Rate for Simulated Packages by Vortex Generators," Journal of Chinese Society of Mechanical Engineers, Vol. 12, No. 1, pp. 62-69.

Schmidt, R.R., 1991, "Convection Cooling of Electronic Equipment," IBM Technical Report TR 00.3620.

Voegler, G.R., and Anderson, A.M., 1996, "Liquid Crystal Visualization and Computer Modeling of Enhanced Heat Transfer on a Plate in Forced Convection," Proceedings of the 1996 National Heat Transfer Conference.

A Study of Data Issues in the GIS Environment

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ABSTRACT

Government agencies, industry and national laboratories acquire and store large amounts of geographic data collected from satellites, ground studies and other sources. The data can be used to study such things as the movement of Africanized honey bees and the placement of bridges. A Geographical Information system (GIS) is a computer-based system that provides the means to manage, manipulate, and analyze geographically referenced information, *i.e.*, data identified according to its location. Numerous off-the-shelf computer software packages exist that accomplish some or all of these functionalities. In the GIS environment, it is necessary to write software programs that interact with existing or off-the shelf software. A major issue deals with the amount, storage and format of data and its communication between programs. This paper discusses these issues and reports some preliminary findings of a fields study that we are conducting within the GIS community that may exist in writing cooperating programs.

INTRODUCTION

Government agencies, industry, and national laboratories acquire and store large amounts of geographic data collected from ground studies and other sources. The data can be used to study topics such as the movement of Africanized honey bees, land usage, and the placement of bridges. A Geographical Information System (GIS) is a computer-based system that provides the means to manage, manipulate, and analyze geographically referenced information, *i.e.*, data identified according to its location. Numerous off-the-shelf (OTS) computer software packages exist that accomplish some or all of these functionalities. In the GIS environment, it is necessary to write software programs that interact with existing or OTS software. A major issue deals with the amount, storage and format of data, and its communication between programs. This paper discusses these issues and a pilot field study being developed. The objective of the study, targeted for GIS users and developers, is to identify the issues that exist when writing cooperating programs.

The paper presents a background on GIS in section 2. Section 3 discusses the issues that are present when developing a GIS—the focus of the survey. Section 4 describes a survey instrument that will be used to determine the problems that users and developers encounter in using or developing a GIS. The last section presents a summary and discusses the future research effort.

BACKGROUND

GIS technology can be used for scientific investigations, resource management, and development planning. The types of analysis that this system must provide are measurement, mapping, monitoring, and modeling usually called the four M's of a GIS [Star 1995]. *Measurement* is concerned with storing data with various environmental parameters. A GIS must be able to retrieve old data and collect new data both efficiently and accurately.

The information may be combined with data from different sources to provide data about a region. A concern, then, is the ability to form comparisons on separate types of data. The feature of GIS that deals with integrating different types of data is referred to as *mapping*. For example, a system may allow one to relate information about the amount of rainfall to an aerial photograph of a region, providing information about which areas of the region tend to dry up at certain times of the year. Mapping data from numerous data sets permits more intense studies of regions to be conducted.

A GIS should also allow a user to *monitor* changes in data over periods of time. For example, if a GIS can store data measurements taken at different points in time, a researcher can monitor changes that may occur in these areas.

Modeling allows a user to create models based on relations. For example, given an aerial photograph of a region and elevation readings taken from remote sensing, a model of a region could be produced allowing a more detailed study of the landscape.

Systems that provide the features discussed here can be created using OTS software. Software packages such as ESRI's ArcInfo, exist that provide all of the features in one package. ArcInfo is a series of six integrated software modules that provides basic GIS tools and utilities for cartographic design, query data entry and editing, data translation, polygon overlay and buffering (image processing), network analysis, and modeling. A GIS can also be constructed by combining the different software packages that provide features necessary in such a system. A database management system such as Oracle7 can be used to store, manage and query spatial or multidimensional data. Image processing software, such as PCI's ACE, provides a complete environment for producing digital maps, integrating both vector and raster information. In addition, it includes a complete cartographic editing environment. Networking software such as Novell could also be used to create a GIS.

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ISSUES AND SURVEY FOCUS

There are a number of issues that should be considered when developing systems in the GIS domain. These issues include the storage of data sets, handling of multiple formats, precision issues, and the integrity of the data in a GIS. GIS typically handles large amounts of data that are stored in one or more databases. It is the central part of a GIS, and must be taken into account by a developer.

One characteristic that distinguishes GIS from other computer applications is that a GIS typically uses many different types of file formats, such as raster, vector, and image data. For example, if a developer wishes to use an existing OTS database to store the data, an image processing software package that provides mapping features, and a custom-built application, then determining how the multiple packages store and operate on data must be communicated to the relevant stakeholders.

Another issue that must be considered in GIS is the precision of data. Data used for geographical studies can vary greatly in precision. Because higher resolution of data requires considerably more storage and processing time, multiple data sets may be available for the same physical area with varying resolutions. A developer who plans to interface OTS software with a custom-built application must realize that the data may vary in precision. Consider, for example, a database package that uses 32-bit numbers, and an image processing tool that interfaces with a database that uses 64-bit numbers. Because of the differences in precision, there may be loss of data during computation. Providing specifications of interfaces of the software packages that include this information would alert a developer to these types of changes.

The final issue deals with the support of integrity checking. In a GIS, data integrity is critical as data is transferred from one software component to another. Invalid data input can significantly modify information used in a study.

In order to integrate multiple software packages and, possibly, custom-built software, it is necessary to understand how the various components communicate and behave. A software architecture specification helps with analysis of the connections of a system being built because it defines the system in terms of computational components and the interactions among those components. In addition, it defines the different functionalities of the components that make up the system. Through an Architectural Description Language (ADL) [Luckham 1993] [Wiederhold 1992] [Luckham et al. 1995], the behavior, connections, and constraints of a system can be defined which allows verification of system integration. Software architectures and selected specification languages are explained in greater detail in [Acosta and Alvarado 1997].

Identifying and categorizing the ADL's that are well-suited for describing software programs in the GIS domain is a central issue. It is essential that the architectural language addresses the issues related to communicating data between components in a GIS, *i.e.*, file formats, precision, integrity of data, and other relevant information. Before looking at architectural languages as a means of specifying OTS and custom-built software in the GIS domain, several questions must be answered:

1. Do organizations have a software staff to create custom-built software in order to meet their special needs?
2. Do users find that OTS software is sufficient for their applications?
3. Is it necessary to integrate OTS software in order to get the functionality needed? If so, are the packages integrated into a single system, executed as stand-alone or piped?
4. Are hybrid systems, *i.e.*, systems built from both OTS and custom-built software, being developed?
5. If the answer is *yes* to any of the last two questions, then the following questions arise:
    (a) Do file formats, precision issues and integrity of data create problems when integrating systems?
    (b) Is an architectural specification language expressive enough to capture the properties that must be communicated in the GIS environment?
    (c) What problems occur when integrating systems in the GIS world?

The intent of the survey instrument that is described next is to find answers to these questions from the GIS community.

THE SURVEY INSTRUMENT

The survey questions are divided into five major categories: user profile, hardware platforms, OTS software, custom-built software, and data descriptions. The user profile allows us to analyze the data based on the perspective of the respondent. The intention is to survey end-users as well as developers. We are also interested in separating those developers that are Computer Scientists and those that are domain experts in order to determine if the issues vary. This section also identifies the applications of the users including their field of interest.

The section on hardware platforms is used to determine if the hardware restricts the type of OTS software that can be used. In addition, it identifies portability issues. In other words, we want to identify if problems exist when information is communicated across different platforms. The methods used to store the data are also being investigated to determine if it is an issue.

Software concerns are divided into two sections: OTS software and custom-built software. The OTS software section asks the respondent to identify the packages that he or she is using and how the packages are being used (stand-alone, integrated, or piped). There are many different types of software that can be used in a GIS, such as information software, mapping tools, database software, and image processing software. Having specific information on the software will allow us to determine what kinds of software are being combined and how they are being combined. The next section determines if the applications in

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question require custom-built software. Again, we are interested in identifying the packages that are being used and how they are being used.

The last section examines the data issues concerning file formats, data integrity, and precision. Specifically, the intention of this section is to determine whether these areas create problems or have caused problems for the GIS in question. A GIS may potentially use many different file formats and being aware of the formats is necessary to determine whether data migrates correctly between software components. Data is stored with varying degrees of precision and it is important for developers to know information pertaining to differences in precision.

Open-ended questions are included to allow the respondent to convey other issues not asked explicitly by the survey. Selected questions from the survey are given below.

Hardware

1. What hardware platforms are used with your GIS? Check all that apply.

   (a) Desktop computer

   (b) Workstation

   (c) Mainframe

   (d) Other

Software

1. Which off-the-shelf GIS packages are you using? Check all that apply.

   (a) ARC/Info

   (b) PCI

   (c) GRASS

   (d) None

   (e) Other

2. In Table 1, list 1-4 OTS packages that you use most frequently. Rate the documentation of the given features for each of the packages using the following scale:

   0 Not present
   1 Not informative
   2 Not complete
   3 Complete, but could be better
   4 Very informative

Table 1. OTS Frequently Used Packages

Package Name	*Behavior*	*Functionalities*	*Constraints*	*Interfaces*	*Data Formats*

Data

1. What type of image file formats do you use?

   (a) GIF

   (b) JPEG

   (c) EPS

   (d) Other

2. As a developer, did you encounter problems integrating software in terms of the file formats being supported?

   (a) Yes

   (b) No

3. If you answered yes above, please explain the nature of the problem.

In order for the survey to be effective, developers and users in the GIS field must provide information on a number of characteristics pertinent to a GIS. These are reflected in the categories of questions that are present in the survey tool.

The survey is being piloted at the Integrated Training Area Management (ITDS) program under the Directorate of Environment at Ft. Bliss. After analyzing the pilot-test [Fink1 1995][Fink2 1995], the survey will be refined, finalized, and distributed through the Web. The participants will be identified through contacts in the GIS community, notified by mail about the purpose of the survey, and given the address of the web sight where the survey is located. The on-line survey provides accessibility, and the ability to administer it with ease.

After the survey has been administered, organizing the data will be the next step. This involves data entry and data screening, i.e., removing data that is not consistent with the rest of the data set [Fink2 1995].

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[Fink3 1995] Next, the results of the survey will be analyzed. This will require explaining the findings and performing numerical computations some of the data. Through analysis, we hope to determine if the existing architectural specification languages are capable of describing the packages sufficiently. Finally, we will report the results and distribute them to the participants.

SUMMARY

GIS is applicable to scientific investigations, resource management, and development planning. These systems can be created using OTS and/or custom-built software. Frequently, systems must be built that integrate the software packages, requiring knowledge about the package's interface. Defining the system's software architecture through an ADL is beneficial; however, the language that is chosen to specify these systems must be capable of capturing knowledge that may be specific to this domain of problems. In order to determine if the issues identified in this paper are indeed issues and to discover other relevant problems, a survey instrument is being developed. The survey categorizes the information being sought into four sections: user profile, hardware, software, and data. The results of this survey will be the first step in determining whether the present ADLs are expressive enough for the GIS arena.

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REFERENCES

[Acosta and Alvarado 1997] Acosta, J. and Alvarado, L., "Issues in Defining Software Architectures in a GIS Environment", *Proceedings on NASA URC-TC, VOL 1*, Jamshidi, M. *et al* (Eds.), Ace Center Press, Albuquerque, NM (1997), pp. 13-18.

[Fink1 1995] Fink, A., *How to Ask Survey Questions*. London: Sage Publications, 1995.

[Fink2 1995] Fink, A., *How to Analyze Survey Data*. London: Sage Publications, 1995.

[Fink3 1995] Fink, A., *The Survey Handbook*. London: Sage Publications, 1995.

[Luckham et al. 1995] Luckham, D., et al. "Specification and Analysis of System Architecture using Rapide", *IEEE Transactions on Software Engineering*, 21(4):336-355, April 1995.

[Luckham 1993] Luckham, "Micro Rapide: An Architecture Description Language", *Journal of Systems and Software*, 21(3):253-265, June 1993.

[Star 1995] Worboys, M., "GIS: A Computing Perspective", Bristol: Taylor and Francis, 1995.

[Wiederhold 1992] Wiederhold, G., Wegner, S., "Toward Megaprogramming", *Communications of the ACM*, 35(11): 89-99, Nov. 92.

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Proceedings — NCUR XI (1997)

Quick Write vs. Quick Run
Implementation Methods for Goal Definition

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In Artificial Intelligence, planning is a process where searching is done in order to generate a sequence of actions to solve a particular problem. UCPOP is a planning system that provides this type of problem solving. When defining a problem or goal, there are different implementation methods that may be used. Each implementation method has an effect on the computational process of the planner. In this paper, an examination of the computational and notational tradeoffs was done between the following three implementation methods: (1) defining a goal using primitive predicates, (2) defining a goal using a special domain-level operator, and (3) defining a goal using higher level axioms.

INTRODUCTION

The field of artificial intelligence(AI) is based on the study of intelligent entities. Research done in this field has one primary motivation: to examine intelligent behavior so that it may be emulated and understood through the use of computers. One aspect of intelligent behavior is the ability to plan and act so as to achieve one's goals; this process is called "planning." UCPOP is a planning system that represents a planning problem with an initial, incomplete plan, which is called the partial plan. It then attempts to complete the partial plan by expanding it with new steps until a complete plan that guarantees goal achievement is constructed. In order to execute this final plan, the agent must carry out any total order that is consistent with the partial order.

The manner in which a goal is specified can affect not only the planner's execution time for generating a final solution, but it can also affect the amount of notation that the user is required to provide when defining the goal. The use of compact, convenient notation implies hiding the details--the underlying primitive actions that the plan comprises. Since the planner can only achieve primitive predicates, it is necessary to break down abstract goals into primitive ones. How does this affect the manner in which a goal is defined? It simply means that no matter how a goal is specified, the steps used to achieve the goal must be able to be broken down in terms of primitive predicates.

This paper describes the advantages and disadvantages of specifying a goal was done in terms of primitive predicates and specifying a goal in terms of derived predicates and axioms. The research domain, called Beds World, was created in order to conduct experiments on each goal defining method. In the remainder of this paper, there follows a brief description of the research domain Beds World , a discussion of the specific methods of goal definition that were implemented, and a brief conclusion of the results regarding the tradeoffs between compact notation and efficiency.

PLANNING ENVIRONMENT

brief description of beds world

The Beds World Domain is an environment that consists of situations where actions are those that relate to making a bed. This domain contains a set of items that are needed in order to make the bed. The initial location of the items is inside of a trunk until they are retrieved for putting on the bed. In order to retrieve an item from the trunk, the trunk must be open. Only one item may be removed from the trunk at once, which in turn forces the

1131

rule that only one item may be placed on the bed at once. The following provides a description of the actual items found inside the trunk:

1. a fitted sheet, which must be placed directly on the bed
2. a flat sheet, which can only be placed on top of the fitted sheet
3. a pillow, which may be placed on the flat sheet or the comforter
4. a comforter, which may be placed on the bed after or before the pillow

vocabulary

In Beds World, the objects are the bed, the trunk, and the items located inside the trunk. They are denoted by the predicate *item* in the following manner: *(item fitted)*, which simply defines the fitted sheet as an item. The operator for placing one item on top of another is *puton(X,Y)*. This is the main operator that puts items on the bed. For example, suppose *X* is the fitted sheet and *Y* is the bed. The operator *puton* places the fitted sheet on the bed as long as the fitted sheet is not in the trunk and the two items are not the same. *Takeout(X)* is the operator used for removing items from the trunk. It removes one item from the trunk as long as the trunk is open and the item is located inside the trunk. The operators *Opentrunk(trunk)* and *Closetrunk(trunk)* are used to open and close the trunk respectively. See Figure 1 for the formal description of the operators *puton* and *opentrunk*.

goals in beds world

The main goal in Beds World is to successfully make a bed. This means that all necessary materials must be placed on the bed according to their specified order. The pillow and the comforter may be placed on the bed in two different ways: (1) the pillow before the comforter or (2) the comforter before the pillow. These two alternatives provide the planner with a choice when attempting to successfully make the bed. When this situation occurs, it is referred to as disjunctive goals--there is more than one acceptable goal. The use of disjunctive goals makes the process of planning more flexible due to multiple alternatives.

```
( operator puton
        parameters (?X ?Y)
        precondition (and (not (in ?X trunk)) (not (in ?Y trunk))
                                    (neq ?X bed) (neq ?X ?Y)
                                    (neq ?X trunk) (neq ?Y trunk))
        effect (on ?X ?Y))


( operator opentrunk
        parameters (trunk)
        precondition (closed trunk)
        effect (open trunk))
```

Figure 1. Shown above are the formal descriptions of the *puton* and *opentrunk* operators. *Puton* takes two items for its parameters and requires that both items are not in the trunk, not equal to each other or the trunk, and that the item represented by *?X* is not equal to the bed. When these conditions are satisfied *?X* is then placed on *?Y*. For the *opentrunk* operator, its only parameter is the trunk which must be closed. If this is true, then the state of the trunk changes to open.

DISCUSSION OF METHODS FOR GOAL SPECIFICATION

primitive predicates

Primitive predicates are ones that are not defined in terms of other predicates. The planning agent is able to directly achieve only primitive predicates, therefore, in order for any goal to be achieved, it must be broken down in terms of primitive predicates. One may think of a primitive predicate as implicitly defined in the planning system because the

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planning agent "knows" what it means and how to achieve it. The description of the goal using only primitive predicates is as follows:

```
goal (or (and (on fitted bed)
              (on flat fitted)
              (on comforter flat)
              (on pillow comforter))
         (and (on fitted bed)
              (on flat fitted)
              (on pillow flat)
              (on comforter pillow)))
```

In this example, *on* is a primitive predicate because it does not use any other predicate for its definition. As will be shown in the next section, primitive predicates may also be found in the effects of operators, like *puton*, and therefore can be directly achieved by the planner. In other words, the operator *puton* is a way of achieving a state of the world where the predicate *on* is true of two things.

special domain-level operator

A special domain-level operator is an operator that contains the basic steps for achieving a goal. Goals may still be defined in terms of primitive predicates, but the use of a special operator can reduce the number of primitive predicates that are needed. The programmer is now able to define a goal using a small number of primitive predicates leaving most of the detail up to the special domain-level operator. In order to achieve the goal, the planning agent must reference the special operator in order to find the specific details for the goal. To explain how goal completion works using a special domain-level operator, consider the following scenario.

A worker for a delivery service has the assignment of delivering a package to a business in St. Louis, Missouri. The worker's goal is to get the package delivered, but he or she does not know how to get to St. Louis. In order for the assignment to be completed the worker must somehow figure out where St. Louis is and how to get there; therefore, he or she uses a map to find a specific route to St. Louis and is now able to deliver the package.

In this scenario the worker is the planning agent and the goal, i.e. the primitive predicate, is "deliver a package to St. Louis, Missouri." The map represents the special domain-level operator because it provides specific directions to St. Louis. These directions represent the primitive predicates the worker, who is the planning agent, is directly able to achieve. To show the formal notation for goal specification using primitive predicates and a special domain-level operator, the goal was defined as the following: *goal (made bed)*, where *made bed* is the primitive predicate. The special domain-level operator that provided the details, which were also primitive predicates, for achieving *made bed* was defined as:

```
( operator do-goal
     :parameters (?X ?Y)
     :precondition (or (and on fitted bed) (on flat fitted)
                        (on comforter flat) (on pillow comforter))
                        (and (on fitted bed) (on flat fitted)
                        (on pillow flat) (on comforter pillow)))
     :effect (made bed)))
```

In order for the planning agent to execute the goal *made bed*, it must use the special domain-level operator *do-goal* in order to get the specific steps that result in achieving a made bed. The use of a special domain-level operator makes the job of the programmer easier by reducing the number of primitive predicates used to define a goal. However, execution time is prolonged due to the extra reference made by the planning agent to the special domain-level operator. See table 1 for the execution times for each method.

Table 1. CPU times for both primitive predicates and special domain-level operators

Method	CPU Time
primitive predicates	0.1480
special domain-level operators	0.2550

higher level axioms

Axioms define derived predicates in turns of primitive and derived predicates. Using axioms provides a notational advantage for operators. They allow an effective way to describe domains. Even though the notation is beneficial, there is also a disadvantage when using axioms. A performance penalty can result in the use of axioms. These pros and cons of axioms can be seen through the "On" versus "Above" experiment.

The "On" versus "Above" experiment displays the advantages and disadvantages of primitive and derived predicates, with *on* being primitive and *above* being derived.

The first part of the experiment consisted of 25 uses of the primitive predicate *on* specified within the goal. The goal specification using the *on* predicate was defined as the following, where M represents a mattress:

```
goal  (and(on M1 M2) (on M2 M3) (on M3 M4) (on M4 M5) (on M5 M6)
          (on M6 M7) (on M7 M8) (on M8 M9) (on M9 M10) (on M10 M11)
          (on M11 M12) (on M12 M13) (on M13 M14) (on M14 M15)
          (on M15 M16) (on M16 M17) (on M17 M18) (on M18 M19)
          (on M19 M20) (on M20 M21) (on M21 M22) (on M22 M23)
          (on M23 M24) (on M24 M25))
```

The second part of the experiment used the derived axiom *above* instead of the *on* predicate. The derived axiom *above* was defined as the following:

```
( axiom is-above
        context (or (on ?X ?Y)
                    (and (exists (on ?X ?Z) (above (?Z ?Y))))
        implies (above ?X ?Y))
```

The axiom *above* is defined using recursion. This allows one to use more compact notation, which can be seen through the goal specification using the axiom. The goal specification is as follows:

```
goal (forall(mattress ?X) (above ?X bed))
```

The notation using the axiom *above* is more concise than the 25-clause *and* notation used with the *on* predicate. The CPU time using the derived axiom is slower than the CPU time using the primitive predicate. This implies that the uses of axioms result in a performance penalty for the tradeoff of shorter notation. See Table 2 for the execution times for primitive predicates versus higher level axioms.

Table 2. CPU times for both primitive predicates and higher level axioms

Method	CPU Time
primitive predicates	0.074
higher level axioms	0.091

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CONCLUSION

In the area of planning, goals may be defined using several different methods. Depending on which method is used to define a goal, tradeoffs between the notation needed to define the goal and the execution time for achieving the goal may occur. This paper explores the methods of defining a goal by using (1) primitive predicates to explicitly describe the goal state, (2) a special domain-level operator, and (3) higher level axioms.

When using primitive predicates to define a goal, each primitive predicate that is needed in order to achieve the goal must be directly stated. This may force the programmer to provide a large amount of notation depending on the complexity of the problem. One way to reduce the amount of notation needed is to implement a special domain-level operator. The use of such an operator will have as its effect the goal to be achieved. The use of higher level axioms also reduces the amount of notation by using quantification, which allows the programmer to omit intermediate specifications. Although the use of special domain-level operators and higher level axioms make the job of the programmer easier by reducing the amount of notation, they result in an increase in execution time because they both require extra work by the planner.

These results were tested by running three example problems on a research domain, where each problem used a different method to define the same goal. The specific methods that were tested in this research were defining a goal using primitive predicates, special domain -level operators, as with the *do-goal* operator, and derived predicates defined using axioms, as with the *above* predicate. The findings are that primitive predicates allow faster execution time, but require a great amount of notation. Special operators and derived predicates allow a better user interface since less notation is required, but they result in slower execution time.

ACKNOWLEDGMENTS

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REFERENCES

Barrett, A., Christianson, D., Friedman, M., Kwok, C., Golden, K., Penberthy S., Sun, Y., and Weld, D. UCPOP User's Manual, Version 4.0, 1995.

Penberthy, J., and Weld, D. UCPOP: A Sound, Complete, Partial Order Planner for ADL.

Russell, S. and Norvig, P. Artificial Intelligence A Modern Approach, Prentice Hall Inc., New Jersey, 1995.

Weld, Daniel, "An Introduction to Least Commitment Planning", AI Magazine, 1994.

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A Study of Environments For Successful Component Reuse in System Development

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Object Technology (OT), a relatively new computer system development method, has been labeled a "silver bullet" due to its ability to decrease development time by facilitating the reuse of existing system components. However, in order to get developers to reuse existing components, organizations often find that they must create an environment which encourages its developers to reuse rather than rewrite. This research examines the techniques organizations use to successfully motivate their developers to do this. On-line surveys and interviews discovered how organizations build environments which encourage effective reuse. The results provide organizations with the capability to decrease system development efforts by suggesting environments in which developers are motivated to reuse existing system components.

INTRODUCTION

Object technology (OT) is a system development method which allows the encapsulation of data and processes into entities called objects. Because of this close coupling of data and processes, code and its corresponding designs and documentation can be rather easily moved from one system to another. This ability to "reuse" represents one of the biggest advantages in using the OT method.

Reuse is defined as the ability to take a predefined component in an application that is developed in one context with the foresight of "reusing" it in other applications (Karlsson, 1995). This process has the capability to improve software quality and reduce the effort required to build systems. Many claim that reuse, rather than rewrite, allows for the development of more robust and higher quality systems which later cost less to maintain.

Even with such benefits, implementing reuse is not as simple as it may appear. Motivating developers to look into the future while developing present systems is a difficult and daunting task. The notion of reuse has changed the traditional thought process of system developers, as shown in the following quotes:

> *Reuse goes against the grain of the rugged individualism some programmers regard as an inalienable right* (Goldberg, 1995)

> *It is not my code. This is part of the NIH (Not Invented Here) syndrome of making oneself indispensable to assure job security* (Tracz, 1995)

> *Developers are usually trained to analyze a problem and implement the solution. That is, they are taught to think of software development as a complete, independent process. In this approach, using existing code is not encouraged (it's called cheating). Developers often have a strong bias against using another person's work. "I can write this faster than if I try to understand their code" is a common attitude* (Kain, 1994)

Because of the difficulties in breaking old development habits, companies often find it is necessary to provide incentives which encourage their developers to reuse. As Garry Ray points out in his article "Software Reuse Not A Panacea":

> *Programmers must be rewarded for creating reusable modules. Code must be considered a tangible asset* (Ray, 1992)

In order to understand how an organization can provide incentives for its developers to implement reuse rather than rewrite, one should consider general issues in employee motivation. The goal of motivation today, is to get employees to "go the extra mile" (Dessler, 1992). To promote "the extra mile" for reuse, organizations have found the need to create an environment that encourages reuse. Researchers report that it is important for organizations to recognize that money is no longer the incentive which motivates individuals (Hanks, 1991). As Kurt Hanks points out in his book Motivating People, "Often money is a poor motivator, especially if other problems exist" (Hanks, 1991).

Therefore, organizations need to discover what the employees needs are, rather than simply using money as a motivator for encouraging a certain performance. Some nontraditional incentives can be found in increasing an employee's self-worth, professional growth, freedom, confidence, trust, job security, and participation in the planning of the organization's future (Hanks, 1991).

The effectiveness of these incentives indicate that organizations have a new kind of worker with a new kind of attitude towards work. Increasingly, employees are requesting the right to participate in decisions which affect their jobs. It is important for a manager to recognize that "the old methods and expectations of performance will increasingly fail in future job settings" (Hanks, 1991). The idea of dangling a carrot in front of employees to get them to do some sort of task is no longer effective as it once may have been. Rather than forcing them to perform, contemporary views tap the employee's motivation to do a job.

This research explores the issue of motivating system developers to reuse. It developed a profile of twenty organizations who implement reuse by collating the strategies they use. The data will be examined to find common patterns and unique solutions to the success of the transition to reuse within the object-oriented paradigm. Towards this end, the following research question is addressed:

> When implementing Object Technology (OT), what type of environment does an organization create for encouraging its developers to implement reuse?

METHODOLOGY

Through posting to approximately 15 electronic newsgroups on the Internet and e-mailing approximately 400 professional individuals involved in OT, 20 organizations responded to the survey. Each survey requested background information about the organization, strategies used to implement reuse with OT, and a rating of success with their overall reuse plan. A section was also available for additional comments. (See Appendix A) The analysis of the survey data involved searching for common patterns between organizations who implement reuse and the success of their strategies.

RESULTS

In the first set of findings, organizations were asked to rate their success with reuse on a scale of one to four. With one being "not successful" and four being "very successful", this rating was referred to as the RSR (reuse success rate). The most interesting result was the difference between the one organization which rated itself a one and the one organization which rated itself a four. (All others rated two or three.) The reuse strategies between these two organizations were compared and it was found that the organization which reported "not successful" reuse has adopted object-oriented programming only, while the organization with "very successful" reuse utilizes object-oriented analysis and design and management techniques to support the programming development process. Within these management techniques is the management of reuse, so one can see why this organization has a better success with reuse than one which considers only the programming aspects of object technology.

In the second set of findings, organizations checked and described which of the ten particular strategies they use to encourage reuse. Table 1 lists these strategies with the percentage of the twenty organizations who checked each one. The average reuse success rate (RSR) of the organizations included in each percentage appears in the third column.

TABLE 1 Strategies for reuse

	% of 20 org	avg. rsr
Managed Reuse Library	95%	2.1
Reuse Training	75%	2.3
Advertising of reuse program	65%	1.9
Separate Library group	60%	2.2
Techniques for dealing with resistance	55%	2.4
Job positions supporting reuse	50%	2.5
Collaboration environment	50%	2.0
Recognition for writing reusable components	35%	2.3
Recognition for using reusable components	20%	3.0
Reuse management center	15%	2.0

DISCUSSION

To date, information about implementing reuse has been largely anecdotal. While many reports have been written by individual organizations, this study is the first to collate and analyze the strategies.

Ten strategies were examined in this study. The use of each one was compared to an organization's rating of its success with reuse. By far, the strategy which is used the most by the twenty organizations surveyed in this study (95%) is a managed reuse library. This is a repository of software components, which include the code, corresponding design and documentation. Coming in second and third is training in the implementation of reuse (75%) and advertising which promotes the organization's reuse program (65%). The strategy which is used within the least amount of organizations (15%) is the existence of a reuse management center. This is most likely due to the large cost which must be assumed by an organization who attempts to form a center dedicated entirely to the management of reuse.

Second from the bottom, at 20%, appears the recognition for using reusable components. However, although only 4 of the twenty organizations utilize this strategy, it earned the highest average reuse success rate (3.0 on a scale of 4). Some of the ways organizations provide this recognition is through reuse goals on performance plans, and negative feedback. The next highest RSRs were earned among the organizations who have created job positions to support reuse (2.5) and those which have techniques for dealing with resistance to reuse (2.4). Among the job positions are account manager, product manager, software reuse engineer, and infrastructure and technology engineers. Although there are many different titles, the duties include mentoring of staff development personnel, enforcing reuse, and finding new candidate components. Organizations deal with resistance to reuse through training sessions and meetings where examples are shown, reuse metrics are shared, and managers and developers are educated about reuse. Keeping in mind the limited sample, one can cautiously conclude that organizations should consider the use of these three strategies with the highest average RSR when attempting to encourage their reuse program.

LIMITATIONS OF STUDY

The main limitation of this study is the small sample size of only 20 organizations. A larger sample size would have increased the significance of this study, but was not used because this was the first attempt at exploring what organizations are doing to encourage reuse.

CONCLUSION

Object technology is a system development paradigm which holds a great deal of promise, with the facilitation of component reuse from one system to another being seen as the biggest benefit. However, implementing this reuse is difficult. To date, information on how to do this has been largely anecdotal. This study examined the reuse strategies of twenty organizations in an attempt to give a first view of how reuse can be encouraged. It is the first step in helping organizations understand what strategies they may wish to consider when establishing and implementing a reuse plan with object technology.

APPENDIX A

1. For what kinds of projects is your organization using OT?
2. What OO language(s) is/are your organization using?
3. What OO methodology is your organization using?
4. a) How long has your organization been implementing reuse?
   b) How long has your organization been implementing reuse with OT?
5. Briefly explain how your organization implements reuse.
6. Check all of the following which are used to support your organization's reuse strategy
   a)_____ A separate library group which performs quality control of components
   Explain
   b)_____ Training on use of components
   Explain
   c)_____ An environment in which developers collaborate
   Explain
   d)_____Advertisement of reuse program
   Explain
   e)_____ A managed reuse library
   Explain
   f)_____ Job positions which support the implementation of reuse
   Explain
   g)_____ Techniques for dealing with resistance to reuse
   Explain
   h)_____ A well defined reuse management center
   Explain
   i)_____ The consideration of reuse when estimating the cost of a system
   Explain
   j)_____ Recognition for writing reusable components
   Explain
   k)_____ Recognition for using reusable components
   Explain
   l)_____Other Explain
   m)_____ Other Explain
   n)_____Other Explain
7. a) On a scale of 1-4, how would you rank the success for your organization's experience with reuse.
   _____ (1) not successful
   _____ (2) moderately successful
   _____ (3) on the road to being very successful
   _____ (4) very successful
   b) Explain your ranking.

BIBLIOGRAPHY

Dessler, Gary. Managing Organizations In An Era Of Change. Harcourt Brace College Publishers.

Goldberg, Marc. "Reuse in Practice. An industrial perspective". Object Magazine.

Hanks, Kurt. Motivating People. Crisp Publications 1991.

Kain, J. Bradford. "Pragmatics of reuse in the enterprise." Object Magazine. February 1994.

Karlsson, Even-Andre. Software Reuse, A Holistic Approach. John Wiley & Sons Ltd. 1995.

Ray, Garry. "Software reuse not a panacea." Computerworld. December 21, 1992.

Tracz, Will. Confessions of a Used Program Salesman, institutionalizing Software Reuse. Massachusetts: Addison-Wesley Publishing Company, Inc., 1995.

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Digital Simulation Of The Acoustic Guitar: A Physical Model Abstraction

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ABSTRACT

Recent developments in computer hardware speed and specialization have made physical modeling of acoustic instruments a viable method for music synthesis. However, with many diverging schools of thought on the respective roles of software and hardware in the field, it has become nearly impossible to establish benchmarks for the speed or accuracy of the hardware and software components of a given model, or the usability of a given combination. The project's primary goal was to develop an abstract C++ class library that provides a simple delineation of tasks for a complete, functioning acoustic model. The model is separated into interface, representation, and synthesis layers, each representing itself through an intuitive interface. Possible solutions to producing a performance-oriented system are studied, including Fourier-synthesizing ASIC's, scaled-time software, and distributed solutions.

INTRODUCTION

One of the most influential factors upon the music created in any period is the array of instruments and musical tools available to its artists. The twentieth century has seen the advent of widespread use of electronic musical instruments, introducing all varieties of radical new sounds and possibilities to the sonic palette of modern musicians.

There are two classes of electronic instruments: those that convert acoustic events into electronic signals and, in turn, process them (as is the case with electric guitars and the like), and those that synthesize sounds, producing them "from the ground up". Electronic music synthesis is an evolving technology; its history to date can be roughly sub-divided into four functionally and commercially prominent paradigms, each representing an "era" in the development of music synthesis: (1) analog, (2) digital algorithmic, (3) sample playback, and (4) physical modeling. Take note: there are not clear chronological dividing lines between these eras, nor has the dawn of any era led the abandonment of methods and instruments from previous ones. Vintage instruments are a prize to be cherished in the music world, and hybrid instruments are a mainstay.

Analog synthesis produces sounds using basic and well-understood electronic components; the final audio is the product of a series of basic oscillatory behaviors. Production of "realistic" sound by this method is purely coincidental, as basic oscillatory waveforms, envelopes, and filters must be found that simply "happen to" agree with physical processes. Digital algorithmic synthesis (DX, as made popular by the Yamaha DX-7) represents a similar philosophy of sound construction, but in the digital realm and with much greater flexibility. The removal of unreliable analog components (many were known to behave differently as they warmed up from continuous use, causing the instrument to go out of tune) provided a more stable performance platform, and by introducing digital operations to the datastream, programmers could go beyond the simple combinational magic of analog components and use new kinds of modifiers, feedback options, and envelope control. The final audio product was still only a mathematical abstraction, but the conceptual step away from depending exclusively upon natural electrical phenomena was significant.

The next popular technique, sample playback, approaches the problems of synthesis from the opposite end. Rather than (strictly speaking) building a sound, sample playback devices use a sparse set of recordings of an instrument and interpolate to produce the performance audio stream. In terms of simulating a "real" instrument, this was a clear step forward in realism and quality. However, it came at a conceptual cost; the construction of a sound from base components was replaced by the manipulation and combination of audio snapshots. The instrument became represented as a set of samples occurring independently in time.

This brings us to the current favorite for discussion and research, physical modeling (PM). PM techniques attempt to integrate the best of the previous two paradigms: on the one hand, the model is of real behaviors of a real instrument, hopefully producing realism; at the same time, the goal is to actually construct sound from fundamental elements rather than static snapshots, allowing the model far greater realism (Roades).

PROBLEM BACKGROUND

In theory, PM is not mathematically complex. Take, as an example, the 6-string acoustic guitar. Each string is a natural resonator; if some point on the string is displaced, the string will naturally vibrate according to well-known mathematical and physical principles. The vibration's amplitude gradually decays by dispersing energy in two ways: by vibrating the air, producing radiating sound waves, and by alternately pulling and releasing its supports, forcing the front surface of the instrument to vibrate at similar frequencies. This front surface (sounding board) in turn disperses energy by radiating sound waves and vibrating other parts of the instrument (other strings, the sound cavity, etc).

All of these acoustic phenomena are wave-oriented and, by common extrapolation from Fourier's theorem, can be synthesized from a set of sine waves with discrete amplitudes, frequencies, and phase displacements, varying over time.

Starting with a simple string (see Wood for thorough discussion), displacing it at a given point and releasing it causes it to take on an initial triangular shape. This shape is described by a Fourier series, where the amplitudes of each harmonic are described by this equation:

$$a_s = \frac{2\beta l^2}{\pi^2 s^2 d(l-d)} \sin\left(\frac{s\pi d}{l}\right) \qquad (1)$$

(here a_s is the amplitude of the s^{th} harmonic (i.e. its frequency is s times that of the first), l is the string's length, d is the distance of the displacement from an endpoint, and β is the distance of the displacement. Given these initial values, and a fundamental frequency:

$$N_1 = \frac{1}{2l}\sqrt{\frac{F}{\mu}} \qquad (2)$$

Where F is the tension on the string and μ is mass per unit length, we can describe the behavior of a string plucked at time $t=0$ as follows:

$$x(t) = \sum_{s=1}^{\infty} a_s e^{-k_s t} \cos(2\pi s N_1 t + \epsilon_s) \qquad (3)$$

where $x(t)$ is displacement according to time, N_1 is the fundamental's frequency, k_s are decay constants (also available from well-known functions) and ϵ_s are phase constants (zero in this case). These equations are incrementally complicated by factors including string stiffness and loading, support yielding, and so forth.

The subsequent steps become more unwieldy as they progress; the strings are the only components that resonate naturally, and when members of the Fourier series of two individual strings are similar to each other, they produce sympathetic vibrations in accordance with the bell-shaped resonance curve. The set of strings in turn drives vibrations in the body of the guitar and the sound cavity, according to more resonance curves dependent upon the physical descriptions and characteristics of the instrument.

All told, there are simply too many phenomena at work, many of which involve a theoretically infinite set of discrete behaviors. The result is a mathematical quagmire that is simply unsolvable in anything approximating real-time; thankfully, there are at least two popular workarounds. The first is to limit the depth to which the instrument will be modeled, e.g. only representing 64 harmonics of a component or two levels of induction. The second is to represent instruments alinearly, i.e., to represent behaviors not only in terms of discrete components in time, but more (or exclusively) in terms of prior behavior: $x(t)$ is a function of $x(t_0<t)$. Which is the "correct" or "best" approach? No one can say. This is the first part of the problem: there is no "best" methodology for mathematically representing an instrument.

Whatever representation is chosen, the solution of that model at performance-time must be handled by a computer, in which that task must be divided between two components: hardware and software. All told, it is not clear whether hardware, software, or some balanced hybrid represents the "best approach" to executing a model; what's more, the answer is most likely solution-specific.

The problem addressed herein is that of providing a workable standard interface about which one should be able to map a modeling systems onto a hardware/software divide. A template is presented using sets of C++ class libraries, collectively referred to as "PMA" (Physical Model Abstraction). The goal of these libraries is to virtualize interaction between the various components of a working physical model, and provide a method for testing and benchmarking various methods and components used in combination with each other.

SYSTEM REPRESENTATION

For simplicity, the PMA specification assumes that the model will be able to represent its behaviors in terms of sine-wave oscillators. This is not so restrictive as it may appear; a well-parameterized additive sine-wave synthesizer (ASWS) can handle fixed offsets, phase jumps, and other magic that non-linear models may need. The particular PMA library presented also only represents plucked-string instruments (6-string guitar, ukelele, etc); limited groundwork exists for driven-resonator instruments (horns, bowed strings), and these cases are beyond the scope of this project.

A PMA-centered system is decomposed into three parts: the user interface, the physical model itself, and the ASWS engine. The interaction between these layers is defined by the classes composing each layer, which can be arbitrarily implemented in hardware or software.

The PMA library is composed almost entirely of C++ classes; the object-oriented structure was excellent for providing a skeletal functionality and interface, while allowing the normal system-level control of C. A complete specification and source code will soon be freely available on the internet at the PMA web site (Bradley).

WORKING MODELS

No protocol or standard is worthy of substantial consideration until it is shown functional through an at least marginally working implementation. Discussed below are the implementations of a first-principles physical model and two approaches to the ASWS engine.

Demonstration Model: First-Principles Modeling

The excitation of the fully-connected guitar instrument involves the potential total interaction of all components (strings and driven resonators); thus, any change in the system has the potential to propagate in a $O(n^2)$ operation. While escaping the n^2 order is almost impossible for an elementary first-principles model (although conceivable using high-order calculus to represent systematic couplings), a great many optimizations can be performed to produce net reductions in performance and pre-performance calculations.

To reduce storage requirements and list-parsing cost, each string object owns a set of queues representing the oscillators that string is allowed to influence, and how that influence relates to its own particular harmonics. Each of these queues should be pre-created, a classic memory-for-performance trade. The number of queues appears to be quite substantial: each string requires a unique hard-resonator queue for each of its own frets, and each string to string couplings can (through a trick of physics) be characterized by a one-dimensional array, the difference of their frettings (ΔFret).

All told, the final set of queues is representable by these two multidimensional arrays:

```
ResonatorQueue[SourceString][Fret]
StringQueue[SourceString][TargetString][ΔFret]
```

Thus, a potentially massive (and sparse) set of interactions is stored in two easily-accessible arrays of easily-parsed queues.

Demonstration Engine: CPU-Loading

A software-oriented ASWS is not (theoretically) complicated. The state of an individual oscillator is represented by amplitude, phase, ΔPhase (representing frequency), and constant of natural decay. The first two are updated at (theoretically) discrete time intervals, the last as control parameters.

Performance depends greatly upon the choice of internal data formats and operations and the host's ability to perform those operations quickly; however, current common-language compilers (outside of a few academic experiments) cannot handle the selection of data formats to optimize for a given execution environment.

Consider a reasonably complicated model, consisting of 512 oscillators, all of which must be updated and polled at 44.1kHz: over 22 million oscillator updates (66 million values) per second. With a 500MIPS processor (with register-speed memory), that leaves 7 instructions per update, almost impossible with an abstract language or a single-CPU system.

Demonstration Engine: Application-Specific Integrated Circuit

The concept of using an application-specific integrated circuit (ASIC) to perform additive sine-wave synthesis (ASWS) is fairly popular (Houghton 26), but faces problems analogous to those of software-oriented solutions: a highly complicated circuit cannot be clocked any faster than data can propagate through its components, thus restricting how many oscillators can simulated in real-time by a monolithic digital oscillator set. A viable solution is pipelining, breaking an operation into simple sequential components which can be performed serially on an incoming stream of data. The result is a circuit with "stages" that can be clocked quickly, interconnected to allow multiple data to be "in process" at all times.

A high-level model of an ASWS-ASIC was designed with this in mind; it is referred to as "PMA-Impl" and is specified at the PMA web site (Bradley). Design complications such as parallel memory access, data representation, and

Consider the example given for the CPU-Loaded case above, of a fairly involved model with 512 oscillators operating at 44.1kHz. If the proper data input mechanism is provided, the system will do all calculations in real-time with an internal clock of just over 22.5MHz, and requires (if output is direct-to-line instead of back-to-software) zero software overhead.

What's more, the system scales linearly: 1024 oscillators can be handled by clocking the system at 45MHz, and multiple chips can be run in parallel to increase the number of oscillators proportionally. The only constraint is control software speed.

A virtual model of PMA-Impl was constructed using a simple C++ component library. This shows, with clock-level resolution, how the ASIC would perform in real-time. The system is generally sound, although currently suffers a few border-condition oddities.

DISCUSSION: FUTURE IMPLEMENTATIONS

Without the restraint of real-time performance, a great many possibilities are opened up for the modeling layer. There are many theories and approaches that are, for a variety of reasons, simply not practical or performable in real-time. Also of interest is the ability to distribute modeling computations over a loosely-coupled network. Because all control events can be pre-known to the model, the tight coupling needed to do distributed modeling at performance-time is not an issue; this can produce substantial processing-time speedups, potentially (if the distribution process and operations scale well and the system is large enough) allowing computation time to drop below the actual duration of the product audio. This kind of performance would not qualify the model as real-time, however, as it depends on pre-knowledge of performance data, which is by definition unavailable to a real-time model.

The utility of real-time solutions in a commercial market is far more apparent, and it also poses interesting challenges for popular fields of computer science. Perhaps among the most promising avenues to pursue in developing real-time physical models is the use of multi-processing hardware and operating systems. Generally speaking, implementing a real-time physical model in a loosely coupled network is impractical if not impossible. Bandwidth restrictions over serial links and latency and predictability issues for ethernet communications may prevent the kind of microsecond-scale timing necessary to simulate an acoustic system. However, tightly-coupled computers show promise for making real-time software-based synthesis a practical reality; of particular interest is the special case of shared-memory or symmetric multiprocessing (SMP).

Consider, for example, an SMP system with n processors (where n>1), under the complete control of the model system (i.e., no preemptive scheduling and minimal OS processor usage). The first processor is set aside to handle the user interface (generally a minimal task) and the modeling mathematics, and the n-1 remaining processors are all dedicated to emulating the oscillators. The high-end single-processor restriction discussed above is easily overcome if proper memory architecture and safeguards are provided. Porting of a generalized operating system (e.g., a UNIX variant) to such a system would be no small task because of the radical performance restraints on memory layout.

CONCLUSIONS

If physical modeling is to be the next generation of commercial synthesis, then development work must continue in designing software and hardware that will enable it, and standard frameworks around which all varieties of technologies and techniques can be tested would certainly accelerate such work. Approaches taken in this project, including the PMA-Impl ASWS-ASIC, show that complex performance-oriented physical modeling may be realistically doable in the very near future.

What's more, these frameworks provide a vehicle for better understanding the roles and requirements upon all the components of a PM system: not just the model and synthesis systems themselves, but their complete operating environment, including available hardware, operating system mechanisms and policies, and target functionality. Indeed, the goal of this project was not so much to answer the great questions facing this developing field, but to facilitate new ways to discover, understand, and tackle them.

BIBLIOGRAPHY and WORKS CITED

Barabanov, Michael and Victor Yodaiken. Real-Time Linux. Internet. http://luz.cs.nmt.edu/~rtlinux/

Berg, Richard E. and David G. Stork. The Physics of Sound. Prentice Hall. Englewood Cliffs, NJ. 1995.

Bradley, Adam D. The PMA Homepage. Internet. http://www.cs.unca.edu/~bradley/pma/

---. PMA-Impl Specification. Private document. 1996, 1997.

Dannenberg, Roger B. "A Perspective on Computer Music." Computer Music Journal 20:1, p52-56.

George, Alan D. and Steven W. Cook, Jr. "Distributed Simuolation of Parallel DSP Architectures on Workstation Clusters." Simulation 67:2, p94-105.

Houghton, Andy D., Andy J. Fisher, and Thierry F. Malet. "An ASIC for Digital Additive Sine-wave Synthesis." Computer Music Journal 19:3, p26-31.

Jaffe, David A. "Ten Criteria for Evaluating Digital Synthesis Techniques." Computer Music Journal 19:1, p76-87.

Kinsler, Lawrence E., Austin R. Frey, Alan B. Coppens, and James V. Sanders. Fundamentals of Acoustics. John Wiley & Sons. New York. 19XX.

Lapsley, Phil. The comp.dsp FAQ. Internet. http://www.bdti.com/faq/dsp_faq.htm

Lyngmo, Ted. E-mail interviews. 30 January 1996 through 1 November 1996.

Roads, Curtis. "Physical Modeling." Keyboard Magazine, September 1994.

Wood, A.B. A Textbook of Sound. G. Bell and Sons, Ltd., London. 1964.

A Parallel Solution of a Second Order Elliptic System

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This research was focused on the use of a massively parallel processor (MPP) for efficient solution of a second order elliptic partial differential equation with dirichlet boundary conditions on a regular domain. The MPP used was the NASA MasPar MP-1, a SIMD class processor remotely accessed at Morehouse College. The problem domain was discretized with both the 5-star and the 9-star centered difference stencils, and the equilibrium values of the dependent variable computed in parallel at the grid points. The equivalent pentadiagonal system, represented as 5 nonzero vectors, was also solved using the unconditioned conjugate gradient method whose results were used as a testbed for the parallel solutions.

THE PHYSICAL PROBLEM

The problem chosen for the study was a second order elliptic partial differential equation given as

$$\nabla^2 u = \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f(x,y) = -2, \quad 0 < x < 1, \; 0 < y < 1. \tag{1}$$

with boundary conditions

$$\begin{aligned} u(0,y) &= 0, \quad u(1,y) = sinh(\pi)sin\pi y, & 0 \le y \le 1, \\ u(x,0) &= u(x,1) = x(1-x), & 0 \le x \le 1 \end{aligned} \tag{2}$$

The analytical solution of eqn(1), given the domain and the boundary conditions, was found to be

$$u(x,y) = sinh(\pi x)sin(\pi y) + x(1-x). \tag{3}$$

The elliptic equation was a second order Poisson equation which often arises naturally as a model of a number of time-independent physical systems such as the steady state distribution of heat (in which case u is temperature), or the steady state diffusion problem (in that case u is concentration), or the steady state distribution of potential of any quantity where the rate of flow is proportional to the gradient, $\nabla^2 u$. In our study, the Poisson equation was regarded in the context of steady state distribution of heat on a unit square domain, $(0,1) \times (0,1)$.

MATHEMATICAL TOOLS

Because of the regularity of the domain, the finite difference quotients were used for domain discretization. This technique and others not utilized in this study are described in detail in any good numerical texts such as (Burden, 1988) and (Gerald, 1996). The problem domain discretization was carried out by partitioning the domain, $(0,1) \times (0,1)$, in the x- and y-directions using the same width size, h, into n subdivisions in each direction. The result was an $N = (n-1) \times (n-1)$ grid-work whose grid points were ordered row-wise or in what is known as natural ordering. Other ordering schemes exist, and a few of the commonly used ones are the Red-Black, and the Cuthill-McKee orderings (Baucom, 1988).

Next, the second partial derivatives of eqn(1) were replaced by the second centered finite difference quotients to obtain the system approximation

$$\nabla^2 u_{ij} \approx \frac{u_{i-1} + u_{i+1} + u_{j-1} + u_{j+1} - 4u_{ij}}{h^2} = -2. \tag{4}$$

with boundary conditions

$$\begin{aligned} u(0,jh) &= 0, \quad u(1,jh) = sinh(\pi)sin\pi jh, & 0 \le jh \le 1, \\ u(ih,0) &= u(h,1) = ih(1-ih), & 0 \le ih \le 1 \end{aligned} \tag{5}$$

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Note that eqn(4) is the approximation of eqn(1), and that every grid point (x,y) was replaced by (ih, jh). Eqn(4) could be represented symbolically as

$$\nabla^2 u_{ij} = \frac{1}{h^2}\left\{\begin{array}{ccc} & 1 & \\ 1 & -4 & 1 \\ & 1 & \end{array}\right\} u_{ij} + 2 = 0. \tag{6}$$

the representation often known as the *five-star* difference template, for an obvious reason. Following the similar arguments, a *nine-star* finite difference template,

$$\nabla^2 u_{ij} = \frac{1}{h^2}\left\{\begin{array}{ccc} 1 & 4 & 1 \\ 4 & -20 & 4 \\ 1 & 4 & 1 \end{array}\right\} u_{ij} + 2 = 0. \tag{7}$$

was also obtained for the system approximation.

Finally, the above templates were separately applied on each of the interior grid points, and the result was an $N \times N$ linear system of equations, $Au = k$, where the vector k resulted from the boundary conditions and the forcing function, $f(ih, jh)$. The linear system had the following properties. The matrix A was

- a symmetrically banded structure with a semibandwidth of β, (recall that β = n-1, and that "symmetric" implies that $\mathbf{A} = \mathbf{A^T}$).
- diagonally dominant. That is, $|\, a_{ii} \,| > |\, \sum_{k=1, k\neq i}^{N} a_{ki} \,| \quad for\ i = 1, 2, \cdots, N$.
- positive definite. That is, $\forall \mathbf{x} \neq \mathbf{0}, \mathbf{x}^T\mathbf{A}\mathbf{x} > 0$. Hence the system was guaranteed to have nonzero eigenvalues, and, consequently, to be **nonsingular** (that is, have unique solutions).
- highly sparse. That is, most of its elements were zeros. In fact, for the linear system of dimension N = 129 (that is, when $h \approx 0.0078$), 16,641 equations, each with at most five variables, resulted. The matrix **A** then had over 276 million entries of which about 83,000 ($\approx$ 0.03%) were nonzero. Thus, in double precision arithmetic, which was the precision for computations in this work, over 2,000 MBytes of memory space would be needed to hold just the zero elements! In this study, we used data structures to hold only the nonzero elements and thus to enormously conserve the memory space utilized.

COMPUTATIONAL TOOLS

The parallel processor used for all of the computations in this study was the NASA MasPar MP-1 manufactured by the MasPar Computer Corporation. MP-1 is a 16,384-PE, *fine-grained, massively parallel, SIMD-class* processor with *distributed memory*. This processor is said to have a theoretical performance peak of 550 Mflops (double-precision) and 1,200 Mflops (single-precision) (Dongara, 1994). The MP-1 (see figure 1) consists of two major components, the Front End (FE) which is a DECstation 5000 running the ULTRIX

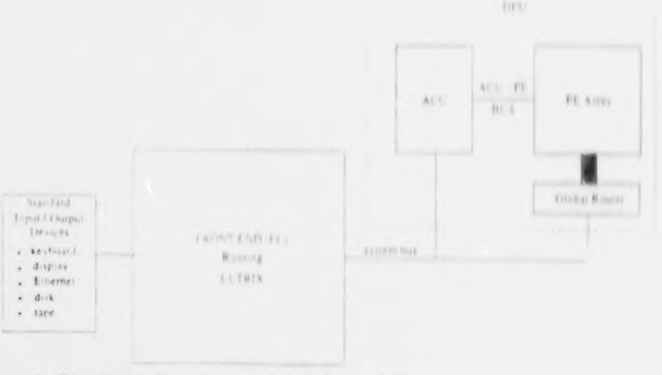

Figure 1. The Major Components of the Maspar MP-1

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and the Data Parallel Unit (DPU) which consists of a control processor known as the Array Control Unit (ACU) and an array of processing elements called the PE Array. The ACU is a register-based load/store processor with its own registers (32 32-bit registers), and a 128Kbyte memory. Each PE is a 1.8 MIPS, RISC-based, load/store processor with its own 42 32-bit registers and a 16KByte RAM. PEs are arranged in a two-dimensional array of 1K, 2K, 4K, or 16K PEs. Our MP-1 has 16K (or 16,384) PEs. ACU is the control processor which performs instruction decode and broadcast to the active PEs in the PE array. Thus the DPU is the only MP-1 component responsible for parallel computation.

The MP-1 softwares fall into two main categories: the Maspar Programming Environment, a very rich source of programming and programming-aiding tools, and programming languages. Presently, MP-1 supports two programming languages: the MasPar FORTRAN (MPF) which is based on FORTRAN 77 and FORTRAN 90, and the ANSI-based MasPar Programming language (MPL), the language of choice in this study. MPF is quite high level, and programming in MPF does not call for a detailed understanding of the underlying hardware. Programming in MPL, on the other hand, calls for a reasonable mastery of the underlying hardware features of the MP-1.

In MPL, a variable belongs to one of the two storage classes: *plural* or *singular*. Any variable (elementary or structured) declared with the key word "plural" is allocated identically on each PE's local memory, whereas any variable declared without the *plural* key word is a *singular* variable which is allocated on the ACU's memory.

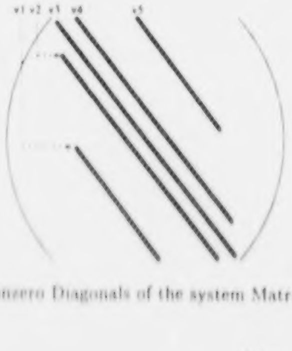
NUMERICAL SOLUTION OF THE PROBLEM

In the parallel computation, the gridwork was regarded as the MP-1 PE array, and each interior grid point as a PE. The simulation used the algorithm in figure 2 below:

```
STEP 1: Choose integer, m, and determine the corresponding grid width, h (see §2.1).
STEP 2: Partition the domain (0,1) × (0,1) to obtain the grid work. Each grid
          point is a PE and the system dimension, N, is the number of active PEs.
STEP 3: Determine the boundary values as elementary plural variables.
STEP 4: Declare 3 plural variables, old_u, new_u, temp_u and a singular parameter, tol.
                    plural double old_u, new_u, temp_u;
                    double tol;
STEP 5: Initialize old_u, and tol. /* tolerance = 10^-9 */
STEP 6: For each active PE DO
        Step 6.1: Simulate eqn(6) (or eqn(7)) getting old_u from neighboring PEs.
        Step 6.2: Update temp_u with old_u, and old_u with new_u.
STEP 7: UNTIL |new_u - temp_u| ≤ tol.
```

Figure 2: Algorithm for Parallel Program

The sequential solution method chosen for solving the linear system was the unconditioned *conjugate gradient* method. Because the system was highly sparse, the nonzero elements of the matrix were held in five vectors v1,···,v5 whose structures are given in figure 3, while the sequential solution algorithm is given in figure 4.



$$v1 = (\overbrace{0, \cdots, 0}^{\beta}, 1, \cdots, 1)$$

$$v2 = (\overbrace{0, \cdots, 1}^{\beta}, 1, \cdots, 1)$$

$$v3 = (-4, -4, \cdots, -4)$$

$$v4 = (1, \cdots, 1\ \overbrace{1, \cdots, 0}^{\beta})$$

$$v5 = (1, \cdots, 1\ \overbrace{0, \cdots, 0}^{\beta})$$

Figure 3: Nonzero Diagonals of the system Matrix and the Vectors to hold them

```
STEP 1: Declare the vectors v1,···, v5, fe_v:

 double v1[N],v2[N],v3[N],v4[N],v5[N];

STEP 2: Initialize v1,···,v5 (see figure 4)
STEP 3: Pass the vectors and N to DPU
 callRequest(Cgrad, 24, v1, v2, v3, v4, v5, N);
STEP 4: Get solution vector, fe_v, from DPU:
 copyIn(fe_v, dpu_v, sizeof(double));

STEP 5: Print out the solution vector.
```

(A)

```
STEP 1: Declare the vexes vv1,···,
  vv5, dpu_v:
   plural double * vv1, *vv2, *vv3, *vv4,
  vv5, *dpu_v;
STEP 2: Obtain memory slices for vexes:
  nd = N >> lnproc + 1;
  STEP 3: Allocate the vexes
   vv1 = gestord(nd);
   vv2 = gestord(nd);
   vv3 = gestord(nd);
   vv4 = gestord(nd);
   vv5 = gestord(nd);
  dpu_v = gestord(nd);
STEP 4: Represent the vexes in virtual
  memory space
STEP 5: Call the function, Cgrad with
  the vexes.
STEP 6: Copy back to FE the solution
  vector, dpu_v:
  blockOut(dpu_v, v1, 0, 0, 1, N,
  sizeof(double));
```

(B)

Figure 4: Algorithms for the Sequential Program: (A) Front End, (B) DPU

Table 1: Solution for selected grid points at h = 0.2, N = 16

Grid Point	Analytical Soln	Conj_Grad Soln	5-Star Soln	9-Star Soln	Error Con_Grad	Error 5-Star	Error 9-Star
1	0.55410	0.57979	0.57979	0.55530	0.02569	0.02569	0.00120
4	3.76438	3.83351	3.83351	3.78083	0.06913	0.06913	0.01645
8	5.99200	6.10386	6.10386	5.99813	0.11186	0.11186	0.00613
12	5.99200	6.10386	6.10386	5.99813	0.11186	0.11186	0.00613
16	3.76437	3.83351	3.83351	3.78082	0.06914	0.06914	0.01645

RESULTS

Both the parallel and sequential algorithms were implemented with several different grid widths, h, for the numerical solution of the physical system whose model is given in eqn(1). The analytical or exact solution of the same problem, was also obtained by solving eqn(3). Table 1 shows one set of results in the case where h value is 0.2.

At large grid widths, there was no significant difference in the accuracy of the 5-star and the conjugate gradient solutions, but, as the grid widths became small, the 5-star solution became increasingly more accurate than the conjugate gradient. Thus, when $h = 0.2$, the average absolute error of both the 5-star and the conjugate gradient solution was the same, 0.07096; at $h = 0.1$, the average error of the 5-star solution was 0.01817 compared to 0.01830 of the conjugate gradients; at the smaller values of h, the accuracy of the 5-star's solution in comparison to that of the conjugate gradient was even more pronounced. The 9-star solutions were more accurate than both the 5-star and the conjugate gradient solutions at all grid widths, and were even more so for smaller values of h. For example, at $h = 0.2$, the average absolute error of the 9-star solution was 0.00514 compared to the 5-star's 0.07096, and at $h = 0.05$, the 9-star's average error was 0.00039 compared to the 5-star's 0.00456.

The speedups were determined with respect to the CPU time from the execution of the conjugate gradient program and also from the average time n for execution of the parallel counterparts, the 5-star and 9-star programs. Such comparison was deemed fair since all programs ran on the DPU except, of course, the preprocessing code portion of the conjugate gradient which ran on the Front End. At the values of h ranging from 0.2 to 0.05 ($N = 16$ to $N = 361$), the average CPU time to execute the conjugate program was 0.8424, while those of the 5-star and 9-star programs were respectively 0.6606 and 0.5353. This gave the average speedup of 1.27 for the 5-star solution, and 1.57 for the 9-star solution.

Finally, at all values of h, the 5-star solutions had a better load balance than the 9-star solutions, the difference was greater as h became smaller. Thus, at $h = 0.2$, the 5-star showed a load balance of 91% compared to the 9-star's 89%; at $h = 0.05$, the 5-star's load balance was 90% while the 9-star's was only 77%.

CONCLUSION

From the results, we concluded that the 5-star solution of the Poisson equation given in eqn(1) is more practical than the conjugate gradient solution method. This is because the 5-star solution is not only more accurate than the conjugate gradient solution especially in large system dimensions, but it is also much simpler to understand and code than the conjugate gradient method. Representing the system with *vexes* for nonzero elements, instead of a *mat* for the original matrix, significantly complicated coding of the conjugate gradient program. On the other hand, the dominant portion of the 5-star program involved 4-nearest neighbor communication which was easily realized with the *xnet* constructs. Because the 9-star solution was more accurate than the solution of any other method in all system dimension, then, if accuracy is premium, the 9-star solution approach should be preferred to other approaches only at small h values since the 9-star shows significant load imbalance at small h values. The two parallel approaches, the 5-star and 9-star, however, were deficient in speedup, but this deficiency was somewhat offset by the simplicity of their codes.

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REFERENCES

Baucom, C. L., Reduced Systems and Preconditioned Conjugate Gradient Method on a Multiprocessor. M.S. Thesis, Univ. Illinois at Urbana-Champaign, 1988.

Burden, R. L., Numerical Analysis, PWS-Kent Pub. Co., Boston, 1988.

Dongara, J. J., Performance of Various Computers using Standard Linear Equations software. Tech. Rep. No. CS-89-85, ORNL, 1994.

Gerald, C. F, et al. Applied Numerical Analysis. Addison Wesley Pub. Co., Reading, 1996.

MPML, MasPar Mathematics Library (MPML), Softwr. ver. 9302-0300, Revision No. A3, 1991

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Formulation of a Parallel Recursive Substructuring Method for Finite Element and Finite Difference Solutions

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The solution of finite element and finite difference problems is important for a variety of physical problems. A recursive substructuring method is presented that allows for a lower processor communication overhead and therefore more efficient parallelization of such problems. To illustrate the method, an example finite difference solution is developed and the advantages of the method are discussed.

INTRODUCTION

Numerical solutions to physical problems and differential equations often involve utilizing finite element and finite difference methods and result in the creation and solution of matrix equations that feature large, sparse matrices. In particular, the parallel version of a global atmospheric circulation model developed by *Porter et al.* [1996], an extension of the model developed by *Chan et al.* [1994], requires the solution of such large matrix equations. The sheer size of these and other matrix systems means that any serial solution technique would be slow. Thus, such problems are often tackled using multiple parallel processors, requiring a reformulation of the problem for a parallel method of solution. The classic parallel approach to such problems involves an LU factorization of the matrix equation accomplished through a round robin distribution of the matrix equation over the processors involved [*Fox et al.*, 1988]. However, this method is limited in that it requires the entire matrix to be passed among the processors, and the back-substitution step is virtually performed in serial, meaning that the communication overhead for this method is high. Because of the high communication for this approach, *Porter et al.* explored a different parallelization made possible by large scale granularity of the block diagonal structure for a spectral formulation of a global atmospheric model and found significant speedups. However, slow communication speeds for the distributed network environment prevented parallel speedups beyond a factor of five. The recursive substructuring method presented in this paper was developed to improve upon these communication drawbacks and those of the round robin distribution method as well, and it does so by developing a new parallel formulation of the problem. This paper presents an overview of the recursive substructuring method, a demonstrative example of the method applied to a simple differential equation, and a brief analysis of the advantages offered by the method.

OVERVIEW OF THE METHOD

The recursive substructuring method involves three key concepts that grant it its parallel advantages -- the hierarchical structure, the elimination step, and the resolve step. The first is a different logical approach for decomposing the problem, and the second two exploit mathematical relationships that can take advantage of that hierarchy. The basic mathematics simply utilizes established techniques for matrix formulation of systems of equations such as the finite element and finite difference method [*Press et al.*, 1992].

The hierarchical structure of a given problem begins by discretizing the problem into n similar elements. As might be expected, the larger n is for a fixed domain, the finer the solutions generated but the greater the amount of computation involved. The hierarchy is a collection of bottom-, middle-, and top-level processors with varying responsibilities. (See Fig. 1) Each bottom-level processor is responsible for assembling basic elements and condensing them into a single superelement. Then, bottom-level processors send their superelements to the middle-level processor immediately above them in the hierarchy. Middle-level processors, like the processors below them, assemble and condense their elements into a single superelement to be passed above. A single top-level processor collects the resultant superelements, assembles and condenses them into a single element that represents the final reduced problem. It is here that boundary conditions are used to solve the reduced system. This solution is passed down the hierarchy, a resolve for internal elements occurs at each level, and eventually the bottom-level processors generate solution vectors for their internal elements. (See Fig. 1) Taken together, these resultant basic elemental solutions describe the entire solution vector for the problem.

The method depends on the ability to assemble elements hierarchically and recursively condense them into a single element. The assembly and condensation is an extension of the static condensation method often used in finite element analysis. In a typical problem formulation, each elemental component of the problem generates a composite matrix equation of the form

$$KX = F \tag{1}$$

where X is the solution vector we wish to solve for, and K and F are known. This composite matrix is termed an elemental matrix. Each elemental matrix has a similar form, and, through some operator that depends on the problem domain, these elemental matrix equations can be assembled into a larger matrix equation that has the same form as (1). This assembled matrix equation is remapped so that all information about the exterior of the region covered by the local elements is sent to the rightmost columns and bottom-most rows of the respective matrices. When this is done, the assembled matrix equation takes the form

$$\left[\begin{array}{c|c} K_{II} & K_{IE} \\ \hline K_{EI} & K_{EE} \end{array}\right]\left[\begin{array}{c} X_I \\ \hline X_E \end{array}\right] = \left[\begin{array}{c} F_I \\ \hline F_E \end{array}\right] \tag{2}$$

where the subscripts $_I$ and $_E$ refer to the interior and exterior of the region. Note that (2) gives us the system of matrix equations

$$\begin{aligned} K_{II} X_I + K_{IE} X_E &= F_I \\ K_{EI} X_I + K_{EE} X_E &= F_E \end{aligned} \tag{3}$$

The first equation can be solved for X_I

$$X_I = K_{II}^{-1}(F_I - K_{IE} X_E). \tag{4}$$

Substituting that into the second equation

$$K_{EI} K_{II}^{-1}(F_I - K_{IE} X_E) + K_{EE} X_E = F_E \tag{5}$$

and rearranging terms, one obtains

$$K' X_E = F_E' \tag{6}$$

where

$$K' = K_{EE} - K_{EI} K_{II}^{-1} K_{IE} \qquad \text{and} \qquad F_E' = F_E - K_{EI} K_{II}^{-1} F_I$$

Note that (6) has the same form as (1) and all interior variables have been eliminated. Given proper boundary conditions, we can solve (6) for X_E, the external part of our desired solution vector.

Once all elements have been assembled and eliminated and passed up the hierarchy, the resolve process can begin. The top-level processor receives its boundary conditions -- which equate to the final X_E in the top-level elimination process. When X_E is known, (4) is used to find X_I for the top-level maximal element. Then the current level's full solution vector is known. This solution vector is then decomposed into its local elemental pieces, and these elemental solution vectors are sent down the hierarchy for further solutions. Eventually the bottom-level processors receive their X_E from above, and they resolve for the basic elemental solution vectors, and the full solution is generated.

EXTENDED EXAMPLE

In the following, a simple example will be used to illustrate an application of recursive substructuring to the solution of a differential equation. Let us consider the second order differential equation

$$\frac{dy}{dx} + \frac{d^2y}{dx^2} = x \tag{7}$$

on the interval [0,2] with initial conditions y(0) = y(2) = 1. Analytic solution of this problem yields

$$y(x) = \frac{1}{2}x^2 - x + 1 \tag{8}$$

The numerical solution found through recursive substructuring should accurately approximate this analytic result.

The first step is to partition the solution interval [0,2] into 8 subintervals of equal length at $x_0 = 0$, $x_1 = 0.25$, $x_2 = 0.5$, ..., $x_7 = 1.75$, $x_8 = 2$. Solutions $y_0, y_1, \ldots, y_8$ will be generated corresponding to each of the x_i. Note that from the initial conditions, $y_0 = y_8 = 1$.

Next, applying the finite difference method to the differential equation (7) yields

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$$\left(\frac{1}{(\Delta x)^2}-\frac{1}{2\Delta x}\right)y_{n-1}+\left(\frac{-2}{(\Delta x)^2}\right)y_N+\left(\frac{1}{(\Delta x)^2}+\frac{1}{2\Delta x}\right)y_{n+1}=x_n \tag{9}$$

Note that since Dx=0.25 for this sample problem, (9) simplifies to

$$14y_{n-1}-32y_n+18y_{n+1}=x_n \tag{10}$$

This approximate solution for y is valid for each of the interior points in the partition, namely x_1 through x_7. Thus, 7 "elements," in our terminology, are generated -- 7 coupled equations with solution vector $<y_0, y_1, \ldots, y_8>$.

Using traditional finite difference methods, the system of 7 equations generated by (10) for n=1,...,7 would be translated into matrix form and solved simultaneously. In parallel, this would typically entail using a round robin distribution method to achieve load balancing. However, the recursive substructuring method will be applied at this point in order to clarify the workings of that method.

The first step in the recursive substructuring method is to place the "elements" in a processor hierarchy. Four processors will be used -- three bottom-level processors and one top-level master processor. The bottom-level processors are chosen to illustrate the various couplings possible between processors. Each bottom-level processor will be responsible for a given subinterval. Because each element is coupled to its neighbors, there will be some overlap among the y_i contained on each bottom-level processor. However, this overlap is minimal, in that only y_i on the borders of the processor subintervals will be shared among processors. The small-scale example here does not reflect this, but ordinarily, a given processor is responsible for a number of y_i, with only a few of those shared with another processor.

Each bottom-level processor will condense its three elements into a single superelement that represents the subinterval from which it was formed. In the following, envision processors P_{21}, P_{22}, and P_{23} as bottom-level processors in Fig. 1. All three superelements, one from each bottom-level processor, will be sent to the fourth top-level processor P_{11} where a similar process will condense those superelements into one element for the entire interval [0,2]. The processor responsibilities for the problem at hand based on the elements L_1 through L_7 as seen in Figure 2 will be as follows:

Processor One (P_{21}) : handles the interval $[x_0, x_4] = [0, 1]$, has responsibility for elements L_1, L_2 and L_3, and it produces superelement S_{21}.

Processor Two (P_{22}) : handles the interval $[x_2, x_6] = [0.5, 1.5]$, has responsibility for elements L_3, L_4, and L_5, and it produces superelement S_{22}.

Processor Three (P_{23}) : handles the interval $[x_4, x_8] = [1, 2]$, has responsibility for elements L_5, L_6, and L_7, and it produces superelement S_{23}.

Processor Four (P_4) : handles the entire interval $[x_0, x_8] = [0, 2]$, accepts superelements S_{21}, S_{22}, and S_{23} and solve the reduced system.

Assembling P_{21}'s equations and rewriting to isolate the "exterior" y_i, we obtain

$$\left[\begin{array}{cc:ccc} -32 & 0 & 14 & 18 & 0 \\ 0 & -32 & 0 & 14 & 18 \\ \hdashline 0 & 0 & 0 & 0 & 0 \\ 14 & 18 & 0 & -32 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right]\begin{bmatrix} y_1 \\ y_3 \\ y_0 \\ y_2 \\ y_4 \end{bmatrix}=\begin{bmatrix} 0.25 \\ 0.75 \\ 0 \\ 0.5 \\ 0 \end{bmatrix} \tag{11}$$

This places all of the interior degrees of freedom in the top and left of the matrix, meaning that (11) has the same form as (2). Elimination can be formed on (11) to yield

$$\begin{bmatrix} 0 & 0 & 0 \\ 6.125 & -16.25 & 10.125 \\ 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} y_0 \\ y_2 \\ y_4 \end{bmatrix}=\begin{bmatrix} 0 \\ 1.03125 \\ 0 \end{bmatrix} \tag{12}$$

the superelement S_{21} output by P_{21}.

The assembly, remapping, and elimination steps performed on P_{22} and P_{23} proceeds as they did on P_{21}. P_{22} generates the superelement S_{22}

$$\begin{bmatrix} 0 & 0 & 0 \\ 6.125 & -16.25 & 10.125 \\ 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} y_2 \\ y_4 \\ y_6 \end{bmatrix}=\begin{bmatrix} 0 \\ 2.03125 \\ 0 \end{bmatrix} \tag{13}$$

P_{23} generates the superelement S_{23}

$$\begin{bmatrix} 0 & 0 & 0 \\ 6.125 & -16.25 & 10.125 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} y_4 \\ y_6 \\ y_8 \end{bmatrix} = \begin{bmatrix} 0 \\ 3.03125 \\ 0 \end{bmatrix} \tag{14}$$

Now the recursive nature of this algorithm becomes evident. P_{11} receives S_{21}, S_{22}, and S_{23} from its slave processors and due to the elimination that occurred below, is able to treat these as elements as if it were a bottom-level processor. Assembly and remapping at the top level yield

$$\left[\begin{array}{ccc:cc} -16.25 & 10.125 & 0 & 6.125 & 0 \\ 6.125 & -16.25 & 10.125 & 0 & 0 \\ 0 & 0 & -16.25 & 0 & 10.125 \\ \hdashline 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right] \begin{bmatrix} y_2 \\ y_4 \\ y_6 \\ y_0 \\ y_8 \end{bmatrix} = \begin{bmatrix} 1.03125 \\ 2.03125 \\ 3.03125 \\ 0 \\ 0 \end{bmatrix} \tag{15}$$

At this point all seven elements have been condensed into a single element that captures all interior coupling.

The solution stage of the method is ready to begin. Since X_E is now known on P_{11}, that matrix equation can be "resolved," reversing the elimination process, solving for one internal solution on each resolve step. Each resolve step is accomplished by applying the resolve equation (4) from above to the eliminated matrix equation of the prior step. Resolve using (4) yields $y_2=0.625$, $y_4=0.5$, and $y_6=0.625$. Once this occurs, each superelement has a complete internal solution vector, and these are passed back to each bottom-level processor for local resolving. When the whole process is done, the bottom-level processors will contain the overall solution vector $<y_0, y_1, \ldots, y_8>$. Note that this resolve process is performed in parallel according to the hierarchy designed. Each bottom-level processor generates its solution vectors independently for all the coupling was handled higher in the hierarchy. The solution vector for the above example is

$$\left\langle 1 \quad 0.78125 \quad 0.625 \quad 0.53125 \quad 0.5 \quad 0.53125 \quad 0.625 \quad 0.78125 \quad 1 \right\rangle$$

which is exactly equal to the analytic solution.

ADVANTAGES

The recursive substructuring method presented here offers three main advantages over the traditional round robin distribution method of parallel formulation of a finite element or finite difference problem. The first and most important advantage is that of lower communication overhead. As technology advances and individual processors become ever faster, the calculation time for each parallel processor in a multiple processor solution strategy shrinks. In other words, the actual matrix calculations performed in the problem above are not what is time consuming. Rather, the cost lies in the communication time between processors. Indeed, as the number of processors involved in a multiple processor solution strategy increases, total running time tends to equal total communication time. Thus, communication becomes the key bottleneck for parallel speedups, and it is in this area that recursive substructuring excels. By using the elimination method outlined above, a processor can condense any number of local elements into a single superelement, and that superelement is all that must be passed between processors. In the above example, each of the 3 superelements contains 12 pieces of numeric data. That means passing only 36 data prior to the solution phase using recursive substructuring, where the round robin technique, which requires the entire assembled matrix to be passed, would have to pass 90 data prior to solution. In fact, as the number of elements *n* of a discretized problem grows, round robin communication time grows as *wm*, where *w* is the bandwidth and *m* is the number of equations. Each processor must receive each row of a matrix. In contrast, the recursive substructuring communication time grows linearly with the number of processors. This communication overhead advantage is especially important in large problems.

The other advantages of the method are less important but still nontrivial. The back-substitution phase of the problem is done in parallel under the recursive substructuring method, where the round robin technique performs this phase almost serially. The hierarchical structure means that once the solution phase is initiated at the top-level processor, every processor on a given level will be active in resolving their local elements at once. Because of the use of these methods for nonlinear processes where multiple right hand sides are evaluated, this advantage is significant The other advantage of the recursive substructuring method is that load balancing is very flexible because the hierarchy and assembly process can be structured so as to reflect the processors available. One simply makes the faster processors on any level of the hierarchy responsible for more elements.

CONCLUSION

Recursive substructuring, as presented here, was developed to dramatically reduce the communication overhead in parallel formulations of finite element and finite difference problems. Recall that for a given problem, any number of high performance processors can be used to implement a parallel solution. However, communication between these processors remains a fundamental time bottleneck, and it that bottleneck that the recursive substructuring method was designed to combat. As seen above, with a proper hierarchical decomposition of a given problem, the amount of data that needs be passed under the recursive substructuring method is a fraction of what needs be passed using traditional methods. A language to implement this solution method has been separately developed and is being presented in another paper at this conference. The advantages offered by the method's recursive nature and elimination techniques mean it has broad applicability, not only to the global atmospheric circulation model mentioned above, which lends itself easily to such parallel decomposition, but also to other computationally-intensive grand challenge problems.

ACKNOWLEDGMENTS

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REFERENCES

Bickford, W., 1990, A First Course in the Finite Element Method, (Boston: Irwin)

Chan, K., H. Mayr, J. Mengel, and I. Harris, "A Stratified Spectral Model for Stable and Convective Atmospheres," J. Comp. Physics, 113, p. 165, 1994.

Fox, G. and I. Angus, 1998, Solving Problems on Concurrent Processors, (New Jersey: Prentice Hall)

Porter, H., G. Cogdell, C. Huneycutt, and H. Mayr, "A Spectral Global Atmoshperic Circulation Model for Distributed Parallel Execution," ACM Southeast Conference Proceedings, 1996.

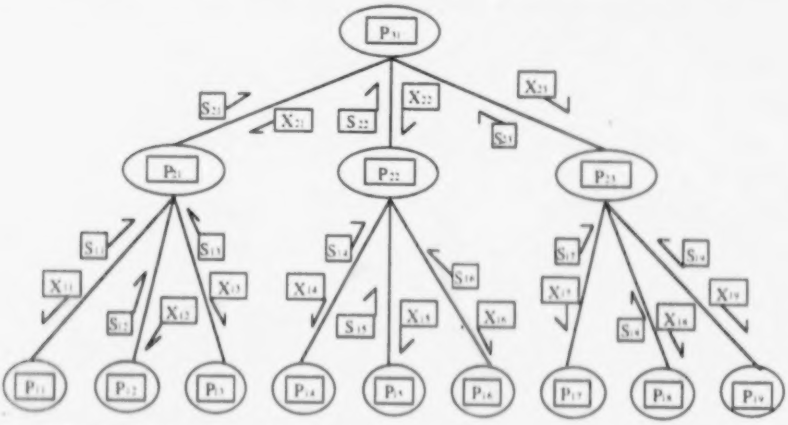

Figure 1: An example processor hierarchy in which elements are condensed and sent up the hierarchy and solutions are returned.

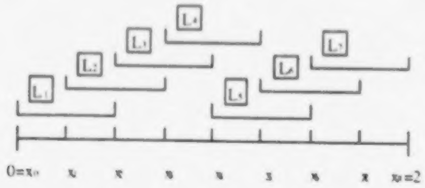

Figure 2: Description of the seven bottom-level elements in the extended example and the intervals to which they correspond.

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Comparing a Particle-System Based Simulation to Other Methods in Modeling Special Effects

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This paper will compare the efficiency of a particle-system based method of modeling special effects with that of other methods by analyzing the complexity of an implementation of a particle-system based method for simulating wind. The authors researched the complexity in terms of time and main memory usage. The paper includes formulas and graphs pertaining to the order of magnitude of the two types of complexity. The authors will explain each method, but focus on the particle-system based method.

THE PROBLEM

The particle-systems technique was developed by William Reeves for use in the motion picture *Wrath of Khan* [Reeves, 1983]. Since that time, they have been used in rendering methods for producing natural scenery such as trees and grass [Reeves, 1985]. Also, they have been used to simulate such occurrences as wind, fire, and explosions. This paper will focus on the use of particle systems to simulate the action of wind on objects in a real-time, three-dimensional environment.

Particle Systems have recently become a popular method of simulating certain natural occurrences such as fire and wind. With the advent of advanced circuitry in machines designed specifically for video-game playing, the video-game industry has expressed an interest in realistically simulating natural events in real-time to heighten users' sense of immersion in the game experience.

Incorporating a simulation based on particle systems into a real-time, three-dimensional game increases the complexity of the game considerably. Because of the limitations of video-game platforms, complexity must be kept at a minimum. Thus, an analysis of the popular simulation technique of particle systems would be of eminent interest to game programmers. It would aid them in judging the fitness of this particular method against other methods for producing realistic special effects.

THE PARTICLE IMPLEMENTATION

Before analyzing the complexity of a particle-system based wind simulation, the author will describe a particular implementation of such a simulation. Then, the complexity of the algorithm will be analyzed and compared to other ideas for algorithms. Conclusions on the fitness of particle systems for the real-time simulation of wind effects will then be discussed based on the analyses.

Two objectives dominate the design of this particular implementation of a particle simulation of wind. Simplicity and modularity are the watch-words. Simplicity enables the algorithm to be easily understood by the user. It also makes analyzing complexity easier. Modularity provides the algorithm with "plugability". That is to say, this algorithm may be easily incorporated into any real-time, three-dimensional simulation.

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The implementation was coded in C++, using elements of object oriented programming. Object oriented programming techniques were employed to produce a separate class for a wind manager, a particle, and a base object that may be acted upon by the wind. The use of objects enhances plugablility and is a natural way to represent a system of particles.

The wind manager is responsible for creating particles, removing particles, updating particles with respect to time, and passing messages to "blowable" objects that tell them the wind strength and wind direction in their part of the world. The wind manager keeps the particles in a linked list. The linked list provides a straight-forward method for updating all the particles and finding particles within a particular distance of an object. In order to blow an object, the wind manager finds all the particles within a certain distance of the object, calculates an average direction and strength for the wind in that area, and passes the direction and strength to the object so that it may take the appropriate action, such as falling in a particular direction at a particular speed. The efficiency of this process will be discussed in the next section.

Each particle has a position in the three-dimensional world, a direction to indicate which way it is blowing objects, and a wind strength. A wind front is initiated by creating a collection of particles with directions and strengths all within specified variances. These variances are defined in the above mentioned wind manager which is responsible for the creation of the particles.

The base object for blowable objects is responsible for containing the position of an object, its susceptibility to wind, and for providing a place to define an action that occurs when the object is blown (implemented as a virtual function in C++ parlance). The user will implement a specific object by inheriting the base class, defining the movement function of the object, giving the object a position in the world, and including whatever three-dimensional, graphics-specific code needed to render the object.

COMPLEXITY OF THE PARTICLE IMPLEMENTATION

The process of simulating wind consists of three tasks. These tasks are creating the particles, updating the particles with respect to time, and applying the wind to the objects. All three of these tasks are carried out by the wind manager. The wind manager directly executes the task of creating the particles; the wind manager uses messaging to affect the updating of particles and the blowing of objects. Each of these tasks will be discussed in turn in terms of complexity.

The first action that takes place in the creation of wind is particle creation. As stated before, each particle object contains a position in the three-dimensional world, a direction to indicate which way it is blowing objects, and a wind strength. The amount of storage required by each particle is thus, three integers for the position, three integers for the direction, and one integer for the strength. Also, each particle contains a link to the next particle in the list, an integer. This is in addition to the wind manager's own three-integer position, two integer variances for controlling the particles' stochastically generated strength and direction, an increment for updating a particle's position, a decrement for updating a particle's strength, and an integer pointer to the first particle in the list of particles being generated. Let i represent the amount of space taken up by an integer in main memory and n represent the number of particles being generated. Then, the overall storage incurred by the creation of particles may be stated as the following formula.

$$8i + 8ni \qquad (1)$$

As can be clearly discerned from the formula, the overwhelming factor in determining the amount of storage needed by the creation of a wind front is the number of particles making up the front.

The amount of time it takes to create particles is determined by three separate functions carried out by the wind manager. These tasks are the time it takes to allocate storage for each particle, the amount of time it takes to stochastically generate deviances for the wind-direction and strength of each particle, and the time it takes to add these deviances to the predefined initial values of the wind-direction and strength of each particle. If the wind manager generates n particles, m is the time it takes to allocate space for one particle, r is the time it takes to generate one random number, and a is the time it takes to add two integers together, then the following formula determines the time-complexity of wind-front generation.

$$n\,(m + 4r + 4a) \qquad (2)$$

From the formula, it may be concluded that the time it takes to generate a wind-front in this manner is of order of magnitude of the number of particles generated.

Now that the wind manager has created a list of particles, it must keep track of those particles and update them with respect to time. The updating process consists of traversing the whole list of particles at specific intervals of time and decrementing the strength of each particle. This process requires no storage of new variables, and so the formula for the amount of storage remains the same. However, the time it takes to decrement the strength must be accounted for in the time complexity formula. This decrementing amounts to the addition of one integer to another integer. Also, each particle will have moved a certain increment of distance. This increment must be added to the particles position. Three more integer additions are required for the wind manager to accomplish the updating of a particle's position. Resolving the addresses represented by the links in a linked list becomes an issue within the context of time complexity in an implementation involving dynamic memory and many particles. But, since this issue is implementation specific, address resolution will not be included in the time complexity formula. Let t be the total time the simulation runs, and u be the number of updates to be carried out over the simulation's lifetime. The overall time-complexity for the simulation now becomes the following, in light of the updating process.

$$n\,(m + 4r + 4a + 4tua) \qquad (3)$$

This addition of another a term doesn't change the overall order of magnitude of the time-complexity, as one can see from the equation.

The wind manager's accounting mechanism for particles thus considered, attention must now turn to the point of the whole simulation, causing wind to act on the objects in the simulated environment. No new variables are to be stored, so the memory model remains the same. To cause an object to be blown, the wind manager must search the list of particles. This search determines which particles are in the object's area. The object's area is defined by a radius stored as the object's susceptibility to wind. Then, the average of the nearest particles' wind directions and wind strengths is calculated by the wind manager. The search requires comparing each particle's position to the predetermined boundary as well as the resolution of addresses in traversing the linked list. Again, this issue is implementation specific. Address resolution will not be included in the time complexity formula. This translates as three comparisons per particle. Also, the object itself must carry out the movement caused by the wind. This movement is in the form of sampling some formula used to determine the path of the object's translation in three dimensions. Let c be the time it takes to compare two integers, b be the number of times an object is acted upon in the simulation, and f represent the time-complexity of an object's movement function. The time complexity formula becomes the following.

$$n\,(m + 4r + 4a + 4tua + 3bc\,) + bf \tag{4}$$

The order of magnitude of the memory-complexity and the order of magnitude of the time-complexity have not changed.

The overwhelming factor in the complexity of the particle-system based wind simulation, both in terms of time and memory, is the number of particles generated. See Figure 1 below. The number of particles determines the degree to which this simulation is stochastic. The fewer the particles, the smaller the sample used in determining the direction and strength of wind acting upon an object. Random variance and complexity are in opposition in the simulation of wind in this implementation.

OTHER IMPLEMENTATIONS AND THEIR COMPLEXITY

Many other possibilities exist for simulating wind. One possible implementation involves keeping a table of static grid-points. These grid-points hold a wind direction and wind strength. The wind is changed by initiating an update of the points along the first row of the grid. Then, the next row updates its values using the values of the previous row. The process continues until all the rows have been updated. The time and memory complexity of this implementation would thus depend on the number of points, analogous to particles, on the wind grid. See Figure 2 below.

Another possibility for simulating wind is defining wind only where objects occur. In this implementation, objects carry their own wind direction and wind strength which are updated by the wind manager. The wind manager keeps a list of objects. This eliminates the need for an intermediate particle or grid-point object and deals with the rendered objects directly. The time and memory complexity of this implementation would only depend on the number of blowable objects. See Figure 3 below.

CONCLUSIONS

The graphs below indicate that ultimately the complexity is dependant upon the detail of the wind simulation. The less detail included in the simulation, the less complex the simulation. The programmer must keep this in mind when programming with time-complexity limits.

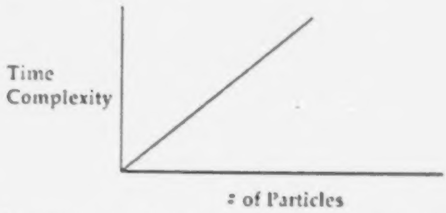

Figure 1: Complexity of the Particle-System Model for Wind

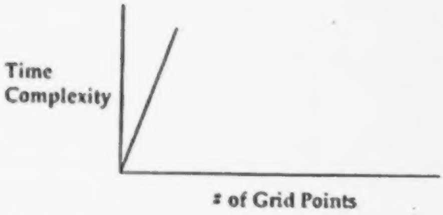

Figure 2: Complexity of the Grid Model for Wind

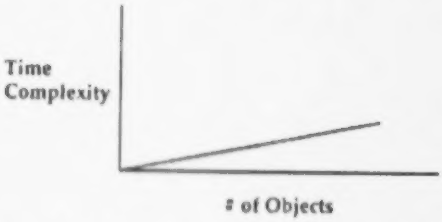

Figure 3: Complexity of the Object Model for Wind

The real-time simulation of wind using particle systems is easily implemented but, depending on the amount of unpredictability desired, can be computationally intensive. Other methods depend on other factors, which may or may not lead to less computational complexity than the particle-system method. The programmer must pick the method best suited to the needs of the simulation.

REFERENCES

Reeves, William T., Computer Graphics, "Particle Systems--A Technique for Modeling a Class of Fuzzy Objects", Vol 17, No 3, July 1983.
Reeves, William T., SIGGRAPH, "Approximate and Probabilistic Algorithms for Shading and Rendering Structured Particle Systems", Vol 19, No 3, 1985.
Reynolds, Craig W., Computer Graphics, "Flocks, Herds, and Schools: A Distributed Behavioral Model", Vol 21, No 4, July 1987.
Wilf, Herbert S., 1986, Algorithms and Complexity, Prentice-Hall, Inc., Englewood Cliffs New Jersey.
Kronsjo, Lydia, 1997, Algorithms: Their Complexity and Efficiency, Second Edition, John Wiley & Sons, Chichester.
Foley, van Dam, Feiner, et al, 1996, Computer Graphics: Principles and Practice, Addison-Wesley Publishing Company, Reading Massachusetts.

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An Examination of Mentoring Methodologies in Object Technology

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Object technology (OT) is the newest and most promising method for developing computer systems. However, a shortage of OT experts is forcing many organizations to "retrain" their employees in this new paradigm. One instructional method which holds much promise for accomplishing this tedious retraining process is mentoring. This research examines the effectiveness of those who do mentoring. Through telephone interviews, data were collected from organizations which use mentors in their OT training process. In order to determine the most effective uses of a mentor's time, the study looks at the various tasks the mentors perform and which of these are seen as effective and ineffective by both the mentors and developers. The results provide organizations with guidelines for allocating their mentors' duties during the training process.

INTRODUCTION

In a field of constant change, object technology (OT) is the newest method for developing computer systems. Proponents claim that OT can save organizations time, resources, and money. OT decreases development time because it facilitates the reuse of previously developed systems. It also allows applications to be easily modified to adapt to changing requirements of users or to increase the useful lifetime of the application (Fayad, 1995).

OT evolved out of, but works on different principles than, structured programming. Alan O'Callaghan, chair of the Object Technology Group at DeMontfort University, states: "The problem is that OT combines the old and the new in a completely new configuration" (O'Callaghan, 1996). Problems arise when developers feel that because they are experts in structured programming they should be capable of switching easily to OT. This is not usually true. According to O'Callaghan, "it is the people most steeped in structured methods who bend their fenders most often in my experience" (O'Callaghan, 1996). Making the paradigm shift to OT requires developers to look at every aspect of the system in a new light.

Although OT seems to be a beneficial way to develop systems, there is a shortage of people who are considered experts in this technology. Therefore, organizations are finding it necessary to "retrain" their current staff in object-oriented (OO) techniques (Gaudin, 1996). This "retraining" is not easy and can be quite expensive. The learning curve is long and steep for the employees ingrained in procedural system development methods. In order to relax this learning curve, an organization often finds it necessary to follow-up intense classroom training with a technique known as mentoring. Mentors can come from within an organization's pool of employees who are considered to be the experts in OT or from outside consulting companies.

Mentoring as a form of instruction has been used for centuries. The most famous historical instance is detailed by Homer in the Odyssey. During the ten years Odysseus was in Troy, Mentor acted as teacher, advisor, friend, and surrogate father to Telemachus, son of Odysseus. The use of this mythological story was important in facilitating relationships between Greek boys and older males. During the Middle Ages, master craftsmen taught their skills to students under the guidelines of the apprenticeship programs. This trend continues throughout history into modern times where the complexity of tasks lends itself to the benefits of learning from a master (Murray, 1991).

Mentoring is an instructional method which holds a great deal of promise in OT. Jason Browning, a member of the technical staff at AT&T Bell Laboratories, believes that "having a mentor show you the OOP ropes enhances any formal training" (qtd. in

Radding, 1995) Eric Lazarus, an independent object technology consultant, points out in the Journal of Object-Oriented Programming that wise managers are using mentoring to help developers learn not only the concept of objects, but development tools and languages unique to OT (Lazarus, 1995) According to a study presented at the 1995 Conference on Teaching and Training in the Technology of Objects, a significant number of organizations feel that "there is no better way to learn OT than mentoring" (Manns, 1995) Two reasons stand out to explain why mentoring is so valuable First, mentoring allows training to take place in small groups of one to ten trainees giving personalized, individual attention Second, it provides the opportunity for the developers to complete a project at the same time they are being trained

The process of mentoring has been described as involving "part intuition, part feelings, and part hunch -- made up as you go along, and composed of whatever ingredients you have available at the moment" (Shea, 1992) However, some of those involved in training developers in OT believe that mentoring should be more than that Therefore, many training and consulting companies for OT have developed more concrete styles for implementing their mentoring programs

Unfortunately, documented styles for mentoring in OT are limited and not easily labeled Lazarus believes that mentoring methods range from "highly structured," similar to a classroom format, to allowing mentors to function as "on-site gurus, available to be consulted . . . when a problem arises" (Lazarus, 1995) Although many different methods are currently being used, the OT field has yet to document which methods are most effective According to Lazarus, "we may find that the wise choice of a mentoring method is often more critical to the success of a project than the details of the object model, the choice of language and tool set, or other more technical aspects of the effort" (Lazarus, 1995) In order to begin determining which OT mentoring methodologies are most effective, the techniques used to mentor must be documented in relation to the change in OT skill level of the developers As Lazarus states, "if we are going to train new mentors, we have to know what it is that effective mentors do" (Lazarus, 1995)

In summary, the training of developers in OT is a difficult process One method which has been shown to hold great promise for decreasing this difficulty is mentoring To date, no one has documented an effective way to mentor OT developers Lazarus states that "a serious study and comparison of the wide variety of mentoring approaches . . . will be immeasurably helpful in [improving the quality of mentoring]" (Lazarus, 1995) This research will make progress towards this end by answering the following research questions

> What are some of the traits in mentors who teach object technology? Which of these traits do the mentors and developers see as effective for decreasing the steep learning curve for object technology?

METHODOLOGY

This research begins to determine some of the successful mentoring methods that organizations are using to teach OT Towards this end, twenty people involved in twenty different OT projects were interviewed about the mentoring process Ten of these where mentors and ten were developers who had received mentoring The subjects volunteered to participate by either responding to a message posted to various Internet news groups soliciting participants for the study, or by replying to a personal e-mail message inviting them to take part in the study All were surveyed by telephone in a ten to fifteen minute conversation Each participant was asked the same 13 questions, although the wording of the questions varied depending on whether the participant was a mentor or a developer who had received mentoring The questions targeted the specific tasks of the mentors and their effective and ineffective traits (See Appendix A for developer's version of survey) The analysis of the data involved searching for similarities between what the developers and the mentors saw as effective and ineffective traits among mentors in OT

FINDINGS

The first part of the survey asked ten mentors to state the specific tasks they perform when mentoring in their OT project The second part asked ten developers who were mentored during ten different OT projects to report on the tasks their mentors

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performed. The responses of these two groups appear in Table 1. The first column states the tasks and the second and third columns show the number of mentors and developers who reported each task. It is noted that the three most frequently appearing tasks are more interactive than the others on the list. This coincides with the philosophy of mentoring, which is a more interactive, less formal, teaching style.

Table 1. Specific Tasks OT Mentors Perform

Task	Mentors	Developers	Total
Reviewing designs w/ trainees	9	10	19
Coding w/ trainees	7	8	15
Discussing project requirements w/ trainees	9	3	12
Designing alone	6	5	11
Coding alone	6	4	10
Stand up lectures	7	2	9

The survey also included an open ended question requesting other tasks the mentors performed. Fifteen different tasks were identified. The majority of these fifteen were only reported by one survey participant. However, five mentors reported that they also were involved in project management. Four developers stated that their mentors also were involved in general coaching, guidance, and feedback. Three survey participants reported that the mentor was involved in either setting standards / methodology, or performing review / audits. Other tasks included helping with system architecture, system analysis, documentation, and forming lunch time talks.

In the second part of the survey, mentors and developers reported effective and ineffective traits in OT mentors. From the mentors' points of view, the most frequently reported effective traits included the ability to relate the work back to the principles being taught, to understand the skill level of the developers, to make the process exciting, and to understand the business side of the organization. Ineffective traits included an inablity to overcome reluctance on the part of the developers, a lack of tolerance and patience, and an inability to effectively estimate time.

From the developers' points of view, their mentors' effective traits included interpersonal skills, a commitment to passing on knowledge, guidance which allowed the developer to work alone, and accessibility and approachability. Ineffective traits primarily consisted of teaching OT with an organizational slant, poor listening skills, and inaccessibility and preoccupation.

One can conclude, from this limited sample, that the most effective traits of mentors are those that are most interactive with the developers. These traits allowed the mentors to understand developers' needs and facilitate the ability to meet these needs. The most ineffective traits of the mentor are those that are less interactive, often occurring in structured classroom training. Therefore, among the twenty individuals in this study, a mentor's ability to interact was seen as having the most effective outcome on learning OT.

LIMITATIONS OF STUDY

The major limitation of this study was the small sample size of only 10 mentors and 10 developers. A larger sample size would have yielded more data, but was not used because this was an exploratory study. Before this study, only anecdotal information was available on the various tasks of mentors, making it difficult to know what to ask the survey participants. Now, this research provides a fairly comprehensive list of the tasks mentors perform and their effective and ineffective traits.

SUMMARY and CONCLUSION

OT is a way of developing computer systems that offers a viable solution to the inadequacies of procedural programming, saving organizations time and money. Although it seems to be a beneficial way to develop systems, there is a shortage of people who are considered experts in this technology. The training of developers in OT is a difficult process with a long and steep learning curve. Mentoring as a form of instruction has been used for centuries and is a method which has been shown to hold a great deal of promise for decreasing the difficulties in training OT developers. To date, no one has documented an effective way to mentor OT developers. This research is the first step in documenting some of the tasks that mentors actually perform, and some of the effective and ineffective traits of these mentors. This information is of value to those facing the difficult task of retraining in the OO paradigm.

APPENDIX A: Developers Mentoring Survey

All of the questions on this survey should reference the most recent OT project in which mentoring was used to train employees in OT in your organization.

General OO Questions

1) For what type of application was this project developed?
2) What object language(s) did the organization use for this project?
3) What object methodology(s) did the organization use for this project?

Questions about Mentoring Program

4) Why did you choose to use a mentor in this project?
5) Was your mentor supplied from within the organization or from a consulting company?
6) a) If in-house --
        1) What is your organization's criteria for choosing someone to be a mentor?
        2) How did your in-house mentor learn to be a mentor?
    b) If from a hired training / consulting company --
        1) How did you choose the company?
        2) What experience did this organization claim to have in mentoring?
7) What was your approximate mentor to developer ratio in this project?
8) Through what point did the mentor remain on the project?
9) What tasks did your mentor perform in this project?
    _____ coding alone
    _____ coding with trainee(s)
    _____ stand up lecture
    _____ designing
    _____ reviewing designs with trainee(s)
    _____ discussing project requirements
    _____ other (describe ______________________________)
    _____ other (describe ______________________________)
    _____ other (describe ______________________________)
10) Rate the OO skill level of each person before and after the project.

	Before Project	After Project
	1-- beginner to OO	1-- still fumbling with OO
	2-- some formal training (but no OO project experience)	2-- some contribution to project
	3-- some OO project experience	3-- key contributor to project
person 1		
person 2		
person 10		

Opinions about Mentor

11) On a scale of one to four, how would you rate the success of your mentor as an OT trainer?
    (With one being least successful, and four being most successful.)
    1   2   3   4
12) Which of your mentor's skills do you believe were the most effective for training your employees?   Explain
13) Which of your mentor's skills do you believe were the least effective for training your employees?   Explain

BIBLIOGRAPHY

Fayad, Mohamed E., and Wei-Tek Tsai. "Object-Oriented Experiences." Communications of the ACM. October 1995: 51-53.

Gaudin, Sharon. "Object Programmers Hard to Find, Keep." ComputerWorld. August 12, 1996: 14.

Lazarus, Eric. "Toward O-O Mentoring Methodology." Journal of Object-Oriented Programming. October 1995: 64+.

Manns, Mary Lynn. "Meeting the Challenge of Object-Oriented Technology Training in Industry." Conference on Teaching and Training in the Technology of Objects. DeMontfort University -- Leicester, England. January 1995.

Murray, Margo. Beyond the Myths and Magic of Mentoring. San Francisco: Jossey-Bass, Inc., Publishers, 1991.

O'Callaghan, Alan. "Organising for the 'Personal Shift'." Object Expert. March / April 1996: 58-65.

Radding, Alan. "Objects of Great Desire." ComputerWorld. November 27, 1995, 107.

Shea, Gordon F. Mentoring. Menlo Park, California: Crisp Publications, Inc., 1992.

3D Special Effects:
Modeling Reflective Surfaces In Real-Time

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The advancement of special effects for real-time graphics has greatly enhanced the realism of virtual reality worlds. These real-time simulations offer virtual reality modelers a dual challenge: create a scene that is both well-detailed and fully interactive with the user. In the real world, glass and other surfaces reflect light sources to produce glare. To model this effect, a non-interactive approach would be to integrate static glare into the initial modeling of objects. Other techniques such as ray tracing produce photorealistic images, but are far too computationally expensive to be of practical use in real-time. This paper examines several approaches to dynamically model this effect in a computationally feasible manner. A single-color bitmap could be rendered over the reflective surface. Changing this effect's location with the position of the viewer might produce acceptable results. A pre-defined texture of a reflection image could be mapped onto the reflective surface. This environment mapping could be made dynamic by tying the texture coordinates to the viewer's location. A final technique would involve rendering a modified view of the scene to a pixelmap texture, which could then be mapped onto the surface. Algorithms developed to implement the three solutions above will be outlined, and, ultimately, graphic demonstrations of these algorithms will be provided for comparison.

INTRODUCTION

Special effects for virtual reality applications have greatly enhanced the immersion into modeled worlds. In real-world situations, phenomenon such as smoke, glare from lights, and images in reflective surfaces are commonplace, occurring naturally; in virtual worlds, these effects must be specifically implemented, often at significant computational expense. Special effects provide the 'finishing touches' that round out virtual reality models, providing nuances lending to the immersive nature of the experience. Therefore it is desirable to successfully model these effects in a computationally reasonable manner.

Specifically examined in this paper are reflective images. Traditional methods for modeling these occurrences could involve adding static reflection images to the initial model. These images do not change with the viewer's perspective so, although they might appear realistic when the viewer is motionless in relation to the reflective surface, changes in relative position reveal the inadequacy of the model. Techniques such as ray tracing are capable of modeling reflections with photorealistic accuracy. Unfortunately, these methods are so computationally expensive that it is impossible to perform them in real-time, thus making them useless for virtual reality models. Current solutions to this problem are either too rudimentary to be effective, or too costly to be reasonable. This paper proposes three possible solutions spanning the realism-efficiency spectrum. These solutions are implemented using the OpenGL rendering engine and the OpenGL Utility Toolkit windowing interface.

Example code for each of the algorithms developed in this paper is available at http://www.cs.trinity.edu/~dcornell/research/reflect/. Each of the sample programs place a viewer in a simple virtual world consisting of a reflective surface and three cones which can potentially be reflected in this surface (See Figure 1). The reader is encouraged to see the individual sources for specific details.

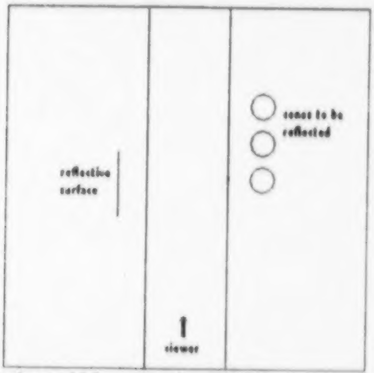

Figure 1: Layout of example world from sample programs

RANDOMIZED PIXEL RENDERING

The most significant problem with integrating reflection images statically into object models is the lack change in reflected images. In the real world, reflection images change as an individual moves. Motion in the world results in a corresponding alteration of the reflected image. Statically modeled reflected images do not change with a change in the viewer's position. Linking a change in reflected image to a change in viewer's position is the first step in creating realistic reflection models.

Modifying the reflected image with changes in the viewer's position can be accomplished by randomly rendering pixels over the reflective surface every time the viewer moves. With each change in the viewer's location, new pixel locations are calculated and these pixels are then rendered over the image of the reflective surface in the scene.

An implementation of this algorithm is available in the file `pixel.c`. This implementation operates by selecting points randomly located within an acceptable range (the extents of the reflective surface) and plotting small triangles in the scene based on these points. Triangles were rendered into the scene rather than points because they covered a larger area of the reflective surface, thus fewer random numbers needed to be generated to complete the reflective image. Every time the viewer's position is incremented, new triangles are calculated and rendered in the scene. In this way, changes in the viewer's position result in changes in the reflected image (See Figure 2).

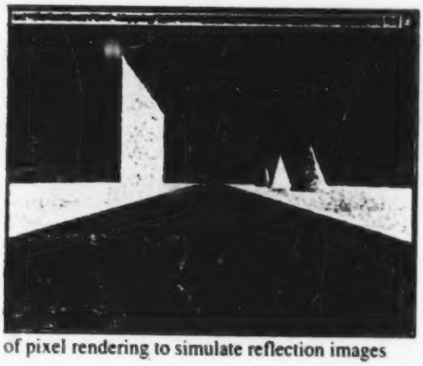

Figure 2: Screen shot of pixel rendering to simulate reflection images

In this implementation, the triangles are colored the same as objects they might potentially reflect, and the random numbers are skewed in an attempt to more accurately mimic a reflected image. However, as a whole these measures are unsuccessful. Although the image does change every time the viewer's position changes, it is rather obvious that the modifications to the image are not an accurate reflection of the scene objects. The effect produced is more similar to television static than a reflection. This inconsistency between the reflected image and the scene objects makes this algorithm, in its present form, unacceptable for use in most situations. For reflective surfaces which cover a very small scene area, or in situations where the viewer is moving very fast relative to the reflective surface this 'quick and dirty' algorithm might provide acceptable results. However other solutions are needed for more common situations.

ENVIRONMENT MAPPING USING DYNAMIC TEXTURE-COORDINATE GENERATION

The foremost problem with the preceding algorithm was the lack of the reflection model's connection to the objects in the scene. In static scenes, a technique known as environment mapping can be used to simulate reflective surfaces. In environment mapping, an image of the reflected portion of the scene is texture mapped onto the reflective surface (Neider, Davis, and Woo, 1993). To make this reflection effect interactive, the texture coordinates of the reflection texture can be changed along with the viewer's position (See Figure 3). If done properly, the image can be made to slide along the reflective surface, simulating the motion of reflected objects as depicted in the reflected surface.

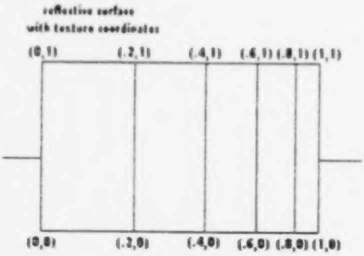

Figure 3: Polygon with skewed texture coordinates which will result in a distorted texture image

An implementation of this algorithm is presented in the file `environ.c`. In this example, the reflection image is a modified view of the scene where the viewer is located at the center of the mirror looking out in the direction of objects in the scene which will appear in the reflected image. This 64 by 64 pixel image was rendered by the `capture` program and saved to the file `image.64`. This file was then read into the `environ` program and set to be the current texture. The reflective surface, in this model, is actually five rectangular polygons. The coordinates of these polygons are determined by a 1dimensional free-form deformation algorithm which 'slide' the texture across the reflective surface. In the deformation algorithm, three control points define the locations of a list of points based on the original locations of these points. The moving points, in this case, are the interior vertices of the system of coplanar polygons modeling the reflective surface. The algorithm, taken from (Vince, 1995) is as follows:

Given 3 control points C0, C1, and C2, and 4 ordinates P1, P2, P3, and P4, after a change in one or more of the control points:

$$P' = (1-u)^2 C_0 + 2u(1-u)C_1 + u^2 \quad (for\, 0 \le u \le 1) \qquad [1]$$

where:

$$u = \frac{P - P_1}{P_4 - P_1} \qquad [2]$$

The control points were made to be a function of the position of the viewer, thus the texture coordinates on the reflective image also change with the viewer's position (See Figure 4).

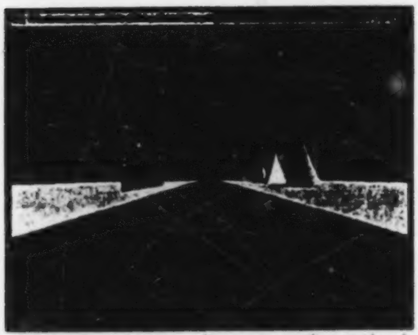

Figure 4: Screen shot of dynamic texture coordinate generation to simulate reflection images

This algorithm overcomes the basic problem with the first: a need for a tie between the reflective image and the reflected objects in the virtual scene. Because the texture-mapping image is a potential reflective image, it is clear that the objects depicted in the reflective surface are linked to the other objects in the scene. The distortion of the textured image on the reflective surface simulates the alteration of the reflection image that would be perceived by an individual in the real world. However, as the viewer nears the reflective surface, the extent of distortion of the textured image begins to reveal inconsistencies between the reflective image and what the viewer would expect to see. This algorithm ran significantly more slowly than the pixel-mapping algorithm presented previously due to the texture-mapping required to render the reflection image. Overall, though, the results of this algorithm were much more encouraging than those of the previous.

ENVIRONMENT MAPPING USING MODIFIED SCENE VIEW RENDERINGS

Building upon previous success in using texture mapping to simulate reflection, the third and final algorithm models the reflected image using a reflected image texture changes every time the viewer changes position. Whereas the previous algorithm used a single texture image that was distorted based on the viewer's position, the texture image in this algorithm is mapped undistorted onto the reflective surface polygon, but the texture is regenerated each frame based on the viewer's position. Each texture image will be an altered view of the scene where the viewpoint is located at the center of the reflective surface and is facing in the direction of a ray originating from the viewer and reflecting off of the center of the reflective surface (See Figure 5).

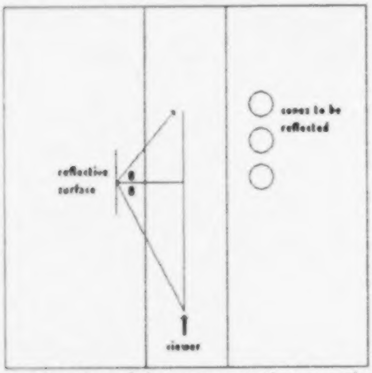

Figure 5: Location and view direction of alternate scene viewer used to render the reflected scene texture image.

This algorithm truly captures the 'feel' of the reflection as the viewer moves past the reflective surface. Not only does the image change with the viewer's position, it is also clearly linked to reflected objects in the scene, and the changes in the reflective image correspond to the relative positions of objects in the scene (See Figure 6). This realistic performance, however, relies on additional scene rendition and texture mapping, dropping the speed of this algorithm below that of the previous two, but still fast enough to be used in real-time applications.

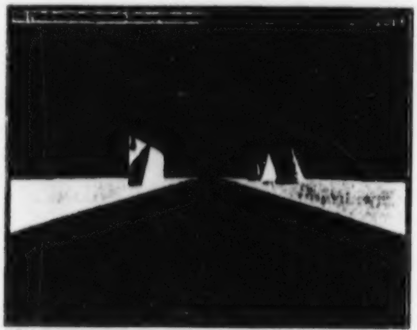

Figure 6: Screen shot of dynamic texture generation and mapping used to simulate reflections

TOPICS FOR FURTHER RESEARCH

These algorithms were all tested on a Silicon Graphics Indigo^2 Extreme and a Silicon Graphics Iris Crimson Reality Engine. Although the algorithms performed in real-time, the dedicated graphics hardware found in these machines may de-emphasize the computational complexity inherent in these types of three-dimensional rendering situations. Because of the portable nature of OpenGL and GLUT code, the sample programs associated with this paper could be easily ported to any number of platforms and tested for performance there.

For the purposes of this paper, all algorithms have been implemented giving the viewer only one degree of freedom. For use in any real-time graphics package, these algorithms would need to be expanded to take into account additional freedoms the viewer might have. The pixel-mapping algorithm could most likely be used as is, but the latter two algorithms using texture mapping would require rotations to the mapped texture in order to properly orient the reflective image in the scene.

The experiments based on these algorithms indicate that it is possible to model reflective surfaces in both an attractive and computationally feasible manner. In modeling these reflected images it appears there is a trade-off between model quality and algorithm speed, forcing the designer to choose an algorithm according to the demands of the situation.

REFERENCES

Neider, Davis, and Woo, 1993. OpenGL Programming Guide, Addison Wesley Publishing, Reading, MA.

Vince, John, 1995. Virtual Reality Systems, Addison Wesley Publishing, Reading, MA

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Formal Methods for Software Specifications: A Case Study

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Formal methods for software specification employ formal logic to model requirements for computer systems and software. The goal of this paper is to explore the process of capturing software requirements specifications in the formal specification language PVS, employing a system modeled as a finite state machine. The problem modeled is the control system for a microwave oven. The specifications for this system include support for nine tasks (or modes) and six inputs. The development of this case study was a part of a larger NASA JOVE funded research effort focused on the issue of technology transfer of formal methods for software specifications.

INTRODUCTION

Formal methods for software specification comprises a new method for capturing system or software requirements and offers many advantages over English specifications. Formal methods are based on formal logic and mathematics. The methods vary in their form and rigor. The least rigorous being English specifications with occasional mathematical notation embedded in them. The most rigorous is fully formal specifications in a formal specification language with a precise semantics. Most specifications are somewhere in the middle.

Formal methods offer many advantages for capturing software requirements. First, creating and maintaining software-intensive systems is difficult. However, formal methods make it easier to create more precise and less ambiguous system specifications and simplify maintenance by providing a more structured specification. Secondly, formal specification methods can discover defects in a system earlier in the system life cycle. This allows the analysts to check for consistency and other errors before the specification enters the design, implementation, testing, and maintenance steps of the life cycle. Finally, defining the specifications formally makes it easier to achieve consistent and correct specifications since they can be checked in a repeatable manner. Since the specification is formal, the same problem analysis can be repeated by several different people with the end product being the same.

There are various formal methods tools, such as PVS (Prototype Verification System) and Z. A general formal methods tool consists of a formal specification language, a parser, a type checker, and a proof checker. The language allows the user to model and formalize the specification. The parser checks to see if the specification is syntactically consistent, and is an automated process. The type checker is also automated and checks for semantic mistakes. The proof checker requires the user to employ proof strategies, and results in a verified specification.

The example in this paper is captured in the formal method language PVS. PVS or prototype verification system was developed at Stanford Research Institute, International (SRI). It includes all of the processes that a general tool would include: language, parser, type checker, and proof checker.

The overall goal of this research is technology transfer. One of the obstacles to widespread use of formal methods is the substantial learning curve encountered. A focus of the NASA JOVE project is on creating materials that will enhance formal methods training and education. The case study presented here will be used as a meaningful example in training materials.

THE ENGLISH SPECIFICATION OF THE CASE STUDY PROBLEM

The objective of this example is to develop a formal specification for the control system of a microwave oven. The system is to be modeled as a finite state machine. The control system supports nine tasks and allows six inputs. Figure 1 illustrates the control panel for the system.

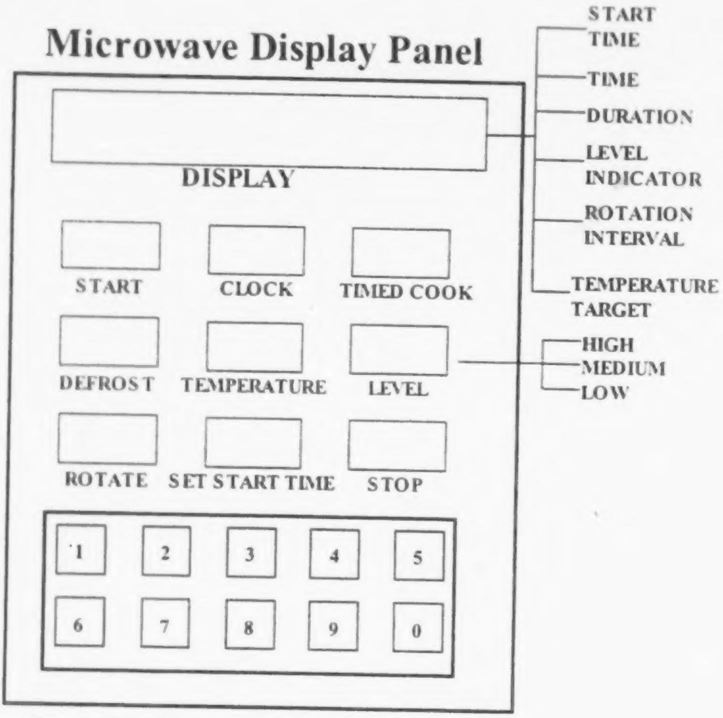
Microwave Display Panel
DISPLAY
START
CLOCK
TIMED COOK
DEFROST
TEMPERATURE
LEVEL
ROTATE
SET START TIME
STOP
1
2
3
4
5
6
7
8
9
0
START TIME
TIME
DURATION
LEVEL INDICATOR
ROTATION INTERVAL
TEMPERATURE TARGET
HIGH
MEDIUM
LOW

Figure 1: The microwave oven control system display panel.

The functions of the microwave control system are defined by the following requirements:

1. The microwave panel contains nine buttons for selecting tasks for the system, and one display for entering or displaying values, one at a time, for six different possible displays. The system supports the following nine tasks:
    - Start
    - Clock
    - Timed Cook
    - Defrost
    - Temperature
    - Level
    - Rotate
    - Set Start Time
    - Stop

   Only one of Clock, Timed Cook, Defrost, Temperature, or Stop may be engaged at one time. One of those should be engaged at all times. The default should be Clock. When one of these is engaged, any of the others that is engaged should switch to a disengaged mode. If the user attempts to engage the same button already engaged, the action should be ignored. Set Start Time may be engaged with Timed Cook, Defrost, or Temperature.

2. There is one display on the panel, but it supports six different display tasks. Only one display can appear at a time. The following displays are supported:

    - time
    - duration
    - level indicator
    - rotation interval
    - temperature target
    - start time

   The display modes show default values or input values. The time should be displayed if no other value is displayed or being entered. Time is used to display or set the current time. The default value is the system time. Duration displays or sets the number of minutes that one of the task is to be performed. The default value is zero seconds. Level indicator is used to display or enter one of three cooking levels: high, medium, or low. The default is high. Rotation interval sets or displays the number of seconds after which the turntable should rotate. The default is zero seconds or continuous rotation. Temperature target is used to enter or display the temperature at which the microwave should stop cooking. It requires a cooking probe to work. The default value is zero degrees, so the function will not operate unless a valid temperature is input. Start time sets or displays the time at which the microwave is to begin cooking. The default value is 0:00, so this function also does not work unless a valid value is input.
3. If the user enters a rotation interval of less than 15 seconds, the system defaults to continuous rotation.
4. Level may be engaged with start, Timed Cook, Temperature, defrost, or Set Start Time and with rotate.
5. Rotate may be engaged with start, Timed Cook, Temperature, defrost, or Set Start Time and with level.
6. After Set Start Time is engaged and a start time is selected or entered, any of the other legitimate combinations can be engaged.
7. Engaging the clock when Set Start Time is engaged cancels Set Start Time and any other buttons that are engaged.

EXCERPTS FROM THE PVS SPECIFICATION

The system is modeled as a finite state machine in PVS. To structure the specification, one defines the relevant types, building to the definition of the state transition function. Once the state transition function is defined, one can then define some properties that this function should have (i.e. system properties). Note that all characters following a % on a line represent comments.

```
% ************PVS SPECIFICATION EXCERPTS****************************
% The problem is modeled as a state machine. (Note % indicates comment)
% Our basic state transition function will be of the following form
% Sn = nextstate(Ac,Sc)          Sn stands for the next state
%                                Ac is am action, Sc is the current state

% Define the actions type
        actions: TYPE = {press_start, press_clock, press_timed_cook, press_defrost,
        press_temp_cook, press_level, press_rotate, press_set_start_time, input_time,
        input_duration, input_lev_ind, input_rot_int, input_temp_targ, input_start_time,
        temp_reached, duration_finished, start_time_reached}
```

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```
% We now define types capturing the modes for the buttons and display on the
% control panel
mode_status : TYPE = {off, engaged}
disp_status : TYPE = {input_value, default}

% State descriptor
states : TYPE = [#      % Record structure
            start : mode_status,
            clock : mode_status,
            timed_cook : mode_status,
            defrost : mode_status,
            temp_cook : mode_status,
            level : mode_status,
            rotate : mode_status,
            set_start_time : mode_status,
            stop : mode_status,
            time : disp_status,
            duration : disp_status,
            lev_ind : disp_status,
            rot_int : disp_status,
            temp_targ : disp_status,
            start_time : disp_status,
            #]          % End of record

% variables
ac : VAR actions
st : VAR states

% The state transition function
nextstate(ac, st): states =
            CASES action of
               press_timed_cook : tran_timed_cook(st)
               press_start : tran_start(st)
               press_clock : tran_clock(st)
               press_defrost : tran_defrost(st)
               press_temp_cook : tran_temp_cook(st)
               press_level : tran_level(st)
               press_rotate : tran_rotate(st)
               press_set_start_time : tran_set_start_time(st)
               press_stop : tran_stop(st)
               input_time : tran_inp_time(st)
               input_duration : tran_duration(st)
               input_lev_ind : tran_lev_ind(st)
               input_rot_int : tran_rot_int(st)
               input_temp_targ : tran_temp_targ(st)
               input_start_time : tran_start_time(st)
               temp_reached : tran_temp_reached(st)
               start_time_reached : tran_start_time_reached(st)
               duration_finished : tran_duration_reached(st)
            ENDCASES

% To complete this definition, we must define all the transition functions for the
% various fields in the state descriptor. We give the definition of the transition function
% for the start button as our example. Other transitions will be omitted for lack of space,
% but they are similar
```

```
tran_start(st): states =
        IF start(st) = off
        THEN
           IF (timed_cook(st) = engaged or defrost(st) = engaged or
                    temp_cook(st) = engaged)
           THEN
                 IF (level = engaged and rotate = engaged)
                 THEN
                       (st WITH [start := engaged])
                 ELSE
                       IF (rotate = engaged)
                       THEN
                             st WITH [start := engaged, level := engaged]
                       ELSE
                             st WITH [start := engaged, rotate := engaged]
                       ENDIF
                 ENDIF
           ELSE
              st          %% Ignore
           ENDIF
        ELSE
           st          %% Ignore
        ENDIF

% ETC - remaining transition function definitions are omitted

% After defining the initial state st0 and a boolean fuction valid_state(st) - returns either
% True or False - to decide when a state is valid, one can capture some of the system's
% basic properties with some putative theorems which can be verified by the PVS
% theorem prover. The following examples illustrate this technique

% The initial state is a valid state
st0_good: THEOREM valid_state(st0)

% The nextstate transition function preserves the valid state property
nextstate_good: THEOREM valid_state(st) IMPLIES valid_state(nextstate(ac, st))
```

FINDINGS

This research exposed the advantages and disadvantages of using formal methods. During the analysis and specification of the problem, various deficiencies were revealed. Questions arose about the actual way some transitions would take place and the purpose of those transitions. The formal specification help to expose redundant functions developing two different functions to perform the same task with the timed cook and the delayed cook. Other problems that occurred were with the rotate and level tasks. These two tasks had not been defined thoroughly and would have caused extensive work to be necessary if the specification were not in a formal language. The modifications were easily made due to the formalized specification. Since the specification is formal, it forces the analyst to consider every possibility because it requires the specification of almost all details. The only disadvantage found was the learning curved involved with formal methods. Learning the syntax and how to use the software both require some extensive study.

SUMMARY AND ACKNOWLEDGMENTS

In conclusion, modeling the microwave control system as a finite state machine was straightforward and helped refine the understanding of the underlying problem. Translating the state machine model to a PVS specification revealed deficiencies in the state machine model. The problem provides a meaningful and accessible example of formal specification capture in PVS, and should prove useful in introducing software engineers to formal methods of software specification.

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BIBLIOGRAPHY

Formal Methods Specification and Verification Guidebook for Software and Computer Systems Volume II: A Practitioner's Companion, Office of Safety and Mission Assurance, NASA, Draft - June 16, 1996.

Owre, Sam, Alan Bull, Natarajan Shankar, and John Rushby, *The PVS Specification Language*, Computer Science Lab, SRI International, Menlo Park, CA, 1993.

Truth Maintenance Techniques for Verification of Knowledge Bases

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ABSTRACT

This paper concentrates on two truth maintenance techniques, an Assumption-based Truth Maintenance System (ATMS) and a Contradiction-based Truth Maintenance System (CTMS), and shows how these techniques accomplish the verification of a knowledge base (KB).

Verification deals with the identification of different types of abnormalities and errors that may occur in a KB. It is very important to ensure the detection and removal of all errors during KB development. Traditional verification techniques, based upon comparing pairs of rules with conflicting or identical conclusions, require test cases to reveal errors. Such test cases, often unavailable especially during early development, cannot assure the detection of all logical and structural errors. The TMS techniques generate test cases automatically or logically deduce all explicit and hidden inconsistencies and circularities in the KB.

This paper compares the ATMS and CTMS techniques and focuses on circular rules and logical inconsistency.

INTRODUCTION

A knowledge base (KB) can be represented by a set of production rules. A few examples of such rules are, $A \Rightarrow B$, $C \wedge D \Rightarrow E$, and $\neg F \Rightarrow G$. These are read as, A implies B, C and D implies E, and not F implies G.

Verification deals with the identification of different types of abnormalities and errors that may occur in a KB. It is very important to ensure the detection and removal of all structural errors during KB development. The most important errors are circular rules, redundant rules, and inconsistent rules. A circular rule, when satisfied, causes a loop to occur. A redundant rule's presence or absence makes no difference. An inconsistent rule, when satisfied, will imply a contradictory conclusion.

The purpose of a Truth Maintenance System (TMS) is to solve, or assist in solving, problems. Such a system, depending on its role in the problem solving process, belongs to one of two groups. The first group contains those systems, considered to be data base management systems, that do not have the ability to make inferences. Inferences are conclusions drawn from facts. The Assumption-based TMS (ATMS) belongs to this group. The second group contains those systems that incorporate some inference facilities allowing them to act on their own. The Contradiction-based TMS (CTMS) belongs to this group.

The remaining sections provide an illustration and comparison of the ATMS and CTMS techniques without presenting the details of the TMSs.

ATMS TECHNIQUE

KB verification can be done by using Knowledge Base Reduction (KBR). KBR is a process that translates the existing knowledge base theory (KB-theory) into the so-called reduced theory which is a kind of ATMS theory. The KB-theory is defined as a pair (F,R) where F is a set of facts and R is a set of rules of the form: $P1 \wedge P2 \wedge \ldots \wedge Pn \Rightarrow H$. P1,P2,...,Pn are premises of a rule and are referred to as the left hand side of a rule. H is the hypothesis which the rule implies and is referred to as the right hand side of a rule.

The following is an example of a KB-theory.

Facts:

N2,N3,N18.

Rules:

R1: $N2 \wedge N3 \Rightarrow N4$
R2: $N2 \Rightarrow N10$
R3: $N18 \Rightarrow N11$
R4: $N18 \wedge N10 \Rightarrow N4$
R5: $N4 \wedge N11 \Rightarrow N13$
R6: $N2 \Rightarrow \neg N13$
R7: $N2 \Rightarrow \neg N11$
R8: $N10 \wedge N3 \Rightarrow N4$.

Hypotheses:

N4,N10,N11,¬N11,N13,¬N13.

The first of two steps consists of dividing the set of rules into disjoint sets, called rule levels, according to a depends-on relation. Rule1 depends on Rule2 if the consequent of Rule2, or the negation of the consequent of Rule2, is an antecedent of Rule1. Level 0 consists of all rules whose antecedents are input facts. Each level that follows consists of those rules whose left hand sides depend only on rules at the preceding levels.

The rules from the above example are divided into three levels. Level 0 contains R1,R2,R3,R6, and R7. Level 1 contains R4 and R8. Level 2 contains R5. Note that R5 is placed at level 2 because it depends on rules at level 1 as well as rules at level 0.

The second step consists of computing labels and checking these labels for redundancies and inconsistencies. It is easier to test the reduced theory for these anomalies because it explicitly states the dependencies between the input set and the conclusions.

The check for inconsistencies can be performed at each step of rule label development. The check consists of two tests: the subset/superset test and the union test. The subset/superset test checks, for any hypothesis that conflicts with the hypothesis of the rule, the partial label of the rule's hypothesis for a subset or superset of the partial label of the conflicting hypothesis. The union test computes the union of every environment of the partial label of the rule's hypothesis with every environment of the partial label of each conflicting hypothesis. An environment is a set of premises under which a hypothesis holds. The union is examined for potential contradictions.

The check for redundant rules can be performed for a level once the labels for all rules within that level are computed. The check consists of considering the contribution of each rule in the final hypothesis with respect to the given level. If some rule has a unique contribution in the label of its conclusion and defines an environment which is also generated by another rule, it is classified as redundant.

The labels for the example are developed as follows.

Level 0:
LabelR1 = {N2 ∧ N3}   LabelN4 = {(N2 ∧ N3)}
Subset/Superset and Union tests: no contradiction

LabelR2 = {N2}   LabelN10 = {(N2)}
Subset/Superset and Union tests: no contradiction

LabelR3 = {N18}   LabelN11 = {(N18)}
Subset/Superset and Union tests: no contradiction

LabelR6 = {N2}   Label¬N13 = {(N2)}
Subset/Superset and Union tests: no contradiction

LabelR7 = {N2}   Label¬N11 = {(N2)}
Subset/Superset and Union tests: union of Label¬N11 and LabelN11
is {(N2 ∧ N18)} indicating potential contradiction between N2 and N18

Redundant test: no redundancy

Level 1:
LabelR4 = {N2 ∧ N18}   LabelN4 = {(N2 ∧ N3) ∨ (N2 ∧ N18)}
Subset/Superset and Union tests: no contradiction

LabelR8 = {N2 ∧ N3}   LabelN4 = {(N2 ∧ N3) ∨ (N2 ∧ N18) ∨ (N2 ∧ N3)}
Subset/Superset and Union tests: no contradiction

Redundant test: R8 is redundant, it has unique contribution in the label of N4 and defines an environment (N2 ∧ N3) also generated by R1

Level 2:
LabelR5 = {(N2 ∧ N3 ∧ N18) ∨ (N2 ∧ N18)}
LabelN13 = {(N2 ∧ N3 ∧ N18) ∨ (N2 ∧ N18)}
Subset/Superset and Union tests: again, potential contradiction between N2 and N18

Redundant test: no redundancy

The user is notified that a potential contradiction between N2 and N18 has been detected and that R8 is redundant. The user is responsible for revising the KB-theory in order to get rid of the anomalies.

CTMS TECHNIQUE

KB verification consists of translating the KB-theory into a CTMS-theory, generating the stable extension of the CTMS-theory, computing the grounded stable extension, and testing the grounded stable extension for circular, redundant, and inconsistent rules.

A CTMS-theory is defined as (SB, R) where SB is a set of beliefs and R is a set of rules. Beliefs have the form A[LV]:(T1,...,Tn)(P1,...,Pm), where A identifies the belief, LV indicates the type (T for true or P for plausible). (T1,...,Tn) is the T-set containing the true beliefs upon which A depends, and (P1,...,Pm) is the P-set containing the plausible (not known to be true) beliefs upon which A depends. Rules have the form (T1,...,Tn,Rx)()⇒Z, where T1,...,Tn are the premises of the KB-rule and Rx is the identifier of the KB-rule. Such a rule says that the conclusion, Z[T]:(T1,...,Tn,Rx)(), will be added to SB whenever Rx is satisfied.

Translation of a KB-theory into a CTMS-theory consists of translating each KB-fact into a true belief of SB, representing each KB-rule by a true belief of SB having the form R[T]:()(), representing each KB-hypothesis by a plausible belief of SB having the form H[P]:()(), and translating each KB-rule into a rule of R.

The following is an example of a KB-theory. It is the same as the example used to examine the ATMS technique but has an addition rule R9.

Facts:
N2,N3,N18.
Rules:
R1: N2∧N3⇒N4
R2: N2⇒N10
R3: N18⇒N11
R4: N18∧N10⇒N4
R5: N4∧N11⇒N13
R6: N2⇒¬N13
R7: N2⇒¬N11
R8: N10∧N3⇒N4
R9: ¬N13⇒N2.
Hypotheses:
N2,N4,N10,N11,¬N11,N13,¬N13.

Translation yields the following CTMS-theory. Note that the beliefs representing each rule and each hypothesis have been left out to save space.

SB = { N2[T]:()(), N3[T]:()(), N18[T]:()() }

R = { (N2,N3,R1)()⇒N4, (N2,R2)()⇒N10,
(N18,R3)()⇒N11, (N18,N10,R4)()⇒N4,
(N4,N11,R5)()⇒N13, (N2,R6)()⇒¬N13,
(N2,R7)()⇒¬N11, (N10,N3,R8)()⇒N4,
(¬N13,R9)()⇒N2 }

The inference process yields the following stable extension labeled SB2.

SB2 = { N2[T]:()(), N3[T]:()(), N18[T]:()(),
N4[T]:(N2,N3,R1)(), N10[T]:(N2,R2)(),
N11[T]:(N18,R3)(), ¬N13[T]:(N2,R6)(),
¬N11[T]:(N2,R7)(), CN11[P]:(N11,¬N11)(CN11),
N4[T]:(N18,N10,R4)(), N13[P]:(N4,N11,R5)(CN11),
N4[T]:(N10,N3,R8)(), N2[T]:(¬N13,R9)() }

The stable extension shows how conclusions inferred depend upon their immediate predecessors. For verification we need to know the input data sets upon which these conclusions depend and the rules that contributed to their inference. This information is implicitly contained in the stable extension. The new extension that results is called the grounded stable extension. Each T-set contains only the identifiers of beliefs representing input data. The SB2 stable extension yields the following grounded stable extension labeled SB2[G].

SB2[G] = { N2[T]:()(), N3[T]:()(), N18[T]:()(),
N4[T]:(N2,N3,R1)(), N10[T]:(N2,R2)(),
N11[T]:(N18,R3)(), ¬N13[T]:(N2,R6)(),
¬N11[T]:(N2,R7)(), N2[T]:(N2,R6,R9)(),
CN11[P]:(N18,N2,R3,R7)(CN11),
N4[T]:(N18,N2,R2,R4)(),
N4[T]:(N2,N3,R2,R8)(),
N13[P]:(N2,N3,N18,R1,R3,R5)(CN11)
N13[P]:(N2,N3,N18,R2,R4,R5)(CN11),
N13[p]:(N2,N3,N18,R2,R3,R5)(CN11) }

The final step is to check for circular, redundant, and inconsistent rules.

The test for circular rules consists of checking the grounded stable extension for beliefs whose identifiers are also elements of their T-sets. The test found N2[T]:(N2,R6,R9)(), therefore R6 and R9 form a circular chain.

The test for redundant rules is applied to sets of beliefs with the same identifier. If two or more of these beliefs have identical data-parts, then their rule parts are checked for redundant rules. A rule is considered redundant if it has a unique contribution to the inference of its conclusion. The test found N4[T]:(N2,N3,R1)(), N4[T]:(N18,N2,R2,R4)(), and N4[T]:(N2,N3,R2,R8)(). The first and third have identical data parts and R8 is not in the T-set of any other belief, therefore R8 is redundant.

The test for inconsistent rules is built into the inference process. Contradictions detected during the inference process are represented by the corresponding beliefs in the grounded stable extension. The test found the CN11[P]:(N18,N2,R3,R7)(CN11) contradiction.

The user is notified of the detected structural errors. After revision of the KB-theory, the process must be repeated to ensure the removal of the anomalies.

CONCLUSION

Analysis of the illustrations, presented in the two previous sections, leads to the conclusion that the CTMS technique has several advantages over the ATMS technique.

The CTMS technique detects circular rules, one of the most common errors, while the ATMS technique does not. Detection of contradictions in the CTMS technique is simply built into the inference process which is handled by the TMS. And finally, the CTMS technique requires much less computation to detect the errors in the KB.

REFERENCES

Zlatareva, N.,(1992), Truth Maintenance Systems and Their Application for Verifying Expert System Knowledge Bases, Artificial Intelligence Review, pp67-110, Kluwar Academic Publishers.

Zlatareva, N.,(1997), Truth Maintenance Systems, Encyclopedia Of Microcomputers, Volume 19, pp1-47, Marcel Dekker, Inc.

Ginsberg, A.,(1988), Knowledge-Base Reduction: A New Approach to Checking Knowledge Bases for Inconsistency & Redundancy, Proc. 7th National Conference on Artificial Intelligence, pp585-589.

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Computer Assisted Data Reduction:
Optimizing the Astrophysicist

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The on-site collection of data during astronomical observations is a sophisticated task, requiring instrumentation operators to simultaneously oversee a variety of complicated operations Additionally, it is desirable to perform real-time processing to produce feedback that allows astronomers to optimize the quality of incoming data These duties are frequently compounded by non-trivial computer interfaces and environmental factors unique to observatories - such as high altitude - which degrade human functioning

To increase the efficiency and quality of *in situ* data collection, the author developed a graphical interface which presents a simple interface between computer and astronomer This technique significantly reduces task complexity, program input and output is organized and presented in an easily assimilated fashion A successful observational run utilizing this interface at the NASA IRTF (on comet Hale-Bopp) is described

BACKGROUND

This paper describes cometary data reduction issues, software developed by Mumma et al and by this author, and its use in observations of comet Hale-Bopp at the NASA IRTF

Infrared astronomy has grown with the advent of digital sensor arrays Driven by constant developments in CCD technology, it continues to be a fertile source of new data Comets produce infrared light largely through flouresence as a result of incident solar energy (Weaver) This light is useful in identifying the many compounds, including organic molecules, found in these bodies (Mumma)

Data collected by IR (infrared) instrumentation is "raw" and requires reduction before it is useful, the increasing resolution of modern sensor arrays produces complex data and requires a greater degree of sophistication from the computer systems used for data reduction

IR data collection begins when photons emitted from an object of interest, such as a comet, are focused on to a CCD array Typically, the light beam is filtered before reaching the CCD array so that specific frequency bands may be studied If spectrographic data are desired, a diffraction grating may also be used to produce a continuum (such as that produced with a glass prism in visible light) instead of a spatially accurate, recognizable representation Because sources can often be dim - particularly if strong filters are used - long exposures are necessary Unfortunately, technological limitations of CCDs preclude lengthy exposures (Young) Instead, several exposures are made and summed in order to generate a single bright data set Often it is necessary to take more than one of these summed sets and add them together for even more brightness Once an adequate signal is achieved, undesirable features, such as interference from the earth's atmosphere, must be subtracted from the data set In order to accomplish this, an image is collected of the sky near, but not on, the object of interest The intensity of data and sky images are then subtracted, pixel by pixel The residual is light from the desired object

Even after this process of additive amplification, more processing is required because of "hot pixels" introduced by cosmic ray hits, thermal shot noise, and other random events

(NASA IRTF) Calibration images, called flat fields and dark fields, are used to compensate for this kind of signal noise, and are used in a similar manner to the sky images in the removal of spurious and unwanted signals Still more signal distortions, such as nonlinearities in the light beam projected upon the CCD chip, complicate the reduction process further

When all of the physical properties of the data collecting apparatus (telescope and CCD camera) have been corrected for, the data must be quantified, i e a micron or wavenumber scale fitted to it so that it is possible to identify specific features Last but not least, a data set must be able to undergo whatever operations are specified by a scientists's particular investigative regimen

Observatories maintain hardware that can provide raw images, but all data reduction is the responsibility of the astronomer, who typically employs computer software for the task This often takes place long after the data is collected, which can cause bad data or data collection errors to be hidden until it's too late to correct It is therefore desirable to have a software tool that quickly produces a spectrogram from raw data

THE EXISTING METHOD

Software to accomplish all of the above-mentioned data reduction tasks does exist and is currently in use (Mumma et al) Written in IDL, the Interactive Data Language (Research Systems), it produces useable spectrograms, although a number of issues make it impossible to use under observational conditions

The software consists of a separate program for each task The components must be run sequentially with no guidance from the software, so operator error is likely Code module names and command line syntax must be memorized Because the code was written with no overarching design principle or guidelines, the interpreter's symbol space quickly becomes cluttered with global variables, resulting in overflows

The creation of a crude spectrogram with this software consists of the steps shown in table 1 The average time needed for an operator to complete each task is also shown in table 1 The first item, creation of an initialization file, must be performed by hand with a text editor or entered line by line into the initialization module during run-time Each part of the data (eight files) and several floating point values must be individually specified Initialization file interpretation is fragile, and a misplaced space or character will cause a crash If the initialization strings are entered during initialization module run-time, a single data entry error can cause a crash, invalidating any data already entered

Thousands of keystrokes are required for the completion of this process Fully reduced data would require about an hour for each data set, as many as one hundred sets or more may be produced during a single session Clearly, it is not possible to spend hundreds of hours reducing data given only a few days at the observatory In addition, the symptoms of hypoxia caused by the high elevation of observatories and the complexity/time demands of operating the data collection hardware prevent astronomers from producing even a handful of representative spectrograms using these methods

Table 1 Task analysis of crude spectrogram production with existing software

Create initialization file	15 minutes
Run initialization module	1 minute
Run file loader	1 minute
Run minimal processing module	2 minutes
Display data	1 minute
Total time required	20 minutes

The IRTF provides a software tool ("Viewfits") which provides the functionality needed for the production of some crude spectrograms However, in addition to requiring several time-consuming steps, this tool performs integer arithmetic and produces erroneous, possibly misleading results

QUICKLOOK - A NEW APPROACH

New software, named "quicklook," was designed in an effort to overcome the

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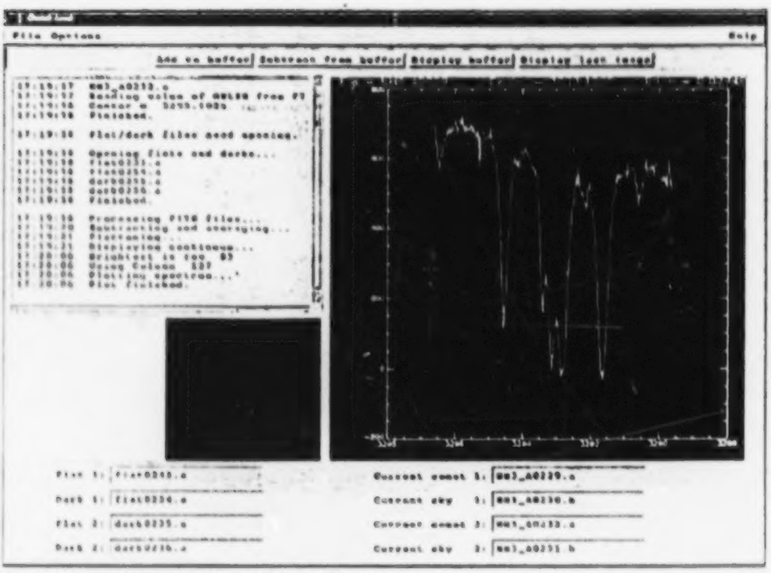

Figure 1. A spectrum displayed in "Quicklook."

difficulties described above. Quicklook is a monolithic entity; there is only one code block to run. It does not utilize a command-line interface as did the previous software, but has a graphical interface created in Interactive Data Language. Keystrokes are minimal or nonexistent because the operator can use a mouse to select input. When sequential operations must exist, all inappropriate controls are inactivated via blocking calls. Unless an operator choice is imperative, the software proceeds automatically to the next step of the reduction process. Time stamped logs of all actions are displayed in a text widget (upper left of figure 1) and saved to a date-marked file.

File commands are intuitive, using the same file menu and open commands with which most users are already familiar. It is only necessary to select the first of a series of data files; the other seven components are intelligently chosen without operator intervention. This is done by comparing filename stems and index numbers; a file called NH3_001 a will be followed by files named NH3_002 b, NH3_003 b, NH3_004 a... File type checking is performed, and if a file is missing or of improper type, an error dialog is generated and the program returns control to the user. Constants used for calculation or display purposes, such as the central wavenumber, are automatically read from data file headers.

Once the user has initiated file selection, quicklook performs all of the calculations necessary to produce a crude spectrum, pausing only to display a continuum so that the user may choose the area of interest which will become a spectrum. The spectrum is then displayed in the large window to the right with a wavenumber scale (right-hand side, figure 1). If the mouse is used to select a particular feature, that feature's wavenumber is identified and printed in the display. The spectrum and continuum can be added to or subtracted from an image buffer using the image calculator buttons above the text and spectral windows. All data products can be saved to disk for later use.

If a user wishes to make unprecedented use of data within quicklook, a shell option is available. When the shell option is selected from the options menu, quicklook exports all spectral information into variables within an IDL shell window and prints a short descriptive message explaining the name, type, and purpose of each variable. Any IDL command may be used to manipulate the data without changing the state of the current quicklook session, which can be resumed at any time.

In a best-case situation, an operator provides only three mouse clicks and zero keystrokes for the creation of a spectrogram. The entire process takes about one minute. Even a worst-case scenario results in only a few tens of keystrokes and mouse clicks,

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stretching spectrum production time to about 2 minutes.

RESULTS

Significant reductions in task complexity and an increase in processing speed were achieved through the application of human factor and object-oriented concepts.

This software has the potential to revolutionize spectral data collection, as it is now possible to quickly and easily produce high-quality spectrograms during observations. Quicklook may supercede some or all of the intensive analysis tasks now reserved for the existing software.

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REFERENCES

Weaver, H. A. And Mumma, Michael J., "Infrared Molecular Emissions from Comets," The Astrophysical Journal, Vol. 276:782-797, Jan. 15 1984

Mumma, Michael J., "Organics in Comets," Astronomical and Biochemical Origins and the Search for Life in the Universe, Nov. 15 1996

Young, Johnathan Douglass, Illustrated Encyclopedic Dictionary of Electronics, Parker Publishing Company, Inc. West Nyak, NY, 1981

NASA IRTF, CSHELL Operator's manual, http://www.ifa.hawaii.edu

Research Systems, Inc., IDL Reference Manual, 2995 Wilderness Place, Boulder, CO. 80301

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HIERARCHICAL PLANNING WITH DEFINITE CLAUSE GRAMMARS

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INTRODUCTION

Previous work in artificial intelligence (AI) has applied planning techniques to natural language generation[Appelt:85]. However, tools and techniques associated with natural language generation have not been applied to planning problems. This research demonstrates that bounded definite clause grammars may be used to solve planning problems. Specifically explored is the relationship between hierarchical task networks (HTNs) used for planning and definite clause grammars (DCGs) used for natural language generation.

The definite clause grammar used for this work is part of the `Joseph` system, described in "A Formal Model for Simple Narratives" [Lang:97]. The `Joseph` system produces natural language stories based on Russian folktales. The hierarchical planner employed for this work is an implementation of the UMCP (Universal Method Composition Planner) technique described by Erol, et al [Erol:94]. This work shows two things: (1) the conditions under which hierarchical planning and generation with a definite clause grammar are equivalent, and (2) demonstrates an implementation strategy for hierarchical planning. To demonstrate that HTNs and DCGs are equivalent under certain conditions, a set of HTN methods are transformed into rules for a definite clause grammar. The algorithm for this mapping is described in "A Formal Model for Simple Narratives." To demonstrate the correctness of this mapping, this work uses the resulting grammar to produce the same plan as produced by a hierarchical planner.

DEFINITE CLAUSE GRAMMARS FOR NATURAL LANGUAGE GENERATION

Artificial Intelligence researchers have long sought to determine the characteristics of connected natural language text. Story modeling falls into two categories: declarative and procedural. The former describes stories by pinpointing their general structure. The latter models and recreates the process used by human authors; procedural modeling then asserts that a story is anything yielded by the recreated process.

THE JOSEPH SYSTEM

The story modeling system being used in this work is the `Joseph` system [Lang:97], a declarative story generation system based on a grammar for narratives. Grammars in general describe lists of things called terminals. For example a grammar for real constants describes lists of digits, decimal points, arithmetic operators, etc. The grammar will then tell what arrangement of symbols are real constants and which are not. `Joseph` is a declarative story generation system built around a formal grammar that governs lists of events and facts. The events and facts are the terminals in the grammar. The non-terminals are high-level and intermediate components of stories such as `setting`, `episode`, `reaction`, and `outcome`. The grammar rules describe which sequences of events are stories and which are not. Figure 1 illustrates the major components of the `Joseph` system.

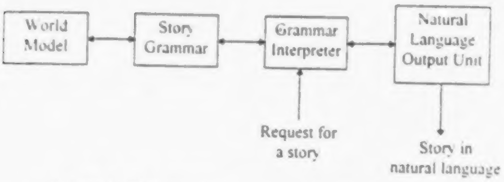

Figure 1: The `Joseph` story generation system

For example, the `Joseph` grammar rule for a `story` specifies that it consists of a `setting` followed by `episodes`:

```
Story --> Setting, Episodes
```

The system works by generating a list of events and facts, expressed as first-order predicate calculus terms. This list is referred to as the "event list." The system also maintains a parse tree of this list as it's building it. Once the event list and parse tree are finished, both of these are sent to a natural language output unit which translates these formal structures into surface text (i.e. language in a form that people actually communicate in). During the process of constructing the event list, the `Joseph` system invokes a world model which describes the events that can happen, the effects that are possible, the reactions characters have, and the goals that characters can pursue.

Below is an example of a story generated by `Joseph` along with the corresponding parse tree and list:

```
once upon a time there lived a peasant.

one day it happened that farmer evicted cat.  when this
happened,peasant felt pity for the cat.  in response, peasant
sneaked food to the cat.  farmer punished peasant.

Tree:
story(setting([p(lives(peasant))]),
  episodes([
    ep(ev(evict(farmer, cat)),
       emot(pity(for(cat))),
       act_resp(a(sneak(food, to(cat))),
                ef(punished(peasant, farmer))),
       outcm(punished(peasant, farmer))])]).

List:
 holds(lives(peasant)),
 occurs(evict(farmer, cat)),
 holds(feels(peasant, pity(for(cat)))),
 occurs(do(peasant, sneak(food, to(cat)))),
 holds(punished(peasant, farmer)),
 holds(punished(peasant, farmer))]
```

The list is a sequence of expressions which describes the story above. The first element of the list states that there lives a peasant which is the protagonist of the story. The second element states that the farmer evicts the cat. The third element of the list states that the peasant feels pity for the cat. The fourth element states that the peasant sneaks food to the cat and the fifth element states that the farmer punishes the peasant for sneaking food for the cat.

HTN PLANNING

This formalism expresses plans in the form of Hierarchical Task Networks. Hierarchical planning as described by Erol, et al [Erol:94] is made up of three types of tasks: goal tasks, primitive tasks, and compound tasks. Goal tasks are properties that an agent wishes to

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make true in the world. These tasks are denoted as `achieve[l]`, where `l` is some state we wish to make true. Primitive tasks are directly achieved by executing a corresponding action. The notation for primitive tasks is $do[f(x_1, \ldots, x_k)]$, where `f` is an element of `F`, a finite set of primitive tasks symbols and $x_1, \ldots, x_k$ are terms. Compound tasks contain one or more goal tasks or primitive tasks. These are denoted as $perform[t(x_1, \ldots, x_k)]$, where t is an element of T a finite set of compound task symbols, and $x_1, \ldots, x_k$ are terms.

Compound tasks are much more complicated than the other two tasks. These tasks are a representation of a desired change cannot be represented as a primitive task or a goal task. Take for example the compound task of "preparing a picnic," which is different from the goal task of "having a picnic", since going to the park and eating would achieve the goal task but not the compound task.

The granularity of the domain dictates what counts as a primitive task. For example, a domain lacking a single action for "pick up something", might include actions such as "open hand," "grab cup," "close hand," and "pick up a cup," as a compound task.

Non-primitive tasks are goal tasks and compound tasks collectively. Tasks associate with each other through task networks, which can represent ordering constraints among the component tasks in the network as well as other constraints. Task networks are denoted as $[(n_1 : \alpha_1) \ldots (n_m : \alpha_m), \phi]$, where each α_i is a task, and n_i is an element of N, an infinite set of labels and ϕ is a boolean formula consisting of variable binding constraints, temporal ordering constraints, and truth constraints.

A method (α, d) associates a non-primitive task α, with a task network `d` specifying one way of achieving α. Take, for example, a method representing the non-primitive task "change a flat tire" with a task network specifying the steps involved in changing a tire, i.e., getting the new tire out, jacking the car up, etc. and the constraints among these steps, such as taking the nuts off before taking the flat tire off, etc.

Here is an example of a plan to change a flat tire. The granularity of a planning domain is arbitrary. In this example, jacking up the car is represented as a primitive, but it could also be represented as a compound act.

```
CHANGING A FLAT TIRE
1. Jack the car up.
2. Loosen the nuts.
3. Take the nuts off the tire.
4. Take the flat tire off.
5. Place new tire on the car.
6. Put nuts on the new tire.
7. Tighten nuts on the tire.
8. Jack the car down.
```

An example of a method (α, d) where α = `perform[change_tire(C,N,F,E)]` and `d` is shown below:

$$
\begin{array}{ll}
(& (n_1\texttt{: do[raise(C)]}), \\
 & (n_2\texttt{: perform[loosen(N,F)]}), \\
 & (n_3\texttt{: perform[remove(N,F)]}), \\
 & (n_4\texttt{: do[remove(F)]}), \\
 & (n_5\texttt{: perform[put\_on(E,C)]}), \\
 & (n_6\texttt{: perform[put\_on(N,E)]}), \\
 & (n_7\texttt{: perform[tighten(N,E)]}), \\
 & (n_8\texttt{: do[lower(C)]}), \\
 & (n_1 \prec n_2) \wedge (n_2 \prec n_3) \wedge (n_3 \prec n_4) \wedge (n_4 \prec n_5) \wedge \\
 & \quad (n_5 \prec n_6) \wedge (n_6 \prec n_7) \wedge (n_7 \prec n_8) \wedge \\
 & \quad (\texttt{car(C)}, n_1) \wedge (\texttt{nuts(N)}, n_2) \wedge \\
 & \quad (\texttt{flat\_tire(F)}, n_2) \wedge (\texttt{new\_tire(E)}, n_5)).
\end{array}
$$

Shown above is an example of a method to change a flat tire and shown its corresponding task network. The left hand side α is the compound task `perform(s(`$x_1, \ldots, x_k$`))`. The right hand side of the rule is the task network. In the task network each primitive task is denoted by the construct `do`, whereas each compound task is denoted by the construct `perform`.

PLANNING DOMAIN

A planning domain is a pair `(Op, Me)`, where `Op` is a list of operators and `Me` is a list of methods. A planning problem, `P` is a triple `(d, I, D)`, where `d` is the task network, `I` is the initial state, and `D` is the planning domain. In other words, the planning domain `D` holds all truths and facts about the world state, `I` is the initial state within `D`, and `d` are the steps which will solve the planning problem `P`.

SIMILARITIES BETWEEN HTN PLANNING AND THE JOSEPH SYSTEM

HTN Planning and the `Joseph` System both attempt to find sequences of events that fit some sort of criteria. The `Joseph` System generates an event sequence that must fit the characteristics of a story when translated to natural language. This means the story has to be coherent, events must happen in the proper sequence, etc. HTN planning attempts to find a sequence of steps which will cause some state to be true after all steps are completed. Because both formalisms search for sequences of actions, one can be mapped to the other. A story grammar can be translated into a set of planning methods and then loaded into a planner to generate a story structure. In a similar fashion planning methods can be translated into grammar rules and then loaded into a grammar interpreter to find a plan.

PROGRESS TO DATE

At this stage a set of set of prolog predicates have been developed which will decompose a planning method and then reconstruct the parts into a grammar rule, and also decompose a grammar rule and reconstruct the parts into a planning method. Shown below is the top level clause for this conversion program:

```
convert(M,R):-
     alpha(M,A),
     task_net(M,T),
     rule_lhs(R,A),
     rule_rhs(R,T).
```

This clause will convert a method `M` into a rule `R`. The subgoal `alpha(M,A)` extracts the α from the planning method `M`; the subgoal `task_net(M,T)` extracts the task network from `M`. The subgoals `rule_lhs(R,A)` and `rule_rhs(R,T)` reassemble these components into a grammar rule. Below is the definite grammar rule that results when the conversion procedure is run on the change tire method shown above:

```
change_tire(C,N,F,E) --->
     [raise(C)],
     loosen(N,F),
     remove(N,F),
     [remove(F)],
     put_on(E,C),
     put_on(N,E),
     tighten(N,E),
     [lower(C)],
     {prec(n1,n2), prec(n2,n3), prec(n3,n4), prec(n4,n5),
      prec(n5,n6), prec(n6,n7), prec(n7,n8),
      holds(car(C), n1), holds(nuts(N), n2),
      holds(flat_tire(F), n2), holds(new_tire(E), n5)}.
```

CONCLUSIONS AND FUTURE WORK

Future work will consist of taking the output of converting a set of methods into a grammar, and then testing the grammar as a way of finding a plan. The next stage of the work will do the reverse: converting a story grammar into a set of planning methods and using a planner to generate a story structure. When this is complete, it will show that hierarchical planning and definite clause grammar generation are isomorphic.

This work explores the similarities between hierarchical planning and generation by a definite clause grammar. Implemented is a conversion between planning methods and definite clause grammar rules using the results shown by Lang [Lang:97]. This conversion allows the use of a grammar interpreter to find plans and a planner to generate story structures. Being able to convert between formalisms allows builders of practical systems to choose from among a wider variety of implementation strategies.

REFERENCES

[Appelt:85] D. E. Appelt. *Planning Natural Language Utterances.* Cambridge University Press, Cambridge, England, 1985.

[Erol:94] Kutluhan Erol, James Hendler, and Dana S. Nau. UMCP: A sound and complete procedure for hierarchical task network planning. In Hammond, Artificial Intelligence Planning Systoms: Proceedings of the Second International Conference, Morgan Kaufmann Publishers, pages 249-254, 1994.

[Lang:97] R. Raymond Lang. A Formal for Simple Narratives. Doctoral dissertation, Tulane University, 1997.

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Algorithm Animation:
Programming On The World Wide Web Using Java

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INTRODUCTION

Algorithm animation allows users to grasp the concept of a program visually in a step-by-step format, rather than relying on a textual explanation. Specifically, it is the process of building abstract models of a program by ignoring inessential features, and creating graphical views of those abstractions (Stasko 1990).

There are numerous applications of algorithm animation. Rather than debugging a program line by line, which can become tedious, an error is much easier to spot if the algorithm is animated and presented to the programmer in real-time simulation (Diacakis). It can also be used as an educational tool. Individual student interaction with an animated algorithm or visual demonstration in a classroom using such an algorithm is likely to increase the depth of understanding of the algorithm for students (Jones and Morgan). Using animation, the user is able to interact with the program as it progresses through the algorithm, rather than a chalk board or transparency method of drawing and erasing steps.

In this project, animated sorting algorithm programs were designed using the Java language. Java allows interaction over the World Wide Web. Using these programs, students in remote locations are able to interactively learn how the algorithms work. The end user does not need a Java compiler, simply a Java enabled web browser. This approach enables many new possibilities for creative teaching and learning methods and the spread of information.

BACKGROUND

Reference to algorithm animation can be traced as far back as 1966 from discussion in Brown and Sedgewick's paper "A System for Algorithm Animation" (London and Duisberg 1985). Since computer programs are difficult to understand in algorithm pseudocode, one might try to explain a program visually. For example, an instructor can draw the before and after effects of a sorting algorithm, representing snapshots of the process. The sequence of snapshots does not portray the dynamic aspects of the process being explained, however. Another problem with this method is that the steps may be confusing and it may be hard to relate the different snapshots. It is clear that the values are exchanged, seeing the values physically swapped is considerably more effective (Citrin and Gurka 1996). Software and movies are also available, which show dynamic presentations. They are expensive and time consuming to produce, however, so other methods began to be developed in order to better explain algorithms visually. Animated graphical views of a program are useful because they help the user understand programs, examine and compare existing programs, and develop new programs.

Different frameworks have been developed for algorithm animation. Tango, developed by John T. Stasko, is a system for "transition-based animation generation", based on the framework (1990). Instead of taking many days or weeks, new animations can be created in a few hours. This system is also useful for programmers to grasp a better understanding of programs by displaying them in an animated graphical way.

Since 1983, visual programming environments such as Balsa and Balsa-II have been used in introductory programming classes as teaching aids (Brown 1988). In order to emphasize small examples with more detail and to create smooth transitions between graphical images, SmallTalk, an object oriented approach, was developed in 1985 (London and Duisberg). Recently, the World Wide Web has expanded the possibilities of algorithm animation. The use of the web has branched from simple read-only applications to taking orders, and now, to running remote applications and simulations (Ibrahim 1995). Programming languages have advanced as well during the changes in frameworks.

By the early 1990's programmers began to see the limitations of C++ (Fifth 1996). A group of researchers headed by James Gosling at Sun Microsoft Systems in Mountain View, CA, worked on a project to design advanced software for a wide variety of networked devices and embedded systems (Winslow and Hammer). C++ was not designed for this type of networking project, so the research team developed the oak language, later renamed Java. The web browser HotJava was made available to the public in April 1995, and the Java Developers Kit in January 1996. An object oriented language, Java is a breakthrough for web use because it allows interaction between the user and web pages. Java is also a portable language. As a platform-independent language, anyone with a Java enabled browser can run a Java program on their computer. The language itself is simple, safe, and secure. This creates many opportunities for animation, specifically algorithm animation as a learning device, over the web.

Another framework model for algorithm animation called Mocha was developed by Baker, Cruz, Liotta, and Tamassia for providing algorithm animation over the Web. Mocha has a client-server architecture that separates the software components of a typical algorithm animation system. It also leverages the power of the Java language, which distributes interactive platform-independent multimedia applications across the web (Baker et al 1995). Other models, X Window and HotJava browser, have code protection and accessibility problems which Mocha is able to overcome. Users with limited computer resources are able to access computer animations with both HotJava and Mocha. Therefore, the end user does not have access to the algorithm code (Baker et al 1995). This breakthrough was big for the Java language, because access to these programs now requires minimal cost to the end user. Since the interactive applications are embedded in HTML documents, this enables transmission of code to the user machine, where the program can then be executed.

RESULTS

When beginning research to decide which algorithms to study and implement, sorting algorithms were found to be the best for starting this animation project. Sorting algorithms are simple in terms of code, but understanding them visually can become complex. Therefore, animation can enhance teaching, and increase comprehension on the part of students(Citrin and Gurka 1996; Jones and Morgan).

For this research, a Power Macintosh computer and the Java Developers Kit 1.0 (JDK) were used for displaying the animated algorithms. The algorithms considered thus far in this project are bubble sort, insertion sort, selection sort, and Quicksort. All of the sorting algorithms attempt to arrange elements in an array or list in increasing order. This work has shown that algorithm animation is able to demonstrate very clearly that some methods are much more efficient than others.

The most straightforward sorting algorithm is the bubble sort. Each element in an array is examined and compared to the next element on the right. If the element to the right is smaller, then the two elements are exchanged. When all the elements in the array are examined and compared in this manner, the largest element is moved to the far right end of the array. The process begins again on the left and continues until it is certain that all the elements have been "bubbled" as far to the right of the array as they belong.

The next algorithm used in this project is the insertion sort, one of the more commonly used sorting algorithms. The insertion sort divides an array into a series of sublists and sorts by comparing elements of one sublist to the elements in the sublist to its left. Starting at the element second from the left end of the array, elements are examined one at a time. The larger elements shift to the right which makes room for the element compared to be inserted in the correct sorted position.

Two other common sorting algorithms are the selection sort and Quicksort algorithms. Although the selection sort operates similarly to the bubble sort, it usually requires more comparisons but fewer exchanges of elements. Again, multiple comparisons are made down the array. First time through the array, the smallest element is located and placed at the far right most place in the array. The element that was there is exchanged with the smallest elements' original slot. The process is repeated for the second smallest element and continues till the array is sorted.

Quicksort is the most frequently used sorting algorithm. It is a recursive algorithm which chooses an element from the list, then uses that element to divide the list into two sublists. All of the elements less than or equal to the chosen element are placed in one sublist; while all the elements larger than the chosen element are placed in the other sublist. Then the same strategy is applied to the sublists recursively, until all the sorting is competed. This will be when all the sublists have only a single element or are empty.

Using HTML, the Java applets were incorporated into web pages for viewer interaction. The user is able to either jump straight from an array of unordered integers to the sorted array, or view the individual comparison and swap steps. Running several algorithms at the same time allows a user to compare and contrast them. Figure 1 shows multiple algorithms running on one screen. The programs are coded to count the number of comparisons and the number of swaps. Algorithms with the fewest number of comparisons and the fewest number of swaps are the most efficient. Using this tool, an observer is easily able to confirm the well-known theoretical facts about the sorting algorithms. For instance, Quicksort is significantly more efficient than all of the others. Users are able to do multiple comparisons of the algorithms with different random number sets, very quickly and effectively.

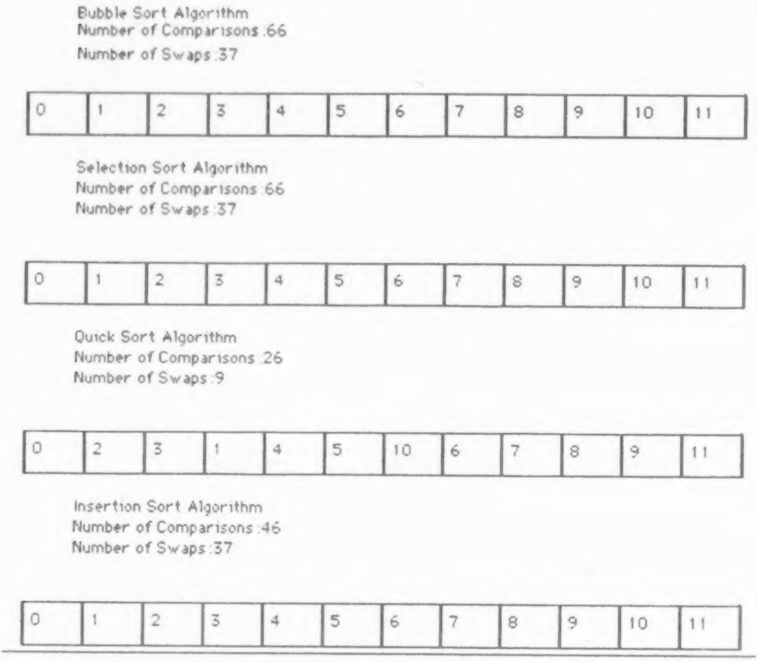
Displayed textually, it can be very difficult for the reader to visualize and understand the mechanics of the algorithms described above. The animated forms of the algorithms are much more user friendly and increase understanding of the programs (Citrin and Gurka 1996). Bubble sort, the most straightforward of the four algorithms, does not demonstrate time efficiency. This is the result of comparisons made through the array multiple times before sorted. Selection sort demonstrates the same efficiency as bubblesort. Theory suggests more comparisons will be made but significantly fewer exchanges. This algorithm returns the same number of comparisons and swaps in both algorithms. The differences in step-by-step comparisons can be viewed on a separate HTML page. Insertion sort demonstrated greater efficiency than the above two algorithms, both in number of comparisons and number of swaps. Fewer comparisons are needed since sublists are used for sorting. It is much easier to see the differences in efficiency between the Quicksort and the previous three algorithms. Quicksort uses a recursive method, thus doing fewer comparisons down the array. The number of swaps in significantly lower as well.

FUTURE WORK

In addition to making improvements on the sorting algorithm problem, my research is continuing with an effort to animate solutions to the well known bin packing problem and to animate a simulation of memory management in a recursive algorithm. In the bin packing problem n objects are given which have to be placed in bins of equal capacity. The objective is to determine the fewest number of bins needed to accommodate all n objects. Therefore, all individual objects must fit completely in a bin, not partially in one bin and partially in another. Many solutions can be devised for this problem. Some possible solutions to animate and compare efficiencies are first fit, best fit, first fit decreasing, and best fit decreasing. In all of these solutions the arrays are sorted first then arranged in bins. First fit sorts the objects so they are considered in order of increasing size. The algorithm places each object on the first bin in which it fits. Best fit also sorts the objects in order of increasing size. Then each object is placed in a bin which is most full among those bins in which the object fits. First fit decreasing and best fit decreasing are the same as first fit and best fit except the objects are sorted first in nonincreasing order.

First fit decreasing and best fit decreasing obtain greater efficiency by packing the objects into a fewer number of bins than first fit and best fit. I plan to demonstrate this by showing these algorithms visually on a web page using Java. This allows the user to compare the different methods and provide a choice to view a step by step packing or to view the before and after results. Again, explaining algorithms in text form can be very confusing.

Algorithm animation for bin packing will allow the viewer to walk through the results one object movement at a time and compare the different solutions for a more in-depth understanding of the algorithm.



Bubble Sort Algorithm
Number of Comparisons :66
Number of Swaps :37

0	1	2	3	4	5	6	7	8	9	10	11

Selection Sort Algorithm
Number of Comparisons :66
Number of Swaps :37

0	1	2	3	4	5	6	7	8	9	10	11

Quick Sort Algorithm
Number of Comparisons :26
Number of Swaps :9

0	2	3	1	4	5	10	6	7	8	9	11

Insertion Sort Algorithm
Number of Comparisons :46
Number of Swaps :37

0	1	2	3	4	5	6	7	8	9	10	11

Figure 1: Web page of the bubblesort, selection sort, Quicksort, and insertion sort algorithms.

CONCLUSION

Algorithm animation on the web is an increasingly useful pedagogical tool for teachers and students. Other methods previously and presently used such as chalkboard, overhead, simply drawing the algorithm designs, and software designed for animation, thus far have had their own specific limitations. The learner loses the linking between steps when algorithms are explained by drawings with the chalkboard and overhead. Although software such as Tango, Balsa I and Balsa II overcome this previous problem, their limitations compared to Java are that software to run the program is needed. Java is able to be created and compiled on one computer, then put on the World Wide Web for users who do not have or need a Java compiler on their computer. All the user needs is a Java enabled web browser such as Netscape 3.0. The algorithms were used in this research to demonstrate the ease of Java algorithm animation. As shown with the sorting algorithms, the user is able to compare multiple algorithms "at work" on one screen. This was never possible before with the blackboard methods. Future work with bin packing and recursive algorithms will further demonstrate that algorithm animation programs written in Java are an effective device for understanding algorithms.

REFERENCES

Baker, James E., Isabel F. Cruz, Giuseppe Liotta, and Roberto Tamassia. ACM

Computing Surveys. A New Model for Algorithm Animation Over the WWW, Vol. 27, Dec 1995. Pg. 568-572.

Citrin, Wayne, and Judith Gurka. A Low-Over head Technique for Dynamic Blackboarding Using Morphing Technology. Computers Education Vol. 26 pg. 189-196.

Diacakis, Athanassios. Algorithm Visualization using Animation. Http://www-dse.doc.ic.ac.uk/~nd/surprise_95/journal/vol2/ad1/article2.html

Fifth International World Wide Web Conference. Http://www5conf.inria.fr/fich_html/slides/Tutorials/T8/slide3.htm May 6-10, 1996 Paris, France.

Jones, Gary M., and Christopher L. Morgan. Multimedia Instructional Aids for Teaching Computer Science. Http://www.mcs.csuhayward.edu/~morgan/gjones/

London, Ralph L., and Robert A. Duisberg. Animating Programs Using Smalltalk. Computer. Vol. 18 August 1985, pg. 61-71.

Stasko, John T. Tango: A framework and System for Algorithm Animation. Computer. Vol. 23, September 1990, pg. 27-39.

Winslow, Maria, and Derek Hamner. Sun Microsystems. Http://www.prominence.com/talks/ncsa/history.html

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Formal Methods for Software Specification

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INTRODUCTION

One of the distinguishing characteristics of modern software development is a very high degree of complexity. The problem domains for which such software is designed are typically much more difficult to fully understand and analyze than was the norm a few decades ago. It is not a gross exaggeration to say that we have long since automated the solutions to the most straightforward problems, and are now seeking to extend the computer's range to more subtle, richer, and more dynamic problem domains. The complexity that is characteristic of modern software efforts far exceeds an individual developer's ability to manage, and software development is now almost always a team effort. Software products containing tens or even hundreds of thousands of lines of code are not uncommon.

How then can such complex projects be managed? Can the complexity of software be reduced? Unfortunately, the answer appears to be no. Complexity is apparently an inherent or essential property of large software systems. We can attempt to manage this complexity but we cannot make it disappear. And given the difficulties that we typically encounter in attempting to produce robust, reliable software products on time and within budget, it is fair to say that we have much to learn about this difficult process.

For more than twenty years, it has been recognized by software developers that a development process involving several fairly distinct phases would be a useful, even essential, approach for large software systems. This multi-phase process is often referred to as the software life cycle. Today, there are several popular models of the phased development process, but most are modifications of the so-called waterfall model. In this model, the development process is conceived as basically a sequential process, moving through at least four relatively distinct phases from the first feasibility study for the development of a system to the delivery and maintenance of a working system

Software reliability is one of the most challenging aspects of software development, and formal methods helps to increase that reliability by using rigorously defined requirements. Formal methods involve the use of techniques from logic and discrete mathematics in the specification, design, construction, and verification of computer systems and software (NASA Guidebook II, p. 4). In the software development life cycle, requirements analysis and specification is the first step, followed by design, implementation, testing, and finally maintenance and operation. Formal methods helps to reduce the errors in the early stages of the life cycle instead of finding them in the testing phase, which can be quite costly.

The project reported on here was performed at NASA's Jet Propulsion Laboratory in Pasadena, California during the summer of 1996. The purpose of the project was to explore the usefulness of formal methods in analyzing the requirements and design of the Attitude Control System subsystem for NASA's Deep-Space 1 spacecraft. Particularly, the goal was to see if formal methods could be helpful in reducing hazardous loss of attitude knowledge. A formal specification tool called Software Cost Reduction (SCR) was used to check the existing specification. It was concluded that the SCR tool may not have been the most appropriate tool for the particular type of specification involved in the ACS subsystem. However, plans call for the continued use of the SCR tool to check other developing and existing specifications.

DESCRIPTION OF RESEARCH

The project involved analyzing the Attitude Control System for the Deep-Space 1 spacecraft, which is part of the New Millennium project. The work was based entirely on the ACS state-transition shown in Figure 1. The project began with some research on the entire system by looking at documents and papers from previous spacecraft in order to get a general idea of how it works. The ACS state-transition diagram then served as a high-level roadmap for organizing research into the lower-level details of the system. While researching the system, any inconsistencies were noted between the diagram and other available information. Some possible inconsistencies were found and noted, but at times there was insufficient information to give a solid background. Because of this, there was a question as to whether the possible problems found were truly going to pose a problem, or if they had been accounted for at a lower level. Using the events and the information that was found, work was begun with the SCR (Software Cost Reduction) tool.

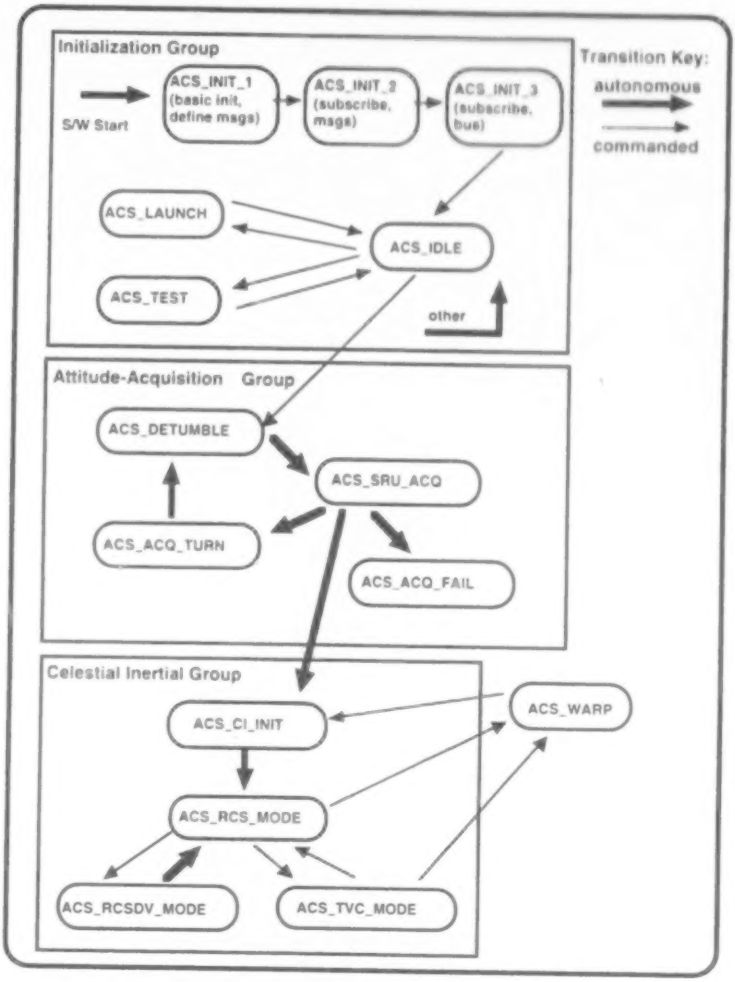
Initialization Group
S/W Start
ACS_INIT_1 (basic init, define msgs)
ACS_INIT_2 (subscribe, msgs)
ACS_INIT_3 (subscribe, bus)
ACS_LAUNCH
ACS_IDLE
ACS_TEST
other
Transition Key:
autonomous
commanded
Attitude-Acquisition Group
ACS_DETUMBLE
ACS_SRU_ACQ
ACS_ACQ_TURN
ACS_ACQ_FAIL
Celestial Inertial Group
ACS_CI_INIT
ACS_WARP
ACS_RCS_MODE
ACS_RCSDV_MODE
ACS_TVC_MODE

Figure 1: The Attitude Control System (ACS) state transition diagram for the DS-1 spacecraft.

SCR is a formal requirements specification tool. The toolset has many features, including a specification editor for building and displaying the requirements specification, a simulator to symbolically execute the specifications, and a formal analysis tool for testing selected properties [Heitmeyer, et. al. p. 109]. The tool is still in the development phase, and only a partial guidebook has been written to accompany it.

The SCR interface consists of tables into which the user enters information. Five general dictionaries are available for use with every specification, and the user is free to make more of his or her own dictionaries for clarification purposes. A mode class in SCR is a state machine whose states are called modes and whose transitions are instigated by events [Heitmeyer, et. al., p. 111]. For this project, three mode classes were declared, one for each major group on the ACS diagram.

Using SCR, the three mode classes were first declared as well as one mode for each of the states that are shown on the ACS diagram. Then a variable table was used and variables were created for each of the events that caused a transition from one state to another. After entering all the appropriate information and checking the specification, it was found that the initial approach was not going to work well with the tool. According to the ACS transition diagram, the ACS will be in only one state at any given time. The way it had been declared, there must be a defined state for every mode class, meaning that it would have to be in three states at any given time, one for each class. This problem was resolved by declaring an Inactive state for each class to account for when that particular mode class is not being activated. Finally, mode transition tables were written for each of the mode classes, using the variables that had been declared.

RESULTS

After all the information had been entered, the SCR Consistency Checker was used to check the tables for any errors. A few things were adjusted in the specification, but finally the checker ran without producing any errors. At this point the simulator was run. Using the simulator, a list of pending events was entered. In this case, each event was either a command from the Remote Agent to the system, or an autonomous event. SCR then used these events to simulate what would happen, and the simulation worked as planned.

It was verified that the diagram appeared to be consistent, but the tool did not provide the kind of information that had been hoped to be discovered. It may be because the SCR tool was not the most appropriate tool to use for this type of specification. SCR was designed for defining requirements, rather than checking existing specifications, like the Attitude Control System. Also, the ACS diagram is a very "flat" diagram and does not exhibit a hierarchical structure. Because of this, the tool can not be expected to generate large numbers of inconsistencies that would not be noticed just by examining the diagram. The possible inconsistencies that were noted from the background research were not accounted for in the tool so nothing new was learned from that standpoint.

What was gained was a better understanding of both the SCR tool itself and the formal methods process in general. The work that was done on SCR will be shown to the ACS domain experts because it gives a different view into the system and how it works, and hence may provide some valuable additional insights into the system's behavior. Also, the SCR tool is still being developed and many features had not yet been implemented. A report was done on the work and the problems that were encountered, which may help the developers of the tool realize some of the problems that are occurring.

DIRECTIONS FOR FUTURE RESEARCH

This work could be continued in several different ways. One way would be to develop a fault tree analysis, a method that "uses Boolean logic to describe the combinations of individual faults that can constitute a hazardous event" (Leveson, p. 317). For each of the faults that could occur in the Attitude Control System a fault tree would be designed to trace the fault back to the source. This method can work very well with software also, as it can "identify safety-critical interfaces and potentially hazardous software behavior" (Leveson, p. 323). Another direction for future work would be to develop different models for comparisons. One of these models could be a SPIN model, another type of model checker that exhaustively explores every aspect of a particular state machine. Another direction would be to develop models of other DS-1 subsystems to check for consistencies in the flight rules. An additional check could be done by modeling the ACS state-transition diagram in another specification tool and comparing it to the results from SCR.

The author's work on formal methods will be continued at Furman University. This work will involve learning and using the formal specification language tool PVS (Prototype Verification System), developed at SRI, International (Owre, et. al.). Using PVS, additional control systems will be modeled, with the goal of comparing the use of PVS and SCR as specification verification tools for control systems.

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BIBLIOGRAPHY

Formal Methods Specification and Verification Guidebook for Software and Computer Systems Volume II: A Practitioner's Companion, Office of Safety and Mission Assurance, NASA, Draft - June 16, 1996.

Heitmeyer, Constance, Alan Bull, Carolyn Gasarch, and Bruce Labaw, *SCR: A Toolset for Specifying and Analyzing Requirement*, COMP [COMP95], 1995, pp. 109-122.

Leveson, Nancy G., *Software System Safety and Computers*, Addison-Wesley Publishing Co., Boston, 1995, pp. 317-325.

Owre, Sam, Alan Bull, Natarajan Shankar, and John Rushby, *The PVS Specification Language*, Computer Science Laboratory, SRI International, Menlo Park, CA, 1993.

RSL, A Language for Distributed Parallel Solution of Sparse Matrix Systems

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A major limitation thwarting high parallel speedups is interprocessor communication. The communication limit can be particularly severe when the problems being solved involve sparse matrices. By coupling the processes of assembling and solving systems of equations (derived from either the finite element or finite difference methods), it is possible to reduce significantly the amount of information that needs to be communicated relative to the standard parallel solution methods. A new parallel language called the Recursive Substructuring Language (RSL) has been developed to implement a recursive substructuring method for solving sparse matrix systems in a distributed parallel processing environment. RSL permits the user to define the parallel hierarchical assembly and solution steps required for recursive substructuring. After discussing the implementation of RSL, empirical results will be presented showing the significant improvements in parallel speedups RSL achieves over more traditional methods for sparse matrices. The application of RSL to our work on a global atmospheric model [*Porter, et. al.*, 1996] will also be discussed.

INTRODUCTION

The parallel solution of sparse matrices has traditionally been a bottleneck in programs that use such stategies as the finite element [*Butler*, 1982] or finite difference [*Press, et. al.*, 1992] method. Approaches generally involve some kind of round-robin algorithm for the forward substitution and a serial back-substitution. The author previously explored a strategy whereby solution of sparse matrices arising in a global atmospheric circulation model was accomplished by exploiting the large granularity of the matrices [*Huneycut*,1996; *Porter, et. al.*, 1996]. Although a speedup of 3.7 over the serial solution was achieved, the method required that the entire solution vector be passed every time step, so a fundamentally parallel strategy was sought. Recursive Substructuring, described by *Bruff* [1997] as a separate paper in this conference, offers such a strategy. Recursive Substructuring Language (RSL) is a language that facilitates the description of the Recursive Substructuring algorithm. Designed to meet three specific goals and implemented using the powerful utilities Lex, Yacc, and PVM, RSL provides this interface.

Recursive Substructuring couples the assembly and solution processes used to solve systems of equations. It is particularly advantageous for parallel solution of sparse systems, because each variable is coupled to relatively few other variables. In Recursive Subtructuring a group of coupled equations (termed an element) can be assembled and solved independently from other groups of equations, eliminating all but the shared boundaries between elements. Then the reduced equations may be assembled into a larger system.

RECURSIVE SUBSTRUCTURING LANGUAGE (RSL)

In developing RSL, there were three main goals. First a language was needed that described the process defined by the Recursive Substructuring algorithm. The language also had to be parallel, that is, it had to allow for the distribution of the algorithm across multiple processors. Finally the language had to have a formal syntax description.

The first goal required that RSL be capable of describing the following objects and operations. The basic objects on which RSL needs to work are matrices. Two types of matrix structures are used, elements and super elements. Elements are primitives in the language and are provided by the user. Super elements are formed from elements and/or other super elements by a user-defined elimination/assembly hierarchy. The RSL must allow the user to describe the operations for creating this hierarchy. In addition to defining the assembly process, the RSL must provide the capability for the user to describe the mapping used in the elimination/assembly process. Mappings define which degrees of freedom are treated as internal or external at each stage of the process. One final feature of the language is the ability to specify the boundary conditions used in the solution. Solution proceeds from the top down through the hierarchy, using the user-specified boundary conditions. Internal degrees of freedom at the highest level of the hierarchy are solved and passed down the chain permitting all internal degrees of freedom to be solved.

The second requirement of the language was that it be parallel. The strength of the Recursive Substructuring algorithm is that it is inherently parallel. Each super-element can be solved independently of any others once the external solutions are known, and once those solutions are known, the super-element's constituent elements can be solved independently, etc. The process stops when the base condition is reached, i.e., the solution process yields an element which is not a super-element. To build this parallelism into the language, directives were included which group the instructions into tasks that can be executed on separate hosts. Send and receive directives to pass the super-elements and solutions around were also included.

The third and final goal in the designing of RSL was not only to code an interpreter for a language that would accomplish the previous two goals but also to develop a formal specification for the language. In this case, a formal specification is a grammar corresponding to the language that is developed in such a way to be powerful enough to meet the goals of the language and simple enough to avoid complex coding. In general the more context-sensitive a grammar is, the more power the associated language has, while the languages derived from context-free grammars are more straight-forward to program. The balance of power and ease of programming in the case of RSL was achieved by dividing the grammar into both context-free and context-sensitive parts. The organization of the tokens, or semantics, of the language corresponds to the context-free portion of the grammar, and the order of characters in the tokens, or syntax, corresponds to the context-sensitive portion. As will be shown later, this division maps onto the utilities lex and yacc quite conveniently, and eases the programming of a compiler for RSL. Having a formal specification for the language also makes the task of maintaining the language easier. Any changes made to the grammar can be easily applied to the code. Furthermore the grammar specification serves as documentation of the code. The context-free portion of the grammar is included below. The symbols in all caps signify non-terminals, lowercase signifies terminals, and underlined signifies a directive or reserved word.

RSL GRAMMAR

START → PROCESSORBLOCKLIST
PROCESSORBLOCKLIST → PROCESSORBLOCK PROCESSORBLOCKLIST
→ PROCESSORBLOCK
PROCESSORBLOCK → processor key level DIRECTIVELIST endprocessor
DIRECTIVELIST → DIRECTIVE DIRECTIVELIST
→ DIRECTIVE
DIRECTIVE → NAMEBLOCK
→ passelement elementname key
→ passelement superelementname key
→ passsolution solutionname elementname (key)
→ passsolution solutionname superelementname (key)
→ print elementname (filename)
→ print superelementname (filename)
→ print solutionname (filename)
→ readboundary boundaryname (boundaryfilename)
→ receiveelement elementname (key)
→ receiveelement superelementname (key)
→ receivesolutionname boundaryname (key)
→ BOTTOMSOLVELIST
→ TOPSOLVELIST
NAMEBLOCK → name elementname ELEMENTBLOCK
→ name superelementname ASSEMBLEBLOCK
ELEMENTBLOCK → element (dof) { kfilename ffilename }
ASSEMBLEBLOCK → assemble (dof , extdof , RANGE) { ELEMENTLIST }
ELEMENTLIST → elementname MAP ELEMENTLIST
→ superelementname MAP ELEMENTLIST
→ elementname MAP
→ superelementname MAP
MAP → { RANGE }
RANGE → rangeint RANGE
→ rangeint
BOTTOMSOLVELIST → solve superelementname solutionname
TOPSOLVELIST → solve superelementname boundaryname solutionname

RESULTS

RSL was implemented using the UNIX utilities Lex and Yacc. Lex is a programming tool that makes writing a lexical analyzer more straight-forward. As the file containing the text to be analyzed is read, Lex, using a "program" containing regular expressions and C code, tries to match each string in the input with the regular expressions. If Lex finds a string that matches one of the regular expressions, then the C code corresponding to that expression is executed. By itself, this utility is quite powerful, but in conjunction with another tool, Yacc (which stands for "Yet Another Compiler Compiler"), it gains more power still. Yacc receives inputs from a lexical analyzer, typically Lex, and using a grammar described by the user with a Yacc "program," determines if they are in the language corresponding to the grammar.

The RSL compiler maps the structure of RSL described above directly onto the functions of lex and yacc. Yacc's role in the process is two-fold; it checks the semantics by applying the production rules to the tokens as lex returns them, and it calls the proper library function when a statement (a directive and all the directive's arguments) is parsed. Lex and yacc are able to communicate because yacc calls the function, yylex, which does the actual lexical analysis and returns the token value of the string that was read, which yacc can then look up to determine the actual token. While lex can easily search for the reserved directives and determine their token values, the non-reserved strings in the language are not so easily determined because the context must be determined. In order to accomplish this task, a state diagram was developed for each statement with a context-sensitive syntax. In a state diagram each state has explicit "directions" for moving from that state to another state given an input symbol. Thus it is possible to ensure that a particular state is only reached if a specific set of inputs is given. Using this reasoning a set of states were developed that disambiguate occurrences of symbols that could belong to multiple tokens. If an otherwise ambiguous input is read, the state provides clarification. Lex provides a state dependent model to translate a regular expression to a corresponding segment of C code. For instance, an integer can occur in an RSL program in a few places. It might represent the external degrees of freedom in an assemble statement, or it might be the total degrees of freedom of the element specified in the element statement. The way lex distinguishes between these two cases is that if it reads the reserved word element, it enters the state ELEMENTSTATE, and in the case of the assemble statement, lex would be in the state EXTDOFSTATE if the number read is the external degrees of freedom.

Lex and Yacc also provide separation of the program and the language. Instead of all-purpose functions that are responsible for reading from the file, parsing the language, and then calling the library routines, with lex and yacc a set of interface functions, called by yacc when a statement is parsed, manipulate the data provided through the language and then call the appropriate Recursive Substructuring library function. For example, once an element statement has been parsed, yacc calls ParsedElement() and sends as parameters the element name, input file names, and degrees of freedom. ParsedElement() then reads in the data stored in the file and calls the appropriate library routines to create a new element. This structure is nice for a few reasons. A different language could be used, and the interface functions would still work as long as all the parameters were defined. Another feature of this structure is that since the lexical analysis is separate from the parsing which is separate from the interface functions, the language can be modified, either by adding new reserved words or changing the grammar slightly, or the Recursive Substructuring library can be modified, and the changes are confined to only that component.

Parallel Virtual Machine (PVM) was also used to develop RSL. PVM is a message passing library developed at Oak Ridge National Laboratories and available as public domain software. PVM allows for message passing across multiple architectures. Although the PVM library contains many functions for parallel computing tasks, only the send and receive functions were required. As described above, it is necessary to send and receive the assembled super-elements and send and receive the solution. The reserved words passelement, receiveelement, passsolution, and receivesolution are included in the language to provide this functionality. For example, if a passelement statement is parsed, then yacc calls the function ParsedPassElement(), which bundles up the element to be sent, and then calls the PVM routines to send the bundle to the appropriate host.

CONCLUSIONS

The Recursive Substructuring Language has been created to provide an efficient means to implement Recursive Substructuring. RSL provides the user with the capability to define an arbitrary assembly/solution hierarchy for a parallel PVM-based architecture. RSL can easily be ported to any PVM-based architecture and used for parallel solutions of sparse matrix systems. The language allows the user to set up the problem solution on multiple processors in an intuitive way.

RSL was used to study the parallel solution of sparse matrix systems, and tests conducted on the Recursive Substructuring algorithm using RSL show a linear parallel speedup is achieved as more processors are added to a problem. With 8 processors working, only a 2% decrease in speed from the expected factor of 8 speedup was detected. Because of the high degree of parallel speedups shown by RSL, a new goal of the global atmospheric circulation model project will be to use Recursive Substructuring for the solution processes.

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REFERENCES

Huneycutt, C.M., "Optimizing a Planetary Global Atmospheric Circulation Model for Distributed Processing," *Proceedings of NCUR-10*, 1996, p.1078-1082.

Porter, H.S., Cogdell, G.B., Huneycutt, C.M., and Mayr, H.G., "A Spectral Global Atmospheric Circulation Model for Distributed Parallel Execution," *ACM Southeast Conference Proceedings*, April, 1996, p.147-152.

Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.P., *Numerical Recipes in C: The Art of Scientific Computing*, 2nd Edition, Cambridge University Press, Cambridge, 1992.

Bathe, K., *Finite Element Procedures in Engineering Analysis*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982.

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A Parallel Solution of a Parabolic System on a SIMD Processor

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Parallel solution, based upon explicit method, was used to study the solution of a 1-dimensional unsteady heat transfer model problem on the NASA MasPar MP-1. All processing elements (PEs) were made to exchange data using a nowrap single-step nearest-neighbor communication scheme. The results of this solution were compared to those of a benchmark, the serial Crank-Nicolson method. Both methods required time-marching. For parallel solution, all PEs were used so that each PE was at a step in the spatial dimension of one of the problem domains. That required some adjustment of time steps to ensure stability. The Crank-Nicolson method is unconditionally stable, but each time level required a solution of a tridiagonal linear system represented with 3 vectors and solved with the cyclic doubling technique.

THE PHYSICAL PROBLEM

The equation chosen for this study was a *parabolic* partial differential equation

$$\frac{\partial u}{\partial t} - \frac{4}{\pi^2}\frac{\partial^2 u}{\partial x^2} = 0, \quad for \;\; 0 < x <, 0 < t, \tag{1}$$

having the conditions

$$u(0,t) = u(4,t) = 0, \;\; 0 < t; \tag{2}$$

$$u(x,0) = \sin\frac{\pi}{4}x(1 + 2\cos\frac{\pi}{4}x), \;\; 0 \le x \le 4. \tag{3}$$

Eqn(2) was the boundary condition because it gave the values of the dependent variable, u, at the end points of the spatial domain, [0, 4], while eqn(3) was the initial condition as it gave the values of u at the beginning of time, 0. A *parabolic* partial differential equation often arises as a model of a system experiencing an unsteady state change of some quantity, u, which is commonly the *concentration* of, say, some gas, as in a system undergoing unsteady state gas diffusion, or *temperature* as in a system with transient heat transfer. In this work, the *parabolic* partial differential equation was regarded in the context of transient heat transfer in some engineering system.

The analytical solution of eqn(1), having the stated initial and boundary conditions, was determined to be

$$u(x,t) = e^{-t}\sin\frac{\pi}{2}x + e^{-t/4}\sin\frac{\pi}{4}x, \quad 0 \le x \le 4. \tag{4}$$

PROBLEM APPROXIMATION FOR NUMERICAL SOLUTION

In order to obtain a numerical solution of eqn(1), both the spatial and time domains were partitioned into discrete uniform intervals of Δx and Δt respectively. Next, the spatial partial derivative in eqn(1) was replaced with the *centered* finite difference quotient

$$\left.\frac{\partial^2 u}{\partial x^2}\right|_{x=x_i, t=t_j} = \frac{u_{i+1}^j - 2u_i^j + u_{i-1}^j}{(\Delta x)^2} + O((\Delta x)^2), \tag{5}$$

the time partial derivative was replaced with the *forward* finite difference quotient

$$\left.\frac{\partial u}{\partial t}\right|_{x=x_i, t=t_j} = \frac{u_i^{j+1} - u_i^j}{(\Delta t)} + O(\Delta x)^2, \tag{6}$$

where $O((\Delta x)^2)$, and $O(\Delta t)$ represented the truncation errors introduced by the respective replacement. In the above equations, as is elsewhere in this paper, a ***superscription*** signifies a time level while a ***subscription*** indicates a location in the spatial domain at which the value of the dependent variable, u, was considered. Carrying out the indicated replacements and simplifying the resulting equation, we obtained an approximation of eqn(1) to be

$$u_i^{j+1} = u_i^j(1 - 2\xi) + \xi(u_{i-1}^j + u_{i+1}^j). \tag{7}$$

where

$$\xi = \frac{1}{\pi^2}\frac{\Delta t}{(\Delta x)^2}. \tag{8}$$

In this study, eqn(7) was solved by both ***explicit*** and ***implicit*** methods, and the results of the solution compared to those obtained from the analytical solution, eqn(4). The explicit solution required that the condition

$$0 < \xi \leq 0.5 \tag{9}$$

be observed for the ***stability*** purpose (Burden, 1988), and (Gerald, 1996). The ***implicit*** solution required no such condition. THE SUPERCOMPUTER

Information concerning the architecture and software environments of MP-1 are well documented in (MPL, 1993), (MPPE, 1991), and (MPML, 1991). The information on the architecture, software supports, and the programming environments of MP-1 the understanding of which were essential for the successful completion of this study are well documented in in (MPL, 1993), (MPPE, 1991), and (MPML, 1991).

NUMERICAL SOLUTION

The solution of eqn(7) was obtained by both ***sequential*** and ***parallel*** methods all of which were based on the explicit solution techniques. The sequential method, whose algorithm is not shown, simply computed eqn(7) at each interior grid point of the partitioned spatial domain. Both the *sequential* and *parallel* solutions involved time-marching which began at *time* = 0 level up to the time level at which the equilibrium solution of the dependent variable was reached.

```
STEP 1: Choose an integer, $n$, and partition interval of $x$, $[0,4]$, into $n$ equal parts each of
            length$\Delta x$, and represent the interior points, $1, \cdots, N$ (where $N = n - 1$)
            with $PE_0, \cdots, PE_{N-1}$.
STEP 2: Declare the plural variables, old_u, new_u, lbc, and rbc:
            plural double old_u, new_u, lbc, rbc;
STEP 3: Declare and initialize the singular variable, time:
            float time = 0.0;
STEP 4: Choose $\Delta t$, and with $\Delta x$ of step 1, compute $\xi$ using eqn(8).
STEP 5: Hold $\Delta x$, $\Delta t$, $\xi$ and $\pi$ in double parameters delta_x, delta_t, z and pi respectively.
STEP 6: Compute the boundary values from eqn(2), and hold them in the plural variables,
            rbc and lbc:
            lbc = rbc = 0;
STEP 7: Compute (in parallel) the initial values using eqn(3) for each active PE with index i
            proc[i].new_u = sin(pi/4.0) * (1.0 + 2.0 * cos(pi/4.0 * iproc * δ_x));
STEP 8: Print out time and new_u.
STEP 9: For all active PEs DO
        Step 9.1: Update time and old_u:
            time += delta_t;   old_u = new_u;
        Step 9.2: Compute new_u using eqn(7):
            new_u = old_u * (1.0 - 2 * z) + z * (xnetW[1].old_u + xnetE[1].old_u);
        Step 9.3: Print out time and new_u.
STEP 10 UNTIL equilibrium u is reached.
```

Figure 1: Parallel Algorithm

The *Crank-Nicolson* solution was used as a benchmark to test both the accuracy and efficiency of the *explicit* parallel and sequential solutions. The *Crank – Nicolson* solution method, which is naturally both *implicit* and *sequential*, was based on the following formulation

$$-\xi u_{i-1}^{j+1} + (2 + 2\xi)u_i^{j+1} - \xi u_{i+1}^{j+1} = \xi u_{i-1}^{j} + (2 - 2\xi)u_i^{j} + \xi u_{i-1}^{j}, \qquad (10)$$

where ξ was defined according to eqn(8).

The *Crank-Nicolson* solution approach is an *implicit* solution method because evaluation of a u value at a given spatial location, say, i, and at a time level, j+1, requires the values of u, such as u_{i+1}^{j+1}, not yet determined. This contrasts the *explicit* method (see §3) in which a value of u at any time level can be completely determined from u values from the immediate previous time level. Another difference between the two approaches is that, while the *explicit* method is always subjected to the *stability* condition such as the one given in eqn(9), the *implicit* method is not limited by any such condition, hence, the *Crank-Nicolson* method, an *implicit* solution approach, is said to be unconditionally stable. One of the disadvantages of the *Crank-Nicolson* method, however, is that it is not amenable to efficient parallel solution, hence, it is usually solved, as in this study, *sequentially*.

We implemented the *sequential* shown in figure 1 to solve the *Crank-Nicolson* formulation presented in eqn(10) above. For any given time level, j, we solved that equation for each of the N interior points resulting from partitioning of the x domain. The result was a *tridiagonal* system of linear equations, Ax = k, which was solved using the cyclic reduction method (Hockney, 1988) whose algorithm is shown in figure 3.

```
STEP 1: Declare time and set it to zero.
STEP 2: Choose $\Delta x$ and $\Delta t$ and compute $\xi$ according to eqn(8).
STEP 3: For each interior point, solve eqn(3) for initial values of u.
STEP 4: Print out time and the computed initial values.
STEP 5: Obtain the tridiagonal matrix A resulting from the Crank-Nicolson method.
STEP 6: Update time by incrementing it with $\Delta t$ value.   /* Time level No. 1 */
STEP 7: For the current time level DO
        Step 7.1: Using u values and the boundary values, compute the vector, k.
        Step 7.2: Call the cyclic reduction algorithm (figure 3) to solve the tridiagonal
                  system to obtain the solution vector, u.
        Step 7.3: Print out time and the solution vector.
        Step 7.5: Update time by incrementing it with $\Delta t$ value.
STEP 8 UNTIL equilibrium u is reached.
```

Figure 2: Algorithm for the *Crank – Nicolson* Method

```
STEP 1: Declare a four-component plural vector, p, to hold A's and k's components.
            plural double p[4];
STEP 2: Initialize p with nonzero values of A and k such that
            $a_i, b_i, c_i$, and $k_i$ are held, in that order, $p_i$ is assigned
            to $PE_{i-1}$, where $1 \le i \le N$).
STEP 3: Determine $\alpha_i$ and $\gamma_i$
STEP 4: For reduction levels $0 \le l \le \log_2(N-1)$ LOOP /* Parallel Step */
        Step 4.1: Compute $\alpha_i$ and $\gamma_i$
            $\alpha_i = -a_i/b_{i-2^{l-1}}$
            $\gamma_i = -c_i/b_{i+1}$
        Step 4.2: Compute new $a_i, b_i, c_i, k_i$
            $a_i = \alpha_i a_{i-2^{(l+1)}}$
            $c_i = \gamma_i c_{i+2^{(l+1)}}$
            $b_i = b_i + \alpha_i c_{i-2^{(l+1)}} + \gamma_i a_{i+2^{(l+1)}}$
            $k = k_i + \alpha_i k_{i-2^{(l+1)}} + \gamma_i k_{i+2^{(l+1)}}$
        Step 4.3: Update p with new values of $a, b, c, k$ computed in step 4.2
STEP 5: ENDLOOP
STEP 6: Compute the solution vector, u.
            $u = k/b$.
```

Figure 3: Algorithm for the *Cyclic Reduction*

Some of the salient features of figure 3 are noted below:

- Steps 1 and 2 are the only *serial* steps carried out by the ACU, while steps 3 to 6 are performed in *parallel* by each of the active PE.
- N four-component vectors, $p_1 \cdots, p_N$, were used as as special data structures to hold nonzero components *a*, *b*, *c*, and *k* of matrix A for rows $1, \cdots, N$ respectively. The unsubscripted *p* instead had the components of 0, 1, 0, 0. The vectors, $p_1, \cdots, p_N$ were assigned to $PE_0, \cdots, PE_{N-1}$ respectively.
- An index on a parameter is the *iproc* of the PE that the active PE is communicating with. For example, occurence of b_j in a parallel step of PE_i means that PE_i is using (by copying) the *b* component of PE_j's p vector.
- Step 3 determined the special parameters, γ and α, needed in the *cyclic reduction* scheme.
- In step 4, each PE carried out the indicated computations and updates in parallel. In this step, the maximum reduction level of $\log_{10}(N\text{-}1)$ was used with no attempt to minimize it in the manner suggested by Hockney.

THE RESULTS

One set of the numerical and the analytical solutions of the parabolic system modeled in eqn(1) is shown in tables 1 for the case $\Delta x = 0.2$, and $\Delta t = 0.01$, and in which the entry, CN, stands for results obtained from the *Crank-Nicolson* approach. Because the results from the sequential and parallel implementations of the *explicit* method (eqn5) were the same for all ξ values, only the parallel solution results are shown in the table 1. The CPU times required by the various solution mehods are given in table 2. The results of computations used in this study are summarized as follow:

1. The *explicit* solutions were reasonable approximation of the system (tables 1 and 2) only when the stability condition (eqn(9)) was satisfied. When the *stability* condition was not satisfied, the *explicit* ,methods gave very poor approximation of the system. Such poor results were indicative of instability in the solution process.
2. The *Crank-Nicolson* method took much larger time steps to reach the equilibrium values of *u* than did any of the *explicit* methods. At the fixed $\Delta x = 0.2$, the equilibrium time of about 28 could be reached by the *Crank-Nicolson* method at the fourth time level of computation (that is, with $\Delta t \approx 1$ or with $\xi \approx 10.1$), whereas, to reach the equilibrium state without offsetting stability, the maximum Δt required by any of the *explicit* methods was $\Delta t \approx 0.05$. When the *explicit* and the *Crank-Nicolson* programs were time-marched using the same Δt, the *implicit* solution was about 10 times as accurate as the solution from *explicit* methods, for all ξ values.
3. As shown in table 4, the parallel *explicit* method was a lot faster than the sequential counterpart at all ξ values. The *speedup* of the parallel solution, when compared to the sequential method, averaged 15.13 for all ξ values. When compared to the *Crank-Nicolson* method, the speeds of the *explicit* approach was even more spectacular, with the *speedup* averaging 56 for all ξ values. The speed gains of the parallel *explicit* method, was reduced to only about 3 when both the parallel method and the *Crank-Nicolson* executed at their respective maximum ξs of 0.5 and 10.12.

CONCLUSION

The parallel method proposed in this study for the solution of the one-dimensional *parabolic* system was found to be much faster than the *sequential* methods used in this study when all methods used the same ξ values and when the *stability* of the *explicit* solutions was guaranteed. Based upon speeds alone, the parallel solution is highly recommended over the other methods provided that the ξ values chosen are within the limit provided by the stability condition. If the solution of such a system must not be constrained by the stability condition, or if as few as possible number of time levels of execution are required to reach equlibrium state, then the *Crank-Nicolson* method should be preferred over the other methods including the *parallel* solution approach proposed in this study.

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REFERENCES

Baucom, C. L., Reduced Systems and Preconditioned Conjugate Gradient Method on a Multiprocessor, M.S. Thesis, Univ. Illinois at Urbana-Champaign, 1988.

Burden, R. L., Numerical Analysis, PWS-Kent Pub. Co., Boston, 1988.

Dongara, J. J., Performance of Various Computers using Standard Linear Equations software, Tech. Rep. No. CS-89-85, ORNL, 1994.

Gerald, C. F, et al, Applied Numerical Analysis, Addison Wesley Pub. Co., Reading, 1996.

MPML, MasPar Mathematics Library (MPML), Softwr. ver. 9302-0300, Revision No. A3, 1991.

Table 1: Solution at Selected Grid points for $\Delta x = 0.2$ and $\Delta t = 0.01$, and $\xi = 0.101$

Time Level, t	x Value	Analytical Soln	Parallel Soln	Error	CN Soln	Error
$t = 0.02$	0.2	0.4586	0.4321	0.0265	0.4586	0.0000
	1.0	1.6838	1.5943	0.0895	1.6839	0.0001
	1.8	1.2857	1.2430	0.0427	1.2857	0.0000
	2.6	0.0936	0.1374	0.0438	0.0934	0.0002
	3.4	-0.3413	-0.2889	0.0524	-0.3414	0.0001
	3.8	-0.1472	-0.1269	0.0203	-0.1473	0.0001
$t = 2.00$	0.2	0.1367	0.0131	0.1236	0.1375	0.0008
	1.0	0.5642	0.0594	0.5048	0.5669	0.0027
	1.8	0.6409	0.0829	0.5580	0.6422	0.0013
	2.6	0.4309	0.0748	0.3561	0.4297	0.0012
	3.4	0.1659	0.0381	0.1278	0.1643	0.0016
	3.8	0.0531	0.0131	0.0400	0.0525	0.0006
$t = 4.00$	0.2	0.0632	0.0011	0.0621	0.0635	0.0003
	1.0	0.2784	0.0050	0.2734	0.2796	0.0012
	1.8	0.3690	0.0070	0.3620	0.3699	0.0009
	2.6	0.3130	0.0063	0.3067	0.3131	0.0001
	3.4	0.1522	0.0032	0.1490	0.1520	0.0002
	3.8	0.0519	0.0011	0.0508	0.0580	0.0001

Table 2: The CPU Times (ns) for theExplicit and Implicit Solutions

ξ	*Explicit Soln*		*CN Soln*
	Sequential Soln	*Parallel Soln*	
0.101	0.31702	0.02094	1.12559
0.500	0.06482	0.00428	0.23016
1.216	0.02688	0.00178	0.09542

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Evolutionary Confusion:
When And How To Apply the Genetic Algorithm

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The stochastic of the problems genetic algorithms are commonly applied to make it difficult to quantify the actual advantage of the evolutionary approach. The use of genetic algorithms is not always superior to more conventional function optimization techniques. Indeed, it is clear that genetic algorithms might sometimes be a completely infeasible solution -- useless to a specific problem domain. An important task of theoretical computer science has been to offer some characterization of the types of problems in which the application of the GA is justified – both by its ability to solve the problem and its superiority to other types of optimization methods. Unfortunately, the prodigious amount of research in this area has not yielded any clear conclusions. Researchers are primarily interested in what factors contribute to "GA hardness". A useful restatement of the question is "What sort of problems are hard for the genetic algorithm?". This paper will offer an algorithmic approach towards the answer.

BACKGROUND

There have been two general approaches taken towards classifying a problem as GA difficult or easy. On one side are those researchers who say that the greatest single indication of a problem's difficulty is the degree to which it is deceptive (Goldberg, 1987, Das and Whitely, 1991). The degree to which a search space is deceptive is the degree to which its local maxima's prove problematic. Genetic algorithms are notoriously bad at overcoming certain types of deception.

On the other hand lies the consideration of the problem's epistasis. Epistasis describes the situation where one gene pair masks or modifies the expression of another gene pair. When a chromosome's epistasis is at a high level, many genes will be dependent on each other for their expression; when at a low level, there will be few (if any) genes that are so related. If epistasis is high, the genetic algorithm will likely drift and settle on a local optima (Davidor, 1991). If epistasis is low, the population is not interrelated and the evolutionary approach offers no distinct advantage. Notice that the concern of epistasis is again essentially a concern with the problem of local maxima, the only difference being that deceptive problems are universally difficult whereas problem spaces with low epistasis aren't necessarily *problematic* for the GA -- rather, they would just be more easily tackled by standard heuristic searches.

Their must be sufficient structure in the solution space in order for a genetic algorithm to process information effectively. But solution space structure alone is not sufficient for a guarantee of a successful genetic application. It seems that both the epistasis and deceptive approaches towards quantifying GA difficulty have something to recommend them, but an complete understanding of the problem has yet to be offered.

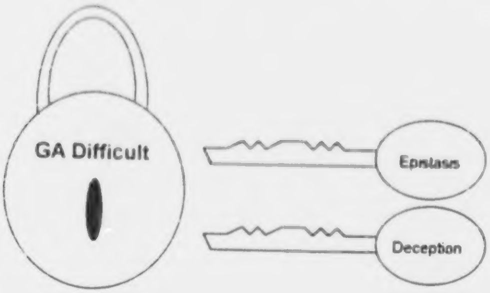

Figure 1: Genetic Algorithm Difficulty and two approaches to the quantification

A PROCEDURE FOR DETECTING GA HARDNESS

The two most important factors in detecting GA hardness are obviously deception and epistasis. And, while there is disagreement as to which factor is the most salient, a procedure can be described to detect which problems are likely to suffer from either or both of these conditions. This procedure is described below.

Phase 1: Detection of epistasis

Following Davidor, problem epistasis can be calculated by the following mathematical formula

$$\sigma_e^2 = \frac{1}{N_p} \sum_{S \in Pop} [v(S) - A(S)]^2 \qquad (1)$$

Table 1: Definitions of Symbols for Equation (1)

S	String
v(S)	Fitness
A(S)	Genetic Value
σ_e^2	Genetic Variance
N	Population Size
	Population

Phase 2: Detection of Deception

The detection of deception will involve the calculation of the order-1 hyperplanes of the solution space. Following Das and Whitely (1994) we can classify any problem as fundamentally deceptive if the globally optimum solution cannot be inferred by solving the order-1 hyperplanes. Although a discussion of hyperplane solutions is not within the scope of this paper, an excellent discussion of this topic can be found in Koza (1992), pages 33-46.

Phase 3: Synthesis and interpretation of the results.

High Level of Epistasis and or Deception:
As stated earlier, the results of the investigation of epistasis can be equivocal. High epistasis indicates that the GA will likely encounter problems with local maxima. For a problem like this, a technique involving a certain measure of random movement (like simulated annealing) would be a useful addition to the evolutionary approach.

Low Level of Epistasis:
A low level of Epistasis simply indicates the genetic algorithm offers no distinct advantage. Although it is sometimes suggested that genetic algorithms are unique in that they can be expected to optimize any function, it must be known that the GA can expect to do no better than random search over the space of all the functions in cases where epistasis is extremely high. If there are no relations between members of the population, how can the GA be expected to do any better than random search? The best alternative in this case is to use a more conventional, non-evolutionary technique such as heuristic searching.

Mid-level of epistasis and low deception:
The evolutionary approach is readily applicable and appropriate to the problem.

CONCLUSION AND FUTURE RESEARCH

This paper has outlined a simple procedure for testing the GA hardness of a problem. The most obvious next step would be to construct a computer program capable of receiving the relevant data and outputting the resulting "hardness level" of the problem. In order for this to happen, three things must come together.

(1) The two steps above must be mathematically or algorithmically formalized.
(2) An appropriate means of program input must be constructed.
(3) The program itself must be written with adequate user interface and output organization.

Input and observations on any of these three steps would be greatly appreciated.

ACKNOWLEDGEMENTS

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REFERENCES

Das, R., & Whiteley, L.D. 1991. The Only Challenging Problems are Deceptive: Global Search by Solving Order-1 Hyperplanes. *Pages 166-173 of*: Belew, R.K., & Booker, L.B. (eds), *Proceedings of the Fourth International Conference on Genetic Algorithms*. San Mateo, CA: Morgan Kaufmann.

Davidor, Y. 1991. Epistasis Variance: A Viewpoint on GA-Hardness. *Pages 23-35 of:* Rawlins, G.J.E. (ed), *Foundations of Genetic Algorithms*, vol.1. San Mateo, CA: Morgan Kaufmann.

Ginsberg, Matt,. 1993 Essentials of Artificial Intelligence, Morgan Kaufman Publishers, Inc.,San Francisco, California.

Goldberg, David E. Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Publishing Company, Inc., Reading, Massachusetts.

Jones, T.& Forrest, S. 1995. Fitness Distance Correlation as a Measure of Problem Difficulty for Genetic Algorithms. *Pages 184-192 of:* Belew, R.K., & Booker, L.B. (eds), *Proceedings of the Sixth International Conference on Genetic Algorithms*. Pittsburgh, Pennsylvania: Morgan Kaufmann.

Koza, John R. (1992) Genetic Programming I, The MIT Press, Cambridge, Massachusetts (pg. 33-46)

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VISUALIZATION OF A GLOBAL ATMOSPHERIC MODEL WITH IRIS EXPLORER

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IRIS Explorer is a powerful visualization system with the capability to handle very large data sets. This paper discusses the need for such visualization capabilities when considering advanced modeling efforts such as the global atmospheric circulation model (GCM) recently developed by Porter et al. (1996). Computations of the temperature, pressure, density, and velocity from the GCM at potentially several hundred thousand grid points results in a vast amount of data that is too overwhelming to be interpreted merely by reading tabulations of numbers. Using IRIS Explorer, a volume visualization application was created to render interactively the atmospheric data generated by the model, displaying the results on a colored, spherical surface. To enhance the visualization, modules were developed to superimpose on the temperature or pressure display the fluid velocity vector at each grid point. As a final level of enhancement, animation and viewing with stereoscopic glasses have been developed to observe the model's predicted changes in atmospheric circulation over a time sequence of the computations. This paper discusses ways that the IRIS Explorer system can be used to develop several example visualizations. This paper will conclude by discussing how VRML was used to publish these visualizations on the World Wide Web.

INTRODUCTION

Computer aided visualization techniques are important in today's society because they allow scientific researchers to understand data through visual perception. Many data sets used by scientists today are extremely large and cannot be interpreted by merely reading tabulations of numbers. It is much less tedious and less time-consuming to view a set of data in the form of an image, whether it be a graph or an animated movie, than it is to carefully examine a large set of numbers in order to interpret its meaning. In *Visualization in Scientific Computing*, a 1987 report to NSF, the National Science Foundation, it is stated that "an estimated 50 percent of the brain's neurons are associated with vision." Therefore, the need for powerful visualization software is essential.

This research involves visualizing the results computed from a global atmospheric circulation model developed by Porter et al. (1996). The work is supported by NASA/University Joint Venture (JOVE) grant NAG8-1101 and was performed in collaboration with scientists at Goddard Space Flight center. IRIS Explorer software was used to render this visualization. This paper first focuses on the atmospheric model itself. Following that is background and explanation about the IRIS Explorer visualization system. The paper will conclude by demonstrating the results obtained with this visualization system, and discuss implications this type of research will have on the future with the advent of VRML, the Virtual Reality Modeling Language.

EXPLANATION OF THE MODEL

The model employs a decomposition of the atmospheric system. The solution is based on a spectral semi-implicit, time-marching scheme that has been optimized for a vector processing machine. Present computations are performed for a global grid consisting of the following grid points on the globe: 318 altitudes, 24 latitudes, and 8 longitudes. The variables used are pressure, density, and momentum density. Formulation of the model is described in Chan et al (1994) and a parallel version of the model by Porter et al. (1994) The main equations on which the model is based are the continuity equation (1), the momentum density equation (2), and the pressure equation (3):

$$\partial_t \rho = -\nabla \bullet \mathrm{M} \tag{1}$$

$$\partial_t \mathrm{M} = -\nabla \bullet (\mathrm{MM} / \rho) + \nabla \bullet \sigma - \nabla p - 2\Omega \times \mathrm{M} + \rho g - \rho\Omega \times (\Omega \times r) \tag{2}$$

$$\partial_t p = -\nabla \bullet (p\mathrm{M} / \rho) - (\Gamma - 1)p\nabla \bullet (\mathrm{M} / \rho) - \nabla_{ad}\Gamma(\nabla \bullet f - \varepsilon) \tag{3}$$

In the above equations, σ is the viscous stress tensor, Ω is the angular velocity of the rotating planet, Γ is the adiabatic exponent, and f is the radiative or conductive energy flux.

By applying visualization to the model we hope to understand the behavior of its five prognostic variables. The model includes important non-linear gravity wave mean flow interactions and has demonstrated that gravity waves may be the source of the observed but yet unexplained quasi-biennial oscillations.

IRIS EXPLORER

When deciding upon software for visualization, IRIS Explorer proved to be the most effective software to use in displaying the global atmospheric model. It is available for SGI computers and is a powerful visualization system with the capability to handle very large data sets. It was developed by Silicon Graphics, Inc., and is supported by the Numerical Algorithms Group (NAG). IRIS Explorer is a full featured visualization environment that is very helpful in creating applications for all fields of scientific visualization, including computational science, engineering, and many other scientific research areas. Explorer is an example of a Modular Visualization Environment, also known as MVE, which consists of a graphical user interface allowing linking of software modules with links called pipelines. Modules used in constructing applications may be either pre-built (which are included in a library of modules) or created by the user from external user-supplied code. A useful source on IRIS Explorer is the NAG website.

IRIS Explorer is built on Open Inventor, an object-oriented toolkit which assists programmers in three dimensional interactive graphics programming. Scenes are developed using Open Inventor and are viewed with a scene viewer, which may either be a walk-through viewer, examiner viewer, or fly viewer. An advantage to using IRIS Explorer applications is that they can be remotely run on any X window system that supports OpenGL.

The most fundamental parts of IRIS Explorer are the modules, as mentioned above. Each module is a tool which performs a particular task, the most common task being the manipulation of the scientific data set. Examples of functions that modules can perform are: handling data input, rendering a scene, image processing, and post-processing of data. Individual modules can each have their own user interface. This allows the user to easily change the parameters of the module using buttons or knobs called widgets. For example, a user may interactively control the color palette used to display the data. The flow of data in and out of each module is regulated by input and output ports. At these ports the user may attach the modules together with pipes in order to perform higher level tasks. A set of modules that are connected together in order to create a specific application is called an Explorer map. The function of the map depends on the functions of the modules and the way in which they are connected. A sample map is shown in Figure 1.

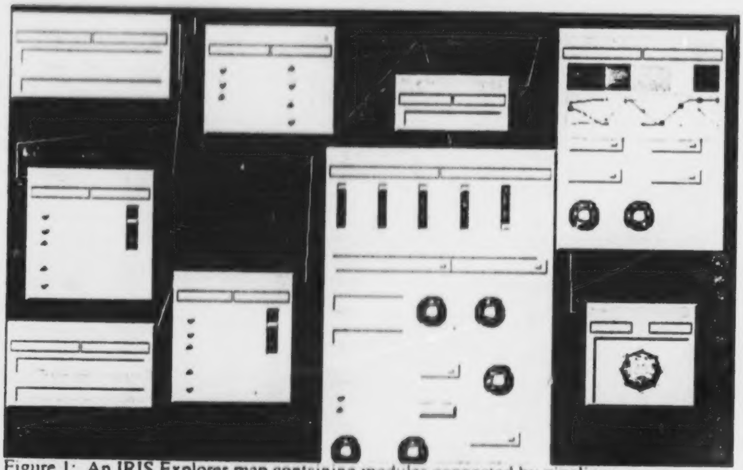

Figure 1: An IRIS Explorer map containing modules connected by pipelines.

The two basic data types provided by Explorer are the pyramid and the lattice. Both provide considerable flexibility for representing model data. The data type used in this work is the lattice, which is used to represent multi-dimensional arrays. For example, a lattice may hold the information for a three-dimensional data set with a scalar value at each point in three space, or it can represent a data set with a vector field at each point. Each coordinate point in three-dimensional space may be associated with a vector of arbitrary dimensions. The lattice is made up of several data sub-structures which serve the purpose of defining the dimensionality of the lattice data structure, and may be chosen depending on the user's needs.

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If a module having a desired function is not already available in the module library, the user can create one with the Module Builder application. The user creates a function in C or FORTRAN and Module Builder encapsulates the function and attaches input and output ports. Once constructed, these user-defined modules can link with other existing modules. The DataScribe is a secondary application which helps to perform data conversion between Explorer data and other data formats. It has a control panel for a data conversion module, whose internal features can be changed by the user. Its main functionality is to convert a data file into a data format which can be used by Explorer. It may also be used to output an Explorer lattice into a specified file format.

MODEL VISUALIZATIONS

The fundamental means of visualization used in the rendering of the global circulation model is referred to as Volume Visualization. Explorer's render module, which is, in essence, an Open Inventor scene, incorporates volume visualization when displaying objects. The data is kept in a 3D volume buffer. Computation time is saved because the scene does not have to be scan converted each time changes are made in the viewing conditions. The 3D grid of uniform cubic volume units which represents the volume data are called voxels and are stored in the volume buffer, or a large 3D array. The volume buffer contains a voxel for each point in the 3D grid space, similar to the way a pixel and frame buffer work in two-dimensional graphics.

Volume visualization permits the user to examine an interior section of the data set: The volume buffer stores the coordinates for the complete volumetric set. Therefore, the visualization tool has easy access to these grid points. Tools that allow the user to see inside the rendered volume rather than just viewing the surface properties include slicers and segmentation tools. A slicer freezes one of the three indices in a 3D array and then displays a two-dimensional slice in terms of the other two indices so the user can see a particular slice of the volume. Segmentation tools chop the object up into separate user-defined volume sets so as to view the properties of a small portion of the volume. These two types of tools are encapsulated as modules and utilized by the IRIS Explorer system in order to make the visualization of volumetric sets simple. Stereoscopic viewing is further enhancement which enables the interpretation of three-dimensional volumetric data. The SGI Indigo 2 computer has the capability of displaying Open Inventor scene graphs in 3-D with the aid of stereoscopic viewing glasses. This enables researchers to better understand volumetric data in three space. This type of viewing is utilized in our research.

IRIS Explorer is used to render interactively the atmospheric data generated by the global circulation model. The model computes velocity vectors, pressure, temperature, and density, for every grid point on the globe. The objective is to display data in a manner that permits direct interpretation. Temperature data at each coordinate point in three-dimensional grid space is viewed in terms of color, with red being hottest and blue being coldest. Along the y-axis are 24 latitude slices, along the x-axis are 8 longitude steps, and along the z-axis are 318 altitude steps. To view this large data set an Explorer map was constructed.

The map has the following structure. First, the ASCII data file which contains atmospheric data is read in by the ReadXYZ3D Module. This module converts the ASCII data into the lattice format which may be used by Explorer for manipulation and rendering. The lattice data is then fed into a SampleCrop module which contains widgets to select how much of the full data set is to be used. For example, if a data set contains 8 nodes in the first dimension, 24 nodes in the second dimension, and 318 nodes in the third dimension, the SampleCrop module has widgets to easily assist the user in viewing only a selected portion of this data. The Orthoslice module takes a 3D data set and isolates one of the dimensions in order to display one slice of the object. The Generate Colormap Module sets the color of the model corresponding to its temperature. The color map can be selected to show the small scale variations in temperature which exist in the model. The module LatToGeom converts the lattice data type to the geometry format and prepares it to be displayed by the Render module. The Render module provides a great degree of user-interactivity. The user can zoom in and out and change the camera angle so as to see the model data from many different viewpoints.

In the above visualization application the model can be viewed as the specific set of points that make up the data set or as a set of planes. The visualization network just described will generate a rectangular style of data, because the array indices are used as the coordinate points in the 3D grid space. For greater realism, the data was mapped onto a spherical surface, resembling the surface of a planet. In order to map the data points properly onto a sphere, the spherical polar coordinates for the grid are used.

Visualization of the velocity fields is somewhat more complex. Each of the points on the sphere, in addition to a temperature value, has a corresponding three dimensional vector value which shows the fluid velocity of the atmosphere at that point. Because these vectors were read out from the model in Cartesian coordinates, they must be transformed for the correct directions on the sphere. The relevant transformations are as follows. The z-axis must be transformed to the direction of r, because for each point on the sphere z must be pointing outward to represent altitude. The x-axis must be transformed into a horizontal vector perpendicular to the direction of r which will map a latitude. And the y-axis must be transformed into a longitude. The following transformation matrix (4) was used for mapping vectors on a spherical surface. (Foley, van Dam, Freiner, and Hughes)

$$\begin{bmatrix} \frac{(z\times r)_x}{|z\times r|} & \frac{r\times(z\times r)_x}{|r\times(z\times r)|} & \frac{r_x}{|r|} & 0 \\ \frac{(z\times r)_y}{|z\times r|} & \frac{r\times(z\times r)_y}{|r\times(z\times r)|} & \frac{r_y}{|r|} & 0 \\ \frac{(z\times r)_z}{|z\times r|} & \frac{r\times(z\times r)_z}{|r\times(z\times r)|} & \frac{r_z}{|r|} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \bullet \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} \qquad (4)$$

A FORTRAN preprocessor was written to perform the conversions utilizing the equations derived from this matrix. The VectorMaker Module, developed by Hans Vahlenkamp and John P. Sheldon at NOAA's Geophysical Fluid Dynamics Laboratory, was located on the web and used to display vectors. The VectorMaker generates vectors with user-defined lengths, colors, and shapes. Vectors can be displayed as arrows, cones, cylinders, and fade lines. The final Explorer map developed renders both the velocity and temperature together in one visualization. In order to achieve this the two separate maps were fed into a single Render module. The images in Figure 3 show examples of results from this visualization. The shading indicates differences in temperature, and the small arrows represent the fluid velocity vectors. The left image shows a top view of the model data, showing a counter-clockwise circulation. The middle image displays the eight latitude slices to see what is occurring inside the sphere of the model. The right image shows the side view with reversals of the vector fields at different latitudes.

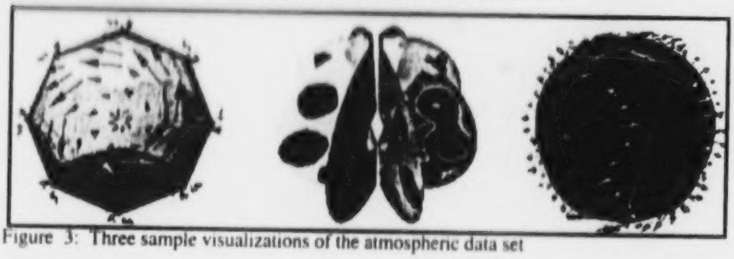

Figure 3: Three sample visualizations of the atmospheric data set

ANIMATION

The For loop is an essential module when trying to create an Explorer animation. The For loop can be attached to the Orthoslice slice number widget allowing continuous stepping in altitude. In order to emphasize the change in temperature with altitude the data at each altitude was plotted with a fixed radius. For this type of animation there is essentially a two dimensional spherical model which is displayed in terms of longitude and latitude, with each altitude slice isolated.

Another goal in this research was to animate a three dimensional data set in which the time dependence of the data at a specified longitude, latitude or altitude could be displayed. This involves using a four dimensional coordinate set with corresponding data for each coordinate using variables x, y, z (coordinates), time, and data. To handle such a four-dimensional data set, Data Scribe was used to develop the Read4DData module. Animation of an Explorer map which uses such large lattices results in a slow run-time. Therefore when running a time-step loop for every altitude, the modules fire too slowly and too sporadically to give a smooth complete animation. The map may also run slower depending on how complex the conglomeration of modules is.

There are two ways to handle the slow run-time. The first is running the modules of a single map application on different machines. Explorer has the capability to run each of the modules contained in the same map on different workstations in order to make the application more efficient. This would be a definite advantage if a map were created in which multiple tasks must be performed at the same time. But in this case, the For loop which runs our animation process depends on manipulation from each module in a sequential order, rather than many modules operating at the same time. So even though multiple machines might make a map run faster in some cases, in this case modules must wait for a task to be completed by a previous module in order to fire so no time is gained.

The other option is to save images from the Render screen and put them together as an animated movie. Two tools on SGI computers make this task an easy one. These are MovieMaker and MoviePlayer. MovieMaker is used to create movies by concatenating successive images. MovieMaker can handle many types of image formats, including tiff and SGI's rgb format. Movies are output in one of SGI's movie formats. MoviePlayer is used only to play back the SGI movies. The only problem with these tools is that it is very time consuming to save many subsequent image files from the Render module, for the model must be in the precisely correct position in order for the animation to look as if it is running smoothly. This type of animation takes up a large amount of disk space, 900 KB for each image. Therefore, a movie of several hundred frames utilizes a large amount of space.

WEB RESEARCH AND TECHNOLOGY

In carrying out the visualization the need arose for additional modules which were not already part of our module library. In some cases, researchers had already developed a module for a user's specific need, and the only problem is locating that module. Once found at a website, a module's source code could easily be downloaded and compiled for use with the Explorer system. A few helpful websites are the IRIS Explorer Repository, the NCSA PATHFINDER home page, and the physics department at the University of Illinois at Urbana-Champaign. A very helpful library of modules is located at the GFDL web site. Hans Vahlenkamp and John P. Sheldon at NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey have developed 48 modules, some of which work on our version of Explorer 2.2, others were written for Explorer 3.0.

A recent development which significantly adds to this type of scientific visualization is VRML, or the Virtual Reality Modelling Language. It allows three-dimensional objects to be rendered and interactively manipulated using World Wide Web browsers. VRML as a modeling language gives us the capability to publish the results of our research world-wide on the Internet. The final model described was saved from the Render Screen Module as an Open Inventor scene graph file. Inventor files are very similar to VRML files and they can easily be interchanged with a converter. Some sites on the Internet will perform this conversion. VRML is actually a subset of Open Inventor with extensions for handling WWW links. A VRML object is downloaded over the web as a scene description and rendering takes place locally on the users machine, which enables the user to easily fly-through the scene on their local machine. Objects within the scene can be hot- links to other VRML, HTML, or other WWW resources.

The fact that VRML has arrived as a standard for scene viewing on the Internet provides many advantages in our field of work. Since VRML viewers have been developed for many platforms, (SGI's, PC's, and Macs), no longer must scientists, researchers, and other interested parties possess the same platform for sharing and manipulating these object scenes. Before the advent of VRML, only two dimensional scanned or digital images could be published; therefore a model such as ours could be viewed as a still image, but not interacted with or manipulated by other researchers in our field of work. Now, researchers worldwide, even those who do not have access to a Silicon Graphics workstation, may view and even manipulate our visualization.

CONCLUSION

IRIS Explorer has been used to develop a 3D stereoscopic visualization of results from our global atmospheric circulation model. The visualization allows the superposition of temperature and velocity data in a detailed and illustrative manner. By extending this model it has been possible to create an animated visualization and then view the model with stereoscopic glasses in order to better understand the characteristics of the data set. As a final element of research the results of this model are being published on the World Wide Web. Though our model is presently in its primitive stages, once fully developed it may help to predict climate changes on a human time scale. The reconstruction of a planet's climate through such a model as this one will eventually help us to better understand our environment.

REFERENCES

Porter, H. S., G. Cogdell, C. Huneycutt, and H. G. Mayr, "A Spectral Global Atmospheric Circulation Model for Distributed Parallel Execution", ACM Southeast Conference Proceedings, p. 147, 1996.

Chan, K. L., H. G. Mayr, J. G. Mengel, and I. Harris, "A Stratified Spectral Model for Stable and Convective Atmospheres", J. Comp. Physics, 113, p. 165, 1994.

Foley, James D., A. van Dam, S. K. Feiner, J. F. Hughes, Computer Graphics Principles and Practice. Addison-Wesley Publishing Company, 1990.

McCormick, B.H., T.A. Defanto, and M.C. Brown (eds), "Visualization in Scientific Computing", Computer Graphics, 21, p.6, 1987.

IRIS Explorer Repository *http://ww.nag.co.uk*

Physics Department at University of Illinois at Urbana-Champaign
http://www.physics.uiuc.edu~jim/cartog/explorer.html

NCSA Pathfinder Home Page
http://redrock.ncsa.uiuc.edu/PATHFINDER/pathrel2/top/top.html

Geophysical Fluid Dynamics Laboroatory
http://www.gfdl.gov~jps/GFDL_Vis_Guide.html

Visualization Specific Topics
http://www.sara.nl/Rik/REPORT.old/3Subsection2_1_2_2.html

VRML *http://sgi.vrml.com/*

Proceedings — NCUR XI (1997)

Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity[*]

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ABSTRACT. We describe our implementation of an algorithm to maintain the connected components and the biconnected components of a graph where vertex and edge insertions are allowed. Algorithms for this problem can be applied to task decomposition in engineering design. Connected components are maintained using a disjoint set data structure and the biconnected components are maintained by a block forest. We implemented an incremental biconnectivity algorithm presented in (Westbrook and Tarjan, 92). The algorithm runs in $O(n\log n + m)$ time, which represents an amortized time of $O(\log n)$ per operation, where n is the number of vertices and m is the number of operations. However, the algorithm does not address the issue of deletions in disjoint sets, which seem to be needed in order to implement the algorithm correctly. Hence we develop the concepts of *dynamic holes* and *static holes* to support variations of the standard disjoint set structure that allow the deletion of certain elements. We present four different implementations for the maintenance of the biconnectivity, which utilize these variants of the standard disjoint set structure, and analyze their performance. We present extensive timing information for each of these implementations.

INTRODUCTION

We consider the problem of maintaining graph connectivity and biconnectivity information incrementally, i.e., where vertex and edge insertions are allowed. Algorithms for this problem can be applied to task decomposition in engineering design. Here we specify an implementation design that uses the algorithm presented in (Westbrook and Tarjan, 92) which runs in $O(n\log n + m)$ time, where n is the number of vertices and m is the number of operations. In order to implement the algorithm, we found the need to delete certain elements from disjoint sets. This issue is not addressed in (Westbrook and Tarjan, 92), however. Hence we developed the concepts of *dynamic holes* and *static holes* to support variations of the standard disjoint set structure that allow the deletion of certain elements. These variants of the standard disjoint set structure are used to maintain the connected components and enables efficient block tree operations in the block forest.

Westbrook and Tarjan also describe another algorithm that uses dynamic trees to maintain the block forest, which runs in $O(m\,\alpha(m, n))$ time, where α is the inverse of Ackermann's function. For the data sets we consider, the first algorithm would likely be faster in practice due to a smaller constant factor in the running time. Hence it is the one that we describe in this paper.

Throughout this paper, n refers to the total number of vertices created; m refers to the total number of operations (*new_vertex*, *insert_edge*, and *find_block*); k refers to the total number of *find* and *merge* operations performed on disjoint sets.

DATA STRUCTURES

Disjoint Sets Structure that allows Deletions:

Disjoint sets are used to maintain both connected components and the children of nodes in the block forest in our implementation. We first present the standard disjoint set structure which supports *find* and *merge* operations (Tarjan, 75). Then we present a variation of the disjoint set data structure that allows selective deletion of elements.

A disjoint set structure is a group of x objects such that each of them is a member of exactly one set at any given time. Each set has a unique label which identifies it. Initially the x objects are in x different sets, each containing exactly one object. In order to handle set unions, we represent each disjoint set using a tree, where each node in the tree represents a distinct object. The trees are bottom-up trees, which means each node knows its parent but not its children. If a node's parent pointer points to itself, it is the root of that tree. The *find* and *merge* operations for the standard disjoint set data structure are well known and can be found in (Tarjan, 75).

In order to manipulate the children sets of nodes in our block forest, we need to both merge two sets together, as well as delete certain elements in a given set efficiently. The disjoint

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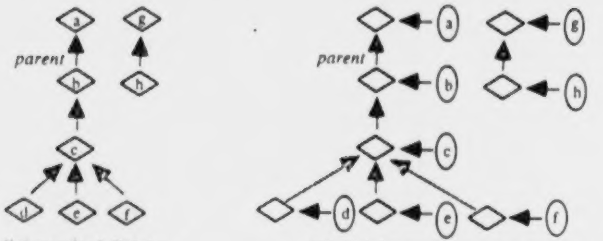
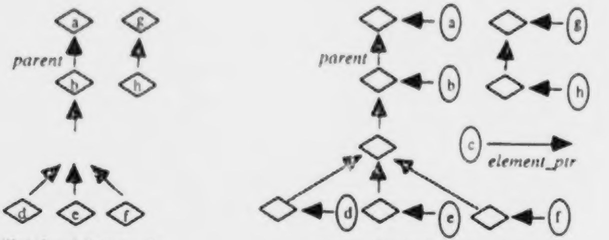


(ia) standard disjoint set structure

(ib) disjoint set structure with selected deletion



(iia) the deletion of c would destroy the standard disjoint set structure

(iib) in the disjoint set structure with selected deletion, simply point the element_ptr of "c" elsewhere

Figure 1. Disjoint set structure that allows deletions, the diamonds in (ib) and (iib) are the elements in the disjoint set that represent the actual objects (ovals), via *element_ptr*

set data structure was chosen to allow fast merging. In order to quickly delete elements from the disjoint set data structure, we developed the concept of *dynamic holes*.

A *dynamic hole* is a node in the disjoint set tree structure which does not represent any element of the set. Its only purpose is to maintain the tree structure of the disjoint set. If we do not use such nodes, in order to delete an element in the disjoint set structure we would have to relink all of the children of that element, which could be a very expensive operation.

In our block tree data structure, each element in a children set is pointed to by a child node that it represents. This representation of the children sets of nodes is of crucial importance, because besides *find* and *merge*, we need to delete elements from children sets when the parent-child relationships change with *block_evert* and *block_condense* operations. This modified disjoint set data structure is maintained even when a node is removed from the set since the elements act as virtual copies of the actual nodes. It is this abstraction that makes the existence of the *dynamic holes*, and thus their future use, possible.

Using the above representation, we delete a child *c* from a children set of a node *v* by making *c* →*element_ptr* point elsewhere. The element in the children set of *v* that used to represent *c* is now a dynamic hole, since it no longer represents any child node of *v* (see Figure 1). We may reuse this dynamic hole when another node is to be added to the children set of *v*, so that the sizes of the disjoint sets are kept small enough to preserve the time bounds (see Lemmas 3). These dynamic holes are not removed, since they do not affect the asymptotic running time of the algorithm and their removal could be very time consuming.

In two of our implementations, we use *static holes* instead of *dynamic holes* to deal with deletions. A *static hole* is created as a singleton element to represent an empty children set in the block tree. Its need will become clear in Implementation III and IV.

Block Tree:

In order to maintain the biconnected components of a graph incrementally, we make use of a tree structure of the blocks and vertices of a connected graph called the *block tree* (Westbrook and Tarjan, 92). The collection of block trees given by the components of a graph $G = (V, E)$ is called the *block forest*. The block tree has two types of nodes: vertex (square) nodes, which represent the vertices of G; and block (round) nodes, which represent the blocks (see Figure 2). A *block* is equivalent to a biconnected component in the graph, where two vertices are in the same *biconnected component* if and only if there are two vertex disjoint paths between them or the component is a single edge. The children of the block nodes represent the vertices that are contained in that block. If a vertex belongs to more than one block, it will be the child of one block node and have the other block nodes as its children. Such a vertex is called a *cut vertex* since its removal disconnects a component into two or more components.

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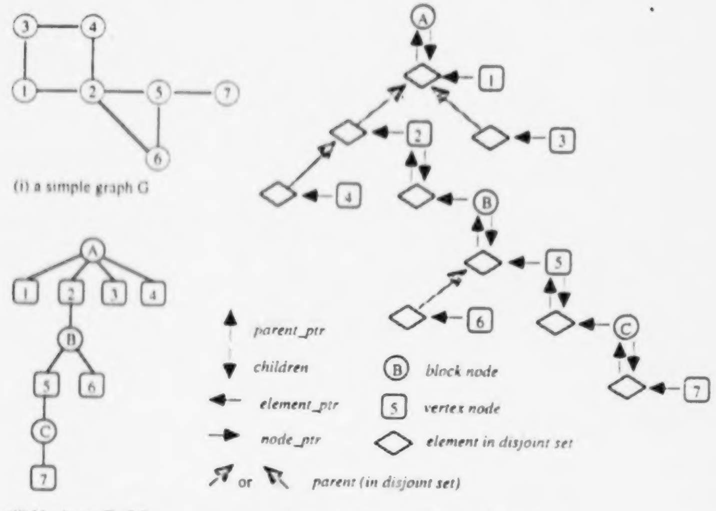

(i) a simple graph G

(ii) block tree T of G

(iii) representation of T in our data structure

Figure 2. Block tree data structure in Implementation I
Each block node or vertex node may have two diamonds linked to it; the diamond directly under it is the root of the disjoint set that represents its children; the one on its immediate left represents itself in the children set of its parent (i.e. the disjoint set that represents its siblings).

All terms such as *parent, child, siblings* and *grandparent* that appear hereafter refer to the relationships within the block forest, unless otherwise specified. Hence all vertex nodes have parent and children of block node type only, and vice versa; also, all siblings are of the same node type.

IMPLEMENTATIONS

We present four implementations, all of which support functions on the block tree which allow us to maintain biconnectivity incrementally. The functions allowed on the block tree are as follows:

- *block_new(u*: vertex node): create a new block for the vertex which will be the root and only element of the disjoint set representing the vertices of this block; return a pointer to the new block.
- *block_parent(u*: vertex node): access the object in the disjoint set which represents the children of the parent of *u*, traverse this object to the root of the disjoint set; access and return the parent.
- *block_find(u, v*: vertex node): given two vertices *u* and *v*, if both are in the same block return that block, return *null* otherwise.
- *block_evert(v*: vertex node): given a vertex node *v*, reroots the block tree at *v* by traversing the tree from *v* to the root, reversing parent pointers along the way. This function is called when edge is inserted between two connected components.
- *block_link(u, v*: vertex node): combine the two block trees containing *u* and *v*, where *v* is the root of the smaller tree. This function is always called after *block_evert*.
- *block_condense(u, v*: vertex node): given two vertices, condense all block nodes in the path from *u* to *v* into a single block node. This function is called when an edge is inserted within one connected component.

Implementation I: Homogeneous Block Tree with Dynamic Holes:
In this implementation we make use of the modified disjoint set structure above to maintain the children of the block tree nodes, since we have to deal with deletions in the disjoint sets. The details of this implementation are discussed in (Korupolo et al., 96). A minor difference in the current implementation with the one described in (Korupolo et al., 96) is that the *node_ptr* field in the elements of the disjoint set structure is removed.

Children sets of nodes in a block tree are maintained using the disjoint set data structure, so that merging the children of two nodes can be done in $O(1)$ time. Each node is doubly linked to its children set, that is, the node contains a pointer to the root of its children set, and that root in turn contains a pointer back to the node (see Figure 3). This implementation is labeled "homogeneous" since the children set of every node in a block tree is maintained by a disjoint set.

Implementation II: Mixed Block Tree with Dynamic Holes:

Our second implementation does not use disjoint sets to represent block nodes. At the expense of uniformity throughout the data structure, it is possible to eliminate the disjoint set representation of block nodes and use direct pointers from block nodes to their parent vertex nodes. With this change, every traversal from a block node to a vertex node is reduced to constant time instead of one pointer step. Additionally, *dynamic holes* caused by *block_condense* are eliminated. The number of *dynamic holes* is only reduced, so the asymptotic running time is the same as Implementation I.

Implementation III: Mixed Block Tree with Static Holes:

The data structure for the block tree in this implementation consists of block nodes, vertex nodes and cut-vertex nodes. The vertex nodes are organized into disjoint sets that represent children sets of different block nodes as in previous implementations. A cut-vertex node is a virtual copy of and doubly linked to its correspondent vertex node. A cut-vertex has a pointer to one of the elements in the children set of its parent block. This way its parent can be accessed while the merging of children sets of different blocks can be done efficiently. A cut-vertex node is created and deleted dynamically, while a vertex node is never deleted once it is created, instead it goes into an obsolete state when a cut-vertex node representing it exists. Block nodes, then, point to their parent cut-vertex nodes, not vertex nodes.

Cut-vertex nodes can only be created when two distinct components are linked together. When these cut-vertex nodes are created, their corresponding vertex nodes become obsolete in the data structure. For example, if u becomes a cut vertex in the graph, the corresponding vertex node in the block tree will point to the newly created cut-vertex node. From that point on, all operations which take u as an argument will use the cut-vertex node instead of the vertex node for information about u, unless u ceases to be a cut-vertex.

In the linking process, it is also possible that a new block B needs to be created between the two cut-vertices, u and v. B will be the parent of one of these cut-vertices, say u, so u must point to an element in the children set of B. Since B has no children at this point, a *static hole* is created as a singleton element to represent the empty children set of B. Then, v can be linked to this *static hole* to complete the linking process. In this implementation, we combine the *block_evert* and *block_link* operations into a single function, *block_evert&link*.

Implementation IV: A Mixed Block Tree with Static Holes and Standard Disjoint Set Data Structure

In this implementation, instead of using the disjoint set data structure that allows deletions above, we use the standard disjoint set data structure described in (Tarjan, 75). Then, instead of using an abstract representation of the elements of a disjoint set, a vertex node itself is an element of the disjoint set . This was not possible in Implementations I and II, due to the need for deletions in the disjoint set data structure. As a consequence, separate sets of functions are used to maintain the disjoint sets used for connectivity and in the block tree.

Overview:

The data structures presented above maintain graph connectivity and biconnectivity properties separately. The disjoint set structure of (Tarjan, 75) is used to maintain connectivity, while the block tree data structures above maintain biconnectivity. The function *new_vertex* creates a new vertex and a new block which contains it; *find_block* simply calls *block_find*; while *insert_edge* is defined below:

```
insert_edge(u, v: vertex):
    if u and v are in the same block, do nothing.
    otherwise if they are in the same connected component, call block_condense(u, v)
    otherwise they are in different connected components, in which case we combine the two
    block trees by calling block_evert() with the vertex in the smaller tree, and make the root of
    the resulting tree a child of the vertex in the larger tree. Then merge the two connected
    components by calling merge(find(u), find(v)).
```

ANALYSIS AND COMPARISONS

We tested our implementations on graphs with 500, 1000, 5000, 10000 and 20000 vertices, respectively. The initial graphs are very sparse (with exactly $n/2$ edges) or sparse (with exactly n edges) and are randomly generated. They are loaded using *new_vertex* and *insert_edge* operations. Ten such graphs are generated for each category, then 3 random test sequences of different sizes are run on each graph. The test sequences are uniformly mixed with 50% *insert_edge* operations and 50% *find_block* operations. The sizes of sequences are approximately $n/10$, n and $2((n\ln n)/2 - n)$, respectively. The largest sequence size was chosen as $2((n\ln n)/2 - n)$ since a random graph is very likely to become connected when the number of its edges reaches approximately $n\log n$ (Spencer, 94), after which every operation will be within one block tree. Once the block tree becomes biconnected the performance of the algorithm speeds up substantially from $\theta(n\log n + m)$ to $\theta(m\,\alpha(m, n))$ as indicated by (Westbrook and Tarjan, 92). Hence we take the length of the update/query sequence to be $n\log n/2$, minus the number of edges in the initial graph, and multiply it by two since half of the test sequence operations are *find_block* queries.

In the course of our experiments, we studied the difference in performance between

vertices	edges	updt/query	Imp. I	Imp. II	Imp. III	Imp. IV
1000	500	100	0.002244	0.001520	0.001177	0.001995
1000	500	1000	0.017091	0.011349	0.010139	0.009936
1000	500	5000	0.035871	0.025890	0.025115	0.023959
1000	1000	100	0.001803	0.001257	0.001194	0.001212
1000	1000	1000	0.009110	0.006737	0.006615	0.006112
1000	1000	5000	0.021395	0.017208	0.017706	0.016491
5000	2500	500	0.010901	0.007270	0.006164	0.005675
5000	2500	5000	0.090828	0.060193	0.056099	0.052272
5000	2500	30000	0.220937	0.164520	0.167698	0.146142
5000	5000	500	0.006852	0.004985	0.004927	0.004271
5000	5000	5000	0.048924	0.035827	0.036958	0.032419
5000	5000	30000	0.145002	0.117246	0.127410	0.105393
10000	5000	1000	0.023026	0.014899	0.013017	0.012411
10000	5000	10000	0.186746	0.122622	0.116186	0.108466
10000	5000	70000	0.498349	0.373678	0.395005	0.339014
10000	10000	1000	0.014015	0.009844	0.009963	0.008997
10000	10000	10000	0.101678	0.074317	0.077466	0.068564
10000	10000	70000	0.340697	0.279543	0.307112	0.257652
20000	10000	2000	0.044760	0.029004	0.027107	0.024595
20000	10000	20000	0.364341	0.242678	0.229329	0.216970
20000	10000	150000	1.064185	0.815021	0.842906	0.733604
20000	20000	2000	0.025839	0.018631	0.018541	0.017049
20000	20000	20000	0.203280	0.149229	0.152558	0.135053
20000	20000	150000	0.770003	0.632414	0.683555	0.575943

Table 1. Selected update times for Implementations I - IV

implementations with *dynamic holes* versus *static holes*. We expected that there would be fewer *static holes* than *dynamic holes*, but were not sure if the overhead of maintaining *static holes* would lead to slower performance. After running the third implementation, we found that the use of *static holes* with the modified disjoint set structure (Implementation III) led to slower performance than Implementation II, but the use of *static holes* with the standard disjoint set structure (Implementation IV) led to the best performance (see Table 1).

CONCLUSION

In this paper, we described and implemented an algorithm for the maintenance of incremental biconnectivity. The algorithm allows insertions of edges and vertices and answers biconnectivity queries, i.e., "given two vertices of a graph, are they in the same biconnected component ?" In the course of implementing the algorithm given by (Westbrook and Tarjan, 92), we discovered an issue that was not addressed in (Westbrook and Tarjan, 92): the need for deletions in disjoint sets to preserve the efficiency of the algorithm. We modified the standard disjoint set data structure and developed two new concepts in dealing with deletions: *dynamic holes* and *static holes*. We have implemented two versions of the algorithm which use *dynamic holes* and two which use *static holes*. With both *static* and *dynamic holes*, we prove that the performance of the overall block tree data structure with our disjoint set structure is still $O(n\log n + m)$, where n is the number of vertices in the graph and m is the total number of queries and updates. We tested the four implementations extensively and presented the experimental results and analysis.

ACKNOWLEDGMENTS: We would like to thank Madhukar Korupolu for the extensive discussions in the early stages of this project. This paper is part of an undergraduate honors thesis project undertaken by Ramgopal Mettu and Yuke Zhao.

REFERENCES

[1] M. Korupolu, R. Mettu, V. Ramachandran, and Y. Zhao. Experimental Evaluation of Algorithms for Incremental Graph Connectivity and Biconnectivity. Presented at the Fifth DIMACS Implementation Challenge, 1996.

[2] R. Mettu, V. Ramachandran, and Y. Zhao. Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity. Manuscript, 1997.

[3] J. H. Spencer. Ten Lectures on the Probabilistic Method. Capital City Press, 1994, 2nd edition.

[4] R. E. Tarjan. Efficiency of a Good But Not Linear Set Union Algorithm. Journal of the Association for Computing Machinery, 22 (1975), 215-225.

[5] J. Westbrook and R. E. Tarjan. Maintaining Bridge-Connected and Biconnected Components On-Line. Algorithmica (1992) 7: 433-464

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An Implementation of Particle Systems for Special Effects

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ABSTRACT

Real-time graphics are becoming commonplace for data visualization. As a result, there is a pressing need for special effects that enhance the illusion of reality in these real-time systems. Many special effects make use of particle systems to model the desired effect, present in effects like explosion and fire. The environmental effect of wind is yet another effect that would enhance the illusion of reality in a real-time system, and can be implemented through the use of particle systems.

Making use of the Ultravision API, the authors have implemented the effect of wind using the particle-mesh method. The authors have manipulated polygons, textures, and animated particles to simulate the effect of wind on real-world objects. The authors believe that a particle-system approach produces a fluid-like simulation of wind that can affect applied to many objects in a scene.

This paper provides a comprehensive explanation of the process of implementation of a particle-based wind effect, and will explore the difficulties inherent in such an implementation. The suitability of the particle-mesh method for modelling wind has been explored and is discussed in terms of implementation in the Ultravision API for the Nintendo64. The authors also provide a breakdown of the time and resources required to implement various parts of the simulation.

INTRODUCTION

As personal computers become increasingly more powerful, applications tend to slowly take advantage of this power. However, computer games have been known to push the envelope -- to take advantage of every available resource, sometimes bypassing the entire operating system in order to maximize efficiency. Of course, with games constantly pushing the limits of machines, theses games are becoming more and more realistic and impressive.

The latest trend of computer gaming (within the last two years) has focused on games that relate to the player through a three-dimensional world. Many games have been created which are first-person combat games (i.e. Doom, Quake). If this trend continues, 3D will become the focus of many more games, much like the development and popularity of the Nintendo 64 has demonstrated.

Realism, being an important requirement of 3D games, can easily put a huge burden on the machine, causing a game to slow to a crawl. Instead, game designers must make use of methods which simulate the real world, making the game world appear more dynamic and lifelike. The use of special effects is one way to make game worlds appear more lifelike. Special effects may include things such as explosions, realistic water, or complex environmental changes.

One type of effect that proves useful in a 3D world is the simulation of natural environmental effects such as wind. Such an effect would be useful when several objects in the world need to be moved in accordance with a system that determines the defining characteristics of wind. The main problem with a wind effect is the potential algorithmic complexity of the system. Therefore, careful consideration of the algorithms used in the design is necessary.

For the purpose of making this preliminary system more available to consumer-level machines (i.e. home-based PC's as opposed to Silicon Graphic workstations, for example), the method to be discussed here will deal with wind within a 3D world, but will make use of a 2D design. In other words, the wind system will exist in a 3D world, but will only affect objects two-dimensionally. This will, of course, limit the realism of the wind system, but for the preliminary discussion of the system that is made here, it will work quite well.

In order to implement a wind system, the algorithm makes use of a particle system. A particle system is a collection of particles whose behavior is defined by an algorithm or a series of algorithms. Many times, a particle system is made up of thousands of particles, which makes particle systems useful for photorealistic rendering of objects which are difficult to model with polygons. However, in the interest of a high efficiency implementation, the use of several thousand particles will not be explored here. Instead, the system will be composed of no more than a couple hundred particles.

IMPLEMENTATION

Particles

The basic idea of a particle is that it is a single point within 3D space. The particles used in the system described here have the following characteristics:

1) Direction vector
2) Speed value
3) Current lifetime value
4) Maximum lifetime value

The direction vector is a two-dimensional variable that defines the heading of the particle in the game world. Note, however, that the direction vector is two-dimensional instead of three-dimensional. As explained earlier, the wind system is based in the three-dimensional game world but functions on a two-dimensional plane, which is equivalent to saying that the Z-coordinate location of an object does not matter when determining wind effect calculations (assuming that the positive Z-axis is pointing upwards in respect to the computer screen, with the positive X-axis to the right and the positive Y-axis pointing into the screen -- see Figure 1).

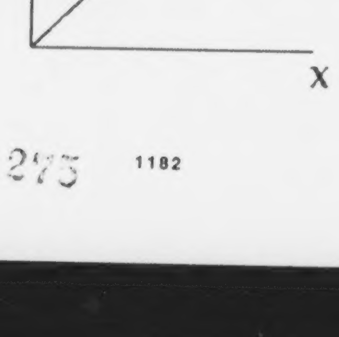

Figure 1: Assumed Axis Orientation of Game World

The speed value should be the speed of the wind particle, which is specific to a couple of things. First of all, the distance aspect of the speed value (as the *miles* portion of a miles per hour unit, for example) will depend on the definition of the game world and how the coordinate system is arranged. The time aspect of the speed value (as the *hour* portion of a miles per hour unit) should be consistent within the implementation of the wind manager (and probably consistent within the implementation of the game world itself). As a result, the time base of the speed value should be the same time base as the lifetime value so as not to create a system that requires translations between time bases in order to function properly.

The current lifetime value is the length of time that the particle has been in existence. Since this application of the wind system is in real-time (as opposed to a frame-based rendering implementation), the length of time value will not be a scalar, but will instead represent a definite increment of time (i.e. seconds, milliseconds, microseconds, etc.).

"Wind Manager"

The collection of particles is known as a particle system. In this implementation, however, a wind-specific particle system will be known as the Wind Manager. The Wind Manager controls the creation, management, and destruction of wind particles, and maintains the overall cohesion and "flow" of the wind system. The Wind Manager has four main functions, as follows:

1) Create particles.
2) Initialize a particle's parameters according to the Wind Manager's parameters for particle generation.
3) Cycle through all the existing particles and kill those whose current lifetime has exceeded their maximum lifetime.
4) Cycle through the list of "blowable" objects and perform the necessary movement routines (which are specific to each object).

Due to the fact that the Wind Manager must initialize all the particles that it creates, there are several characteristics of the Wind Manger itself that must be defined before particle initialization takes place. The necessary characteristics are as follows:

1) Particle base direction
2) Particle direction variance
3) Particle base speed
4) Particle speed variance
5) Particle base lifetime
6) Particle lifetime variance
7) Particle maximum effective distance
8) Particle maximum effective distance variance

What makes the wind system dynamic is the presence of the several variance variables that limit the range that a particle's characteristics can vary from the base characteristics of the Wind Manager. For example, a particle's speed value can be determined by the equation

$$\text{speed}_{\text{particle}} = \text{base speed} + (\text{speed variance} * \text{random number}) \qquad (1)$$

The maximum effective distance characteristic is the maximum distance that any particle can affect an object. During the time that the Wind Manager determines the closest particle to an object, the Wind Manager, upon finding the closest particle, will then make sure that the distance between the particle and the object is not larger than the maximum effective distance as specified in the characteristics of the Wind Manager.

Problems with the Current Implementation

Although this is a viable method for producing wind-like effects in a real-time system, there are several problems with the design of such a system. These problems will be presented here in order to make the reader aware of their existence.

First of all, the algorithm demands that the entire particle system be searched through in order to find the particle closest to an object that is to be affected by wind. Consider a situation in which there is a very large wind system (i.e. covers a large area of the game world) containing 2000 particles. In order to find which particle is closest to any object, the locations of all 2000 particles must be checked. This can end up to be quite time-consuming for the computer, and the time could probably be better spent than searching through massive amounts of particles.

In order to avoid such a dilemma, keep the number of particles in the wind system to a reasonable level. In a real-time computer game, there is no reason to use thousands of particles to model wind, since the user(s) of the game are unlikely to notice the difference between the use of 2000 particles and 20 particles. If designed carefully, a game can function well without overuse of run-time data.

Another potential problem with this wind system design is that every particle in the wind system must be updated regularly. The exact interval between particle updates is not important and is actually under the control of the game designer, but when updated, the entire particle system must be updated to reflect changes within the system. Updates must be performed on the current lifetime values of the particles, as well as the position. In a system of many particles, this can be very expensive (with respect to time), and if the particles are updated very frequently, the speed of the entire game can be affected.

The final major problem with this implementation of a wind system is that the wind system shown here is not at all based on meteorological fact. Therefore, the results obtained from this implementation are not at all realistic enough to pass as the focal point of any game. Instead, the implementation can be used to add variety and realism to a game that does not need realistic modeling of wind effects in order to function.

ALTERNATIVE METHODS

As with most computer-based problems, there is always more than one method that can be used to solve a problem. The implementation of a wind system is no different.

"Wind Array Approach"

One other method of creating a wind system would be to create a grid of particles over a certain area of the game world. In order to simulate wind, the Wind Manager (which is the same as Wind Manager previously described) creates the grid with all the particles having a wind strength of zero. Then, as the game begins to run and wind is called for, the Wind Manager increases the wind strength of the first row of particles according to a wind gengrating algorithm within the Wind Manager. On the frame following that, the second row of particles looks at the wind strengths of the particles in the preceding row and uses those values to find their own wind strengths, while the Wind Manager creates new values for the first row of particles again, replacing the old values. During the next frame, the third row accesses the second row's wind strength values to determine their own values, and so on. What is immediately apparent is that this causes a wave-like effect that travels through the grid of particles as time goes on. Objects, in order to be affected by wind, would find the particle nearest to itself, and use the wind strength value of that particle to determine the action that should be taken.

The main problem with an implementation of this sort is the amount of particles that would be necessary to cover an area of decent size. As the area that is to be affected increases, the number of particles present in the system will also need to be increased if the resolution of the grid of particles is to be maintained. Furthermore, since particles receive their strength values from particles preceding them by row in the grid, it can be potentially expensive to update the entire system every time a new frame of animation is needed, especially when the animation is rendered in real-time.

Non-Particle Approach

Yet another method for developing a wind system would be to avoid particles altogether. This type of system would instead use algorithms to develop the necessary wind data according to the position of each object. The Wind Manager would still be present, but would be very different indeed. During the execution of the program, the Wind Manager would iterate through its list of objects that should be affected by wind, and depending on each object's position, would develop wind strength values and directions on an individual basis. It would be up to the specific implementation as to whether the Wind Manager would provide consistent wind data to all objects in the game world or whether the wind data would be random.

Although this might be an acceptable method of simulating wind, it lacks the ability to have the wind system move through the game world, which the particle-based implementations can easily accomplish. This might be able to be overcome by using more complicated algorithms during an object's wind solution, but it also makes the implementation much harder on the programmer of the system.

CONCLUSION

Now that computers are becoming more powerful, the applications that consumers are looking for will make use of that power. This fact is readily apparent from the number of three-dimensional games that have stormed the marketplace. With this demand for more powerful games comes the demand for more realistic games which incorporate effects that mimic their real-world counterparts. These effects, such as wind, can become part of a game system that helps the environment come alive, but can also put a heavy toll on the machine, possibly hindering the flow of the game. As a result, implementations of special effects must be very efficient, allowing a decent balance between desired realism and algorithm speed (because realism and alogorithm speed are usually mutually exclusive). The algorithm presented in this paper is an attempt to create a dynamic wind system which maintains a fair amount of realism while minimizing overhead. This algorithm can stand on its own, but is better suited as the basis of other algorithms with similar goals.

REFERENCES

Reeves, William T., Computer Graphics, Particle Systems--A Technique for Modeling a Class of Fuzzy Objects, Vol 17, No 3, July 1983.

Reeves, William T., SIGGRAPH, Approximate and Probabilistic Algorithms for Shading and Rendering Structured Particle Systems, Vol 19, No 3, 1985.

Foley, van Dam, Feiner, et al, 1996, Computer Graphics: Principles and Practice, Addison-Wesley Publishing Company, Reading Massachusetts.

Parallel Programming: A Disparate Architectures Approach

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As computers become faster and more advanced, the applications written for them demand more from the system, taking up memory and space. If the limit on processor speed is ever approached, alternate methods of programming will need to be used. Parallel and distributed programming, where the workload of a program is distributed to one or more machines working simultaneously, is one solution to this problem.

The concept of parallel programming has grown rapidly with the development of more efficient programming languages and the availability of networked clusters of workstations. However, many networks are not comprised of machines of the same architecture; often there are workstations that may outperform the other machines due to faster processors or the nature of their architecture. This research will address working in a networked cluster of workstations of disparate architectures, and will attempt to discover the optimal method of distributing work in such an environment.

INTRODUCTION

Since the invention of computers, engineers have quested to design faster and faster computers. As our technology increases, our patience decreases, and even faster results are desired. As modern applications become more advanced, they require more memory and processor usage, consuming the time the processor can use on other applications. Many current problems, such as simulation, modeling, and computations on large amounts of data, require faster processing to allow completion of the tasks in a reasonable amount of time [5]. Will there be a point where it is no longer physically possible to make computers run any faster? Where will programmers turn if this limit is reached? A method of programming needs to be developed that will allow more efficient use of computers. Distributed and parallel processing proposes one possible solution to this dilemma.

The concept of distributed processing can best be expressed by the following analogy: a man is preparing dinner for his family. He begins by cooking the meat. Once he finishes cooking the meat, he sets that dish aside and begins cooking the potatoes. When he has finished preparing the potatoes, he sets them aside and starts on the string beans. He continues preparing dish after dish until the meal is prepared. By the time the last dish is done, however, the meat is cold. An efficient cook would have observed that the stove has four burners, and that preparing the potatoes does not depend on whether the meat has finished cooking. He thus begins the many meal-time preparation tasks simultaneously (in parallel) and attempts to schedule their start times so that they will all finish at approximately the same time. This simple example provides an intuitive idea of performing tasks in parallel. Each step of the preparation of the meal can be thought of as a task and each burner on the stove a processor. Division of problems to tasks and allocation of tasks to processors is one of the goals of parallel and distributed parallel processing. Since there are physical limits to the amount that one processor can accomplish, why not use a divide and conquer strategy? Divide the job at hand into several tasks, and allocate the tasks to processors which work simultaneously in an effort to finish the overall job faster.

This research addresses working in a networked cluster of workstations of disparate architectures, and will attempt to discover the optimal method of distributing work in such an environment. In order to best understand this environment, it will help to review some of the basic principles in parallel processing.

Parallel processing is a method of processing in which the programmer takes a serial task that lends itself to parallelization, and breaks it into subtasks that can run in parallel. In a networked environment, many workstations are linked together and messages are passed in a distributed environment. The tasks are distributed to the workstations and then are executed in parallel. Machines linked in a network do not have shared memory; data must be distributed to the different machines through message passing. Network environments are common since most people have access to a network instead of an actual multiprocessor machine. Multiprocessor machines cost a considerable sum of money, usually more than a network of simple workstations, and are not easily available to all programmers and researchers.

Using the master/slave programming paradigm, a master process sends tasks to slave processes. The master and the slave processes are able to run on one to many processors. The master process handles the input/output and setup procedures. Once it is time for actual computation, the master spawns slave processes and sends them work to do, making sure each slave receives the information it requires. Each slave in turn can proceed to spawn additional slave processes, adding to the workload on the virtual machine. When a slave finishes its computation, it passes information back to its parent, sending any data required. Once the slave process ends, its parent releases the process to allow more of the virtual machine's computation power to the remaining processes [5].

RESEARCH

This research focuses on the distribution of work in a distributed parallel processing environment where the processors in the environment are of disparate architectures. This research sets out to prove that an even distribution of work is not be the optimal workload distribution in such an environment. If any of the processors in the environment are different from the others, whether that be in speed or general architecture, the best workload distribution would likely take place in a situation where the processors that can complete the given task faster receive larger tasks than the processors that have a harder time working on the task. The testing was conducted using the quicksort algorithm, using the additional tools of PVM for parallelization.

Since the quicksort is an O(n log n) sorting algorithm, it is one of the faster sorting algorithms. The quicksort has proven to be one of the most efficient sorting algorithms because it sorts random order and reverse order files faster than most sorting algorithms. The quicksort algorithm was selected because it could be parallelized and yet was simple enough to be readable and understandable by the general audience.

Parallel Virtual Machine (PVM) is a parallel programming tool that was developed at Oak Ridge National Laboratories in 1989 and enjoys considerable usage today. Developed as a collection of C, C++, or Fortran libraries, PVM "software provides a unified framework within which parallel programs can be developed in an efficient and straightforward manner using existing hardware" [1]. PVM was selected as the parallel language because it is available in the public domain and because it had already been ported to both the SGI and HP architectures. PVM enables a group of heterogeneous machines to act like a single parallel "virtual machine." This "virtual machine" effectively acts like a single multiprocessor machine. PVM handles the message passing and data conversion between the architectures. PVM applications are written as groups of cooperating tasks. Using the resources provided by PVM, a task can send and receive data, pass information between other tasks, broadcast information to all processors, spawn new tasks on other processors, and add or remove processors from the "virtual machine" during execution; this provides both flexibility and computational power.

The "virtual machine," operating in the master/slave model, had one master process and four slave processes. One processor was assigned to each process in order to take full advantage of the processor's power. The processors spanned two different architectures, the HP and SGI, each running two different operating systems. The computers selected also had different processor speeds. All five machines run on RISC based architectures. Sinope, an HP 9000 712/60, was used as the machine spawning the master process. It has a 60 MHz processor of VLSI design, with PA-RISC architecture [2]. Calypso and Elara are used as two of the machines where slave processes were spawned. Calypso is an HP 9000 712/60, identical to Sinope. Elara is an HP 712/80, identical to Sinope and Calypso except that its processor runs at 80 MHz [2]. Nereid and Triton are SGI machines with MIPS processor chips. Nereid is an SGI Indy using a MIPS R4600, 132 MHz processor [4]. Triton is an SGI Indigo2 Extreme using a MIPS R4400, 200MHz processor [3].

The primary goal in parallel programming is to increase throughput. The programmer hopes to speed up execution time by running parts of the programs on different processors. Unfortunately, the parallel version of an algorithm is not always faster than its serial counterpart; sometimes this is due to machine concerns that do not exist in serial programming [5].

Load balancing is the process of distributing tasks in the best possible way to get the most efficient performance in parallel. This is most important when there are many tasks of various sizes to be performed. The tasks need to be distributed to the processors so that the least amount of waiting takes place when smaller tasks finish before larger ones. Large or frequent delays slow down the overall performance of the parallel algorithm [5]. The best distribution of data needed to be produced so there would be the least amount of overall waiting time during execution. To guarantee this, multiple test runs were created using different load balances between the tasks in the "virtual machine." An optimal balance point where the faster processors had more of the workload than the slower ones was sought after.

To determine the comparative speed of the processors, the program was run with 100% of the load on one processor at a time. Once the relative speeds of the machines was determined, the first test run started with each task receiving 25% of the load. After this point, work was slowly shifted from the slower processors to the faster processors, recording the overall execution time at each point. Eventually, the load reaches its best balance, and the execution time begins to lengthen with further shifting. Shifting the load slowly in this manner guarantees the optimal balance will be found.

Communication performance is involved whenever two or more machines must pass information. Increasing the number of processors being used may increase execution time depending on the bandwidth of the connections and how much information must be passed. This is especially a problem in a distributed memory environment where large data sets are passed between processors [5]. In this research, large sets of data are being passed between the master and slave processors. In order to minimize the affect of bandwidth and line noise, all the machines in the "virtual machine" were on the same Local Area Network (LAN). This minimized the distance that information would need to travel across the connecting cables, and minimized the chance that other machines were using the same cables to pass information.

Timing began with the start of the program from the command line and ran to the completion of the program. Once the test file was read into a dynamically created array, the program checked the command line arguments of the executable, and then computed the amount of data to send to each processor. Sinope then spawned four slave processes, one on each machine, and passed each process the section of the array they were sorting. Each slave process proceeded to receive the array into a new dynamic array. This new array was sorted on each machine, and then passed back to Sinope. Once Sinope received the data from all four processes, the program halted. Testing was conducted late at night during a week when the computers were not being used to attempt to minimize processor demands from external sources. Multiple test runs were created for one, two, three, and four machine "virtual machines" to get complete information about how the load shifting affected execution time. Each run was timed and run multiple times to get an average execution time for each different load balance.

TESTING RESULTS

The data file consisted of one-hundred thousand random numbers. Before test runs could begin, the relative speeds of the machines needed to be determined so the test runs could be correctly configured, shifting more of the load balance to the faster machines. First, a serial version of quicksort was run on each machine to compare to the speed of our parallel testing program. Table 1 denotes the results of the serial tests.

Table 1 Serial quicksort tested on each machine (all times in seconds)

Machine	run 1	run 2	run 3	run 4	run 5	average
Triton	37.51	37.83	37.82	37.69	37.80	37.73
Elara	43.50	42.80	42.60	42.60	42.70	42.84
Nereid	57.12	57.02	56.97	56.95	56.95	57.00
Calypso	59.80	59.70	59.70	59.70	59.70	59.72

The average time of the serial sort is faster on Elara than on Nereid; despite its faster processor, Nereid was is not able to complete the task as fast as Elara. Based on these results, Elara was given a larger load than Nereid on the virtual machine.

The testing program was then executed on each machine in the virtual machine individually by giving 100% of the load to the machine being tested, and giving 0% of the load to the remaining three machines. Theoretically, these test runs should take more time than the serial versions of the program, because the array must be passed over the network to the machine, and the same serial quicksort is used in the slave testing program. The only difference between the serial test runs and these parallel runs should be the time it takes to pass the array over the network and the time PVM takes in preparing the virtual machine. The results of this test are displayed in Table 2.

Table 2: Quicksort tested on each machine in parallel (all times in seconds)

Triton	Elara	Nereid	Calypso		run 1	run 2	run 3	run 4	run 5	average
100%	0%	0%	0%		41.5	40.8	41.2	42.1	40.9	41.30
0%	100%	0%	0%		46.1	46.4	46.5	46.7	46.5	46.44
0%	0%	100%	0%		61.0	60.7	60.7	60.8	61.0	60.84
0%	0%	0%	100%		62.8	62.4	62.4	62.4	62.3	62.46

Notice that the average execution time is slower for each machine in Table 2 than in Table 1 as predicted. On the basis of these results, the priority computer selection in the virtual machine was assigned to be Triton, Elara, Nereid, Calypso. The actual test runs began using the configuration determined in the preliminary test runs. The first test runs compared machines in pairs to compare speeds intra-architecture and cross-architecture. The following test runs compared three machines at once, and concluded with runs taking advantage of the entire virtual machine.

The most interesting aspect in all of the test runs was that, no matter which method of load shifting was used, there was always a point where the optimal load balance was reached, producing the fastest execution time in the run. Beyond this point, the execution time of the test program would increase. In addition, this point of optimal load balance was always reached very close to the starting load balance. This phenomenon is noticeable in Table 3. Notice that relatively close to the initial starting point of 25% load on each machine, the execution speed reaches an optimal speed of six seconds, and then begins to increase.

Table 3: Sample test run (all results in seconds)

Triton	Elara	Nereid	Calypso		run 1	run 2	run 3	run 4	run 5	average
25%	25%	25%	25%		7.4	6.8	6.8	6.7	6.8	6.9
27%	25%	24%	24%		6.4	6.4	6.4	6.4	6.4	6.4
29%	25%	23%	23%		6.1	6.1	6.1	6.1	6.1	6.1
31%	25%	22%	22%		6.0	6.0	6.0	6.0	6.0	6.0
33%	25%	21%	21%		6.4	6.4	6.3	6.4	6.4	6.38
35%	25%	20%	20%		6.8	6.8	6.8	6.9	6.9	6.84

To insure there is a lower bound on speed, some random test runs of extreme workload imbalance were executed. It was necessary to be certain the curve noticed in the test runs was not a wave that would reach a point of maximum speed and curve back down toward faster speeds.. All of these random tests at extreme load imbalances provided results far above the test runs closer to the starting balance.

The extreme test runs also point out that the percentage of the load on Triton is very important to the overall performance of the virtual machine. The results from the test runs on all four machines were compiled into a list based on the load on Triton. Each group of load percentages for Triton were averaged to calculate the average execution speed of the program for each percentage load on Triton. These results are displayed in Figure 1. In this figure, the execution is fastest on the average when Triton has 29% of the load. This figure also depicts the curve noticed in the individual runs, where a point of optimal balance is reached.

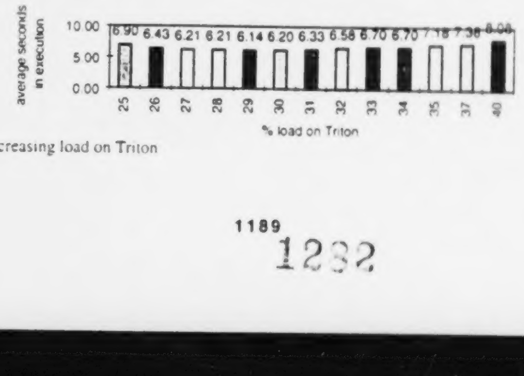

Figure 1. Increasing load on Triton

The percentage of the load given to Calypso is also very important. There is a point where the advantage of having a virtual machine is lost if one processor is not doing enough work. Figure 2 depicts this result. Notice that as less of the load is allocated to Calypso, the execution time increases. (Note: the curve jumps at 20% load on Calypso because a majority of the runs at that percentage had Triton at 35% and 40%, which, as per Figure 1, skew the data at that point.)

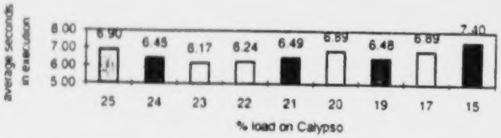

Figure 2. Decreasing load on Calypso

CONCLUSION

After examining all the results from the research, it was concluded that the hypothesis stated above was correct: A perfect load balance, where each machine received the same amount of work was not the optimum configuration. In all the test runs performed, a point was reached where at least one test run was faster than the perfect load balance run. Since the hypothesis was proven true for virtual machines of two, three and four processors, it was additionally concluded that this will be true for virtual machines with more processors, however, additional experimentation with addition processors is need. This researcher is sure there will be a point of optimal balance on a virtual machine with disparate architecture processors on any size virtual machine. On very large virtual machines this optimal balance point may not be noticeable as it could be a difference of a matter of microseconds by that point.

Distributing the load by giving more workload to faster processors indeed decreased execution time of the program overall. Program execution time decreased noticeably as more work was given to Triton and Elara in all of the test runs. It was also noticed that not all the processors always need to have more work shifted onto or off of them. For example, in Table 3, the load on Elara was left alone, and yet, an optimal balance point was still reached. This suggests that some processors may be more important to the virtual machine than others, which was noticed in Triton. The percentage of the load on Triton was important to the overall virtual machine, as depicted in Figure 1. In general, the more work shifted on Triton, the faster the overall runs performed, up to a certain point. Once Triton has too much of the workload, the virtual machine loses some of its effectiveness. This led to the conclusion that shifting the balance too far on one machine increases execution time and ruins the purpose of the parallel machine.

REFERENCES

1. Geist, Al, et al. PVM: Parallel Virtual Machine: A Users' Guide and Tutorial for Networked Parallel Computing. Cambridge: The MIT Press, 1994.
2. HP 9000 Midrange Business Server Family [web page] April 1996; http://www.hp.com/gsy/servers/ghandids.html [Accessed 16 February, 1997].
3. Indigo2 Product Guide [web page] 1995; http://www.sgi.com/Products/Indigo2 [Accessed 16 February 1997].
4. Indy Technical Specs [web page] 1995; http://www.sgi.com/Products/Indy/Tech/indy_ts.html [Accessed 16 February 1997].
5. Maui High Performance Computing Center. Introduction to Parallel Programming [web page] January, 1995 ; http://www.difi.unipi.it/ IntroSP2/html/parallel-intro/ParallelIntro.html [Accessed 20 January, 1997].

A Traceability Tool: Linking Knowledge Programs

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ABSTRACT

Developing large, complex computer programs requires capturing knowledge from multiple domain experts, customers, and end-users. A major concern is the management of this information and its use in identifying the reasons behind design and implementation decisions. Tracing, the mapping between requirements and artifacts of a software system, addresses this issue. Typically, tracing requires that all system artifacts be physically linked to the requirements, an expensive and time-consuming process.

This paper discusses an approach to tracing that does not require physical links from documents to the program code and, as a result, makes the maintenance of traceability a simpler task. The suggested tool is based on context monitoring, an approach which verifies that properties specified in the requirements are met by the program code and alerts the user when a violation occurs. The paper also discysses the issues in implementing this tool.

INTRODUCTION

When developing a large computer program, it is difficult to ensure that the program will meet its specified requirements. Software engineers must elicit a vast amount of knowledge from various domain experts. In addition, the requirements typically continue to change during the development of the program. In such a dynamic environment, it is difficult to guarantee that the system will preserve the current set of requirements. A software traceability tool can support this effort by linking the program to the vast amount of information that is being maintained. More specifically, tracing maps between all the artifacts of the system being developed. Artifacts include documents such as the system definition, interview transcripts, memoranda, software requirements specification, the functional specifications, the design report, user's manuals, and the program's code. Through the links, tracing can provide information concerning accountability for requirements, design and implementation decisions [1]. The ability to track projects and manage design rational are other uses for traceability.

The motivation behind a traceability tool is to validate system features against the requirements specification, identify error sources and manage change [3]. For instance, consider the development of a security system for a bank. In such a system there will be many different stakeholders that includes the development team, bank personnel, customers and experts such as electricians, architects and security specialists. All these stakeholders have a different point of view for the requirements of the system. For example, bank personnel will be concerned about their well-being and accessibility of the system; customers will be concerned about the security of their assets; electricians and architects will give input about how the system can be physically laid out; security specialists provide input on all aspects of the security. With so many points of view coming from all stakeholders, it is difficult to manage them, communicate information to the developers and it is likely that conflictions

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in the requirements will arise. This is where tracing of requirements can benefit the software engineer.

With links between the artifacts of the system, we can now keep track of the requirements and changes to them. These links provide for accountability of the requirements and the justification of design and implementation decisions. The main drawback to this is that, with the large number of artifacts that results from developing a large system, the links between the artifacts can be hard to maintain.

This paper introduces an approach to tracing in which the amount of links that need to be maintained are reduced. Although this approach, based on context monitoring, does not support full tracing, it provides a significant subset. Section 2 provides the reader with a background on traceability tools. Section 3 describes traceability in the context monitoring environment. Section 4 presents the initial steps in defining a framework for specifying constraints in a formal language. Finally, section 5 will give a short summary of the paper.

BACKGROUND

The typical approach to maintaining traceability, especially for complex systems, requires that all system artifacts created at various stages of the development process be linked to the requirements. In such an approach there must be hyperlinks (physical links) between all artifacts and requirements. These links should provide bi-directional, vertical and horizontal traceability. Bi-directional traceability refers to the ability to trace both backward and forward. Vertical traceability allows the user to trace between documents developed at different life cycles, and horizontal traceability provides the ability to link between related objects created in the same life cycle. Each document must have a logical structure so that the tracing tool will understand the interrelationships between different software documents. Furthermore, the ability to update the links as the system evolves must be present. With a large volume of documents, however, it is difficult to maintain and update the links between the artifacts [1].

Some approaches to building a traceability tool include: an object-oriented approach and a graph-based approach. In the object-oriented approach, users define the classes of artifacts and the relationships between them. The classes of artifacts provide the logical structure necessary for the documents to be traced. The relationship classes provide the structure for defining links and their relations. The use of relations instead of simple links lets developers distinguish among different links between the same objects. Also, by using properties of relations, this approach can relate objects that are not directly linked [3].

The graph-based approach takes both the coarse-grain level and the fine-grain level of the system into account. On the coarse-grain level, links represent dependencies between whole documents. On the fine-grain level, the structure of the documents are taken into account. Both levels are necessary to provide for adequate traceability. The collection of documents are represented by the use of hierarchical graphs. Operations on the graphs are defined by means of a formal language based on graph rewriting system. On the coarse-grain level, all project documents and the relations between the documents are represented in the graph. On the fine-grain level, links represent the relation between individual objects in the documents. These objects may be contained in the same document or in separate documents [4].

These two approaches to developing traceability tools have one thing in common: they link all artifacts to the requirements. The advantage to having direct links between all artifacts is that one can trace the system and ensure that the system requirements have been met, thus providing more complete coverage of the system. In a system with thousands of interrelated objects, however, too much information must be managed and the user may be overwhelmed with irrelevant data. This also provides for a very complex system of links to maintain.

TRACEABILITY USING CONTEXT MONITORING

This section introduces an approach to tracing, based on context monitoring, that reduces the number of physical links that need to be maintained. In this approach, constraints on the system are used to link the artifacts. As a result, the links between the development documents and the implementation code are replaced with virtual links simplifying the complex system of links that need to be maintained. This approach does not supply full tracing in that it only provides links to the areas of the document that pertain to constraint specification; however, this is a significant subset of tracing.

Context monitoring is an approach to software development that allows us to accomplish this type of tracing. It captures knowledge of the data objects of a software system to ensure program correctness with respect to selected properties. The approach consists of two parts: the elicitation and specification of constraints on data objects being modeled by the system, and a constraint satisfiability mechanism that dynamically verifies constraint enforcement during program execution.

Constraints capture properties, relationships, restrictions and limitations on data or objects of the program and may be used to reflect the interpretations and assumptions that are made about the objects during development. Constraints are elicited from domain experts, users and members of the development team during the analysis and development process. Constraints are not embedded in the program code, instead they reside in a central repository with links to the documentation. This repository contains the constraints expressed in first-order logic along with the relevant information pertaining to the source of the constraint. The satisfiability mechanism virtually links the constraints to the program by tagging code sections with identifiers of the related constraints as described next.

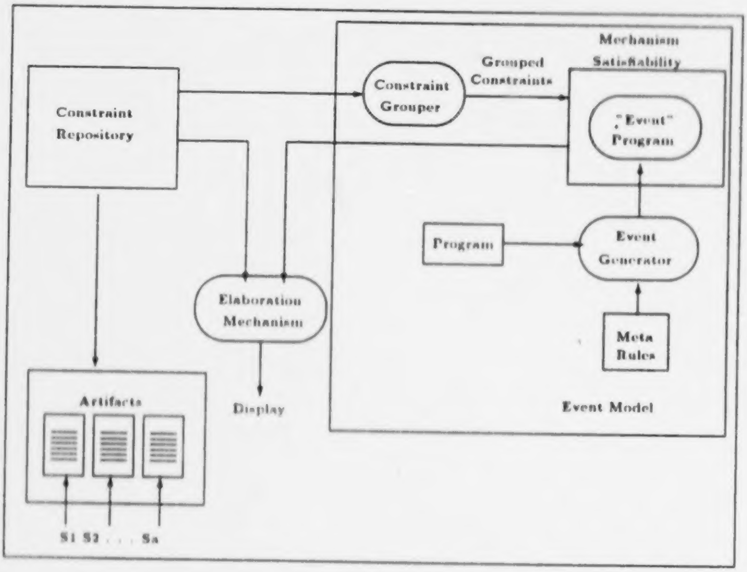

Figure 1: Overview of Context Monitoring with Event the Model

The event model (see Fig. 1) consists of a set meta-rules and the program code that are entered in to an event generator. Meta-rules define where and how to tag a program section with constraints. The event generator uses the rules to tag the program and produces an "event" program. Once this event program is executed, the satisfiability mechanism, an external system monitoring the program, registers state changes and invokes appropriate constraint checks according to the tags [2]. The constraint-grouper gathers all the constraints that pertain to an event. This set of constraints becomes input into the satisfiability mechanism. When a constraint is violated an event occurs. This event is reported to the elaboration mechanism [2].

The elaboration mechanism acts as a bridge between the satisfiability mechanism and the constraint repository providing an interface for tracing. After an event is reported, the elaboration mechanism displays constraint violation and the section of code where the violation occurred. The user then has the option to go into the repository and trace from the constraint to the documentation pertaining to it.

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FRAMEWORK FOR SPECIFYING CONSTRAINTS

This section presents the framework being used to develop a tracing tool using context monitoring. The initial steps are to describe a formal language to store the constraints in the central repository, and to define the links that need to provided within the artifacts. Subsequently, we will be implementing a prototype that will visualize the tracing process.

A formal language is used to describe the format for storing the constraints of a program. The formal language is defined using Backus Naur Form (BNF). Each entry in the constraint repository will follow the syntax as described in the following format:

```
<Constraint Spec> ::= <Constraint> : <Source List>;
<Constraint> ::= <Constraint Def>
<Source List> ::= <Source> | <Source> : <Source List>
<Source> ::= <Document ID> , <Specifier ID> , <Date>
<Document ID> ::= <Document Name> ( <Section> )
<Specifier ID> ::= <Person Name>
<Date> ::= <Month> - <Day> - <Year>
<Section> ::= <Number> . <Section> | ε
```

An example of a constraint specification using this format follows:

$\forall$ salary $\in \mathbb{R} \mid$ salary > 10000 and salary < 100000 : SRS(2.3), Tom Watson, 10-4-96 ; interview1(), Francisco Saenz, 10-4-96;

This constraint specification initially describes the constraint in first-order logic and constrains the variable *salary* to values greater than 10,000 and less than 100,000. After the ':' symbol, the source of the constraint (<Source List>) is given. In this case, <Source List> is comprised of <Source>:<Source>, where the first instance of <Source> consists of <Document ID>, SRS(2.3), followed by the <Specifier>, Tom Watson, and the <Date>, 10-4-97.

Links define the relations that exist within artifacts with respect to the constraints. The constraint repository, through the <Source List>, provides virtual links to the documents where the constraint was first specified. Within the documents, sections that discuss the same constraint are physically linked together. The physical links can be in the same or in separate documents in different life cycles. This allows for the bi-directional, vertical and horizontal links as described in section 2.

SUMMARY

Traceability using context monitoring reduces a significant number of physical links that need to be maintained by the tracing tool. This paper provides a framework to implement such a tool. This system will benefit the software engineer in many ways. First of all, the user can obtain information about a specified constraint. For instance, who specified the constrain, what documents specify the constraint and when it was specified. Also, the satisfiability mechanism can report when and where in the program code a constraint was violated. After a violation has been reported, the elaboration mechanism allows the user to trace back into the documents where the constraint was first specified. One disadvantage to this approach is that it is not possible to ensure that all system requirements are met because the constraints capture only those parts of the requirements that specify properties and relations between objects. The advantage to this approach is that the system does not have to provide physical links from the artifacts to the program code; therefore, if modifications to the code are made the links are not inadvertently affected.

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REFERENCES

[1] Delgado, N. and T. Watson, "An Approach to Building a Traceability Tool for Software Development", in NASA *University Research Centers Technical Advances Vol. 1* (Jamshidi, M. et al., eds.) Albuquerque, NM, 1997: ACE Center Press, pp. 197-201.

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[2] Fernandez F., "Integrity Constraint Monitoring in Software Development: Proposed Architectures", in *NASA University Research Centers Technical Advances Vol. I* (Jamshidi, M. et al., eds.) Albuquerque, NM, 1997: ACE Center Press, pp. 213-218.

[3] Pinheiro, F. and J. Goguen, "An Object-Oriented Tool for Tracing Requirements", in *IEEE Software*, pp. 52-64, March 1996.

[4] Westfetchel, B. "A Graph-Based Approach to the Construction of Tools for the Life Cycle", in *IEEE*, pp. 2-13, June 1992.

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COMMONSENSE KNOWLEDGE REPRESENTATION FOR RUSSIAN FOLKTALES

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ABSTRACT

Computer scientists employ knowledge representation schemes to represent the semantic content of natural language concepts. Representation of knowledge means using a formal language to compose descriptions that correspond to the world. The interest in artificial intelligence is developing descriptions of the world that an intelligent machine can use to derive new conclusions about its environment. This paper describes the construction of a formal world model for the `Joseph` system, a set of programs in the Prolog language which generates short narratives modeled after Russian folktales. The `Joseph` system uses interchangeable world models as its source for the facts and events around which the stories revolve. A world model in the `Joseph` system is a set of prolog predicates which describe the potential characters, events, and range of reactions to events that drive the plot of the story. This paper describes the world model predicates, explains their role in the system, and shows how these predicates capture commonsense observations drawn from example tales. This research contributes to the advance of knowledge representation and artificial intelligence because it demonstrates an understandable and practical means to represent commonsense knowledge about the world in a way that is useful in an automated system.

INTRODUCTION

Computer scientists employ knowledge representation schemes to represent semantic content of natural language concepts [Allen:93]. Representation of knowledge means using a formal language to compose descriptions that correspond to common events and facts. In computer science, these descriptions must be in a form which will allow a computer program to draw conclusions and make predictions based on the represented information. For example, we need to represent two people being married in such a way that the computer can understand that they can no longer marry anyone else or consider themselves single. As another example, a person going on a trip has to be recognized by the computer as someone relocating temporarily. The interest in artificial intelligence is writing down these descriptions of the world in such a way that a machine can derive new conclusions about a given problem domain.

THE `JOSEPH` SYSTEM

The system in which this work has been done worked is called the `Joseph` system [Lang:97]. It is a set of programs in the Prolog language which generates short narratives modeled after Russian folktales. The core of the system is a formal grammar that governs lists of events and facts, which are the terminals in the grammar. The non-terminals are high-level and intermediate components of stories such as `setting`, `episode`, `reaction`, and `outcome`.

```
Example rule:
Story --> Setting, Episodes
```

The system works by generating a list of events and facts, expressed as first-order predicate calculus terms. We refer to this as the "event list." The system also maintains a parse tree of this list. Once the event list and parse tree are finished, both these are sent to a natural language output unit which translate these formal structures into surface text(language in a form that people actually communicate in). Figure 1 illustrates the major components of the `Joseph` system.

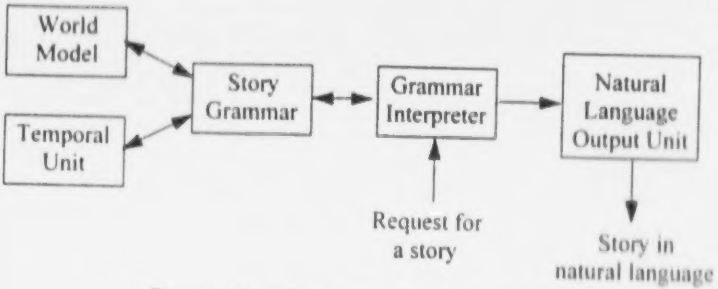

Figure 1: Major Components of the `Joseph` System

During the process of constructing the event list, `Joseph` invokes a world model which describes the events that can happen, the effects that are possible, the reactions characters have, and the goals that characters can pursue. The `Joseph` system uses interchangeable world models as its source for the facts and events around which the stories revolve. The following is a sample story generated by the `Joseph` system.

```
Once upon a time there lived a tsar.

one day it happened that tsar went to the palestine.  when
this happened, tsartisa felt lonely for the tsar.  in
response, tsaritsa waited for tsar to return.  some time
passed.

then king captured tsar.  when this happened, tsaritsa felt
lonely for the tsar.  in response, tsaritsa made it her
goal that tsar would be rescued.  tsaritsa developed a
plan.  tsaritsa rescued tsar.  this is how the plan worked.
tsaritsa disguised herself as the harpist.  tsaritsa went
to the palestine.  tsaritsa entertained king.  tsaritsa
asked the king for the tsar.  tsaritsa selected tsar.  tsar
was rescued.
```

REPRESENTING THE CONTENT OF RUSSIAN FOLKTALES

This particular area of research focused on the world model component of the Joseph story generation system. The system generates a story by performing a top-down construction of a parse tree describing the structure of the story, that is, the facts in the setting, the number of episodes, the number of actions taken in pursuit of a goal, etc. When this generation process reaches a leaf node, the grammar places a terminal schema, or template, at the leaf node. It is the responsibility of the world model, which is separate from the grammar, to instantiate the leaf node.

The following partial parse tree illustrates this. The grammar rules govern the construction of the tree down to the leaf. In this case, a particular event at a particular time is required to start off an episode. The grammar inserts a template at the leaf node and invokes the world model to instantiate it. In this case, the world model must supply some actual event to instantiate the variable `Event`. The temporal module instantiates `Time` to ensure that events happen in the proper sequence.

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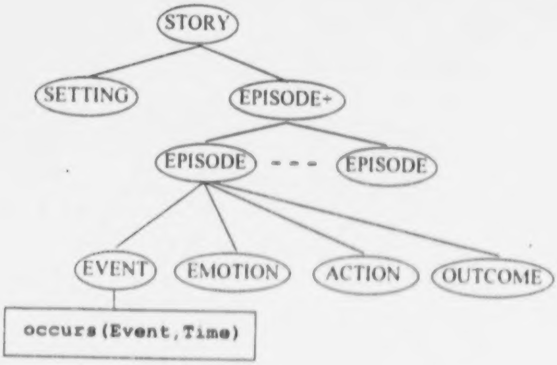

Figure 2: A partial parse tree for a simple narrative showing a leaf template

A world model in the Joseph system is a set of prolog predicates which describe the potential characters, events, and range of reactions to events that drive the plot of the story. The world model is very detail oriented in that it describes the characters that can appear in stories, events that can happen to characters, reactions characters have to these events, actions that characters take, and the goals that characters adopt.

The Joseph world model relates specific actions, events, and states to each other. For example, the action of eating is related to the effect of being satisfied. This information allows the system to determine the effects of agents actions in order to detect, for example, when a goal has been achieved. Most of the relationships in the world model are valid only when certain other conditions are true or particular actions have previously taken place. For, this reason, most of the required world model predicates accept an argument which describes the state of the world. The predicates use this argument to determine if the conditions for a particular relation have been met.

A Joseph world model has two types of predicates: required predicates and auxiliary predicates. Required predicates are the predicates that the grammar invokes in order to instantiate a leaf. The other predicates, auxiliary predicates, are used internally by the world model to support the required predicates. A sample required predicate utilized by the Joseph system is:

```
hero(Agent).
```

The agent of a story is the protagonist of a story. For example, the clause `hero(cossack)` states that a story may have a cossack as its central character. The agent must then be classified into a specific gender by usage of the `gender` predicate, an auxiliary predicate.

```
gender(tsaritsa, female).
```

This defines the tsaritsa as being female in the world of Russian folktales.

Another required predicate is the `fact` predicate, `fact(Fact,World_state)`. This predicate is used in the developing the setting of a story.

```
fact(married _to(Prot, tsar), World):-
        protagonist(Prot, World),
        gender(Prot, female).
```

This defines the protagonist of a story is married to the tsar in the given world. The condition for this fact is that the protagonist be female, since the tsar is male.

Another required predicate is `action_motivation(Emotion, Action, World)`. This specifies the action that an agent who feels emotion will perform in `World`.

```
action_motivation(miss(Spouse), wait(Spouse,return), World):-
     user:protagonist(Prot,World),
     holds_in(married_to(Prot, Spouse), World)
```

The protagonist's emotions are expressed in the missing of the spouse, therefore her action is to wait for the spouse's return. The final line of the clause states the condition that the protagonist will wait for spouse only if the protagonist is married to the spouse.

One final example of a required predicate is `episode_primitive(Event, World)`. An episode primitive is an event in a story that can initiate an episode.

```
     episode_primitive(go(tsar,palestine),_World).
```

This states that in any world state the tsar can go to Palestine.

LIMITATIONS OF THE PRESENT WORLD MODEL

Although much work and effort has been put into the development of knowledge representation techniques, problems still remain. These issues surface in `Joseph` and cause incoherent stories. Sometimes characters reappear after being pronounced dead. Characters sometimes remarry without any resolution to their previous marriage. The system should be able to identify that if someone is dead that they are no longer in existence. A sample story that depicts this error follows.

```
once upon a time it happened that cat wanted food.  when this
happened, peasant felt pity for the cat.  in response, peasant
made it his goal that cat would be fed.  peasant attacked mare.
mare killed peasant.  peasant believed it impossible that cat
would be fed.  cat was starved.

then the younger daughter of baba_yaga went to the palestine.
when this happened, peasant felt lonely for the younger daughter
of baba_yaga.  in response, peasant waited for the younger
daughter of baba_yaga to return.
```

As another example, if someone is married the only way that they should be able to marry again is if they divorce or if their spouse dies. Consider the following story.

```
once upon a time there lived a wolf.  wolf was married to wife.

one day it happened that imp possessed daughter of a boyar.
when this happened, wolf felt love for the daughter of a boyar.
in response, wolf made it his goal that he would be married to
the daughter of a boyar.  wolf exorcised the imp from the
daughter of a boyar.  wolf was married to daughter of a boyar.
```

The above story allows the wolf to marry the daughter of a boyar, without any resolution to the previous marriage established in the setting.

The world model contains the rules which incorrectly allows these stories to be created. Out task is to identify the mistakes in the rules and correct them so that the machine can develop intelligent stories that are sensible to the reader. The following is a clause stored within the world model.

```
effect(attack(mare), state(killed(Prot, mare)), World) :-
     user:protagonist(Prot,World).
```

This clause states that the effect of attacking a mare is being killed. The world model allows or accepts a character as being dead or killed, but doesn't understand that in the state of death that a

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person can no longer carry out further actions. This incompleteness causes incoherent stories in which killed characters go on to act in subsequent episodes.

The clauses below, used in the second story, contains an error with respect to marriages.

```
can_marry(P1,P2) :-
     gender(P1,male),
     gender(P2,female).

can_marry(P1,P2) :-
     gender(P1,female),
     gender(P2,male).
```

The only restrictions placed on marriage by these clauses is that the characters marrying be of opposite genders, there is no mention of previous marriages. A facile correction to this particular problem follows.

```
can_marry(P1,P2,World) :-
     gender(P1,male),
     gender(P2,female),
     \+ holds_in(married(P1,World)).
     \+ holds_in(married(P2,World)).
```

This clause now states that, in addition to the parties to the marriage being of opposite genders, they also may not already be married. Notice that, in order to determine whether the characters were already married, it was necessary to add an additional argument to the predicate.

RESULTS

This research has brought computers a step closer to being able to draw conclusions about a particular environment. This work has shown how a commonsense world can be encoded and used in a larger system. The research has also revealed limitations of the scheme used in the `Joseph` system. These limitations fall into two major categories: (1) incomplete descriptions of events and actions, and (2) interactions among events and actions (the ramification problem). Although limitations of the first type are relatively simple to correct, the ramification problem is not so easily solved.

FUTURE WORK

Although some incoherent stories can be eliminated by identifying incomplete world model predicates and adding conditions to them, this approach will not solve all the problems. For example, the difficulty with dead characters continuing in subsequent episodes cannot be solved by adding conditions to a single clause. Instead, we must add conditions to *every* other clause stating that the agent must be alive. Such a solution is awkward and introduces the problem that, with every new action or effect we add to the world model, we risk having to consider the interactions of that new action or effect on everything already contained within the model. This is an instance of the frame problem known as the ramification problem [Shoham:88], which is currently an unsolved in knowledge representation.

REFERENCES

[Allen:93] James F. Allen. Natural language, knowledge representation, and logical form. In Madeleine Bates and Ralph M. Weischedel, editors, *Challenges in Natural Language Processing*, pages 146-175. Cambridge University Press, 1993.

[Lang:97] R. Raymond Lang. *A Formal for Simple Narratives*. Doctoral dissertation, Tulane University, 1997.

[Shoham:88] Yoav Shoham. Problems in formal temporal reasoning. *Artificial Intelligence*, 36:49-61, 1988.

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Godel's Incompleteness Theorem And Turing's Solution To The Halting Problem: Linking The Foundations Of Mathematics And Computer Science

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There exist many links and similarities in the fields of mathematics and computer science; this paper explores a link at the foundational level. Kurt Godel published his Incompleteness Theorem in 1931, and Alan Turing published his solution to the Halting Problem in 1937. Although these results are native to two different fields, the techniques that each individual used are nearly identical. This paper explores the link between these results and the methods used to arrive at these results.

INTRODUCTION

Since it will serve as a natural introduction to the content of this paper, I shall first briefly introduce the content and background of Godel's Incompleteness Theorem and Turing's Solution to the Halting Problem. Following this short introduction, I will proceed to outline proofs to the theorems, proofs to which we can refer.

In 1900, David Hilbert delivered a famous lecture outlining a list of problems for mathematicians to work on in the coming century. As an answer to the problems Hilbert saw arising in Set Theory, one of his problems asked that it be proven that mathematics is consistent and complete. By 'consistent' we mean that there does not exist a statement such that the statement and its negation are both theorems. By 'complete' we mean that all mathematical truths are theorems. With the publication of Kurt Godel's famous work in 1931, he showed that these conditions cannot both be true. In more general terms, Gödel showed that any axiomatic system at least strong enough to support natural number arithmetic cannot be both complete and consistent, shattering Hilbert's hopes that the contrary was the case.

Now let us consider the Halting Problem. The Halting Problem can be stated as follows: Given an arbitrary algorithm and an arbitrary input, decide if the algorithm will eventually halt on the provided input. In looser terms, this is a "pull the plug" question. Consider, for example, a computer program to find solutions to Diophantine Equations. [Suppose that our computer is theoretical; that it does not have an upper bound on the numbers it can represent.] What happens when our program has been running for several hours (or longer), displaying solutions to the provided input equation. Are there infinitely many solutions, or a finite number, all of which our program has not yet found? It would be convenient if we could first feed this program and its input into a "terminator-tester" to see if the program will eventually halt (implying a finite number of solutions) or not halt (implying an infinite solution set). In 1937, Alan Turing published a paper demonstrating the unsolvability of the Halting Problem.

These two results shook the Mathematics and Computer Science communities. Each is native to separate but related academic fields. The rest of this paper is dedicated to exploring links between Godel's Incompleteness Theorem and Turing's Solution to

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the Halting Problem (hereafter referred to as the Halting Theorem), particularly in the method of proof employed to arrive at each.

GÖDEL'S INCOMPLETENESS THEOREM

Before we explore links between the theorems and their proofs, we should acquaint ourselves with the nature of the proofs. The formal proof of Godel's Incompleteness Theorem is rather detailed and involved, so the reader should be aware that I will not repeat that depth here. When Gödel first published the theorem, he was concerned that it be extremely tight and error-free as possible. The complete proof is readily available, so the reader should refer directly to Gödel's document for a more rigorous proof (found in REFERENCES section).

Godel starts his proof by placing it in the context of a formal axiomatic system. The theorem generalizes to any system at least strong enough to support natural number arithmetic; but let us here refer to our system as TNT (Typographical Number Theory), after Hofstadter's reflection of Gödel's proof (438-460).

The next step is to number all symbols used in TNT, thus numbering all statements of TNT. Now a derivation rule can be interpreted as an arithmetical manipulation of a natural number. For a more in-depth demonstration of this technique, consult Hofstadter (261-264).

Next consider one form of the well-known Epimenides paradox, "This sentence is false." This string is self-contradictory: if it is true, it declares its own falsehood; if it is false, it again contradicts itself. Relating to Gödel's proof, Godel's job is next to find a self-referential string of TNT, say 'G', that in effect asserts that "G is not a theorem of TNT," or "G is unprovable." Thus G is a self-referential statement, similar to the Epimenides sentence above. Of further interest is the fact that G asserts its own nontheoremhood. Next consider the following questions and statements from Hofstadter (448):

> Is G a TNT-theorem? If so, then it must assert a truth. But what in fact does G assert? Its own nontheoremhood. Thus from its theoremhood would follow its nontheoremhood: a contradiction.
>
> Now what about G being a nontheorem? This is acceptable, in that it doesn't lead to a contradiction. But G's nontheoremhood is what G asserts--hence G asserts a truth. And since G is not a theorem, there exists (at least) one truth which is not a theorem of TNT.

So in other words, assuming TNT's consistency, we now know that G asserts a truth, but G is not a theorem. (Thus it cannot be proven by means of a series of derivations from a given set of axioms.) Hence we have an undecidable proposition, and thus the incompleteness of TNT.

Although the proof of which is beyond the scope of this paper, Godel demonstrates two more important properties of TNT. First Godel shows that "plugging up the hole" doesn't work. That is, as soon as we add G (or even G's negation) as an axiom of TNT, we find another string, say G', that is undecidable in the new system. This process can continue indefinitely, and in a manner reminiscent of Cantor's diagonalization trick to prove the uncountability of the real numbers, Gödel shows that TNT is forever incomplete as long as it is consistent. Second, Godel addresses the consistency issue. He expresses the sentence "TNT is consistent" inside of TNT, then shows that the theoremhood of this statement only holds when TNT is inconsistent! Thus there is no rigorous proof that can demonstrate TNT's consistency.

In Godel's original paper, he actually worked with a system titled *Principia Mathematica* (PM), slightly different from TNT. I have borrowed TNT from Hofstadter's work, a major source for this paper. But remember Godel also demonstrates that the aforementioned results hold for any formal system at least strong enough to contain natural number arithmetic.

With all this said, we will next move to the Halting Problem and Halting Theorem. We will continue by exploring links between Godel's Incompleteness Theorem and the Halting Theorem, particularly in their proofs.

THE HALTING PROBLEM

Now we turn our working environment to the context of Turing Machines (TMs). Recall that we can formally define a TM in terms of set theory, but suffice it to say here that a TM is simply a manifestation of an algorithm (provided we accept Church's Thesis). The proof of the Halting Theorem that I will mimic here is not quite the same as Turing's original proof, but the concepts involved are extremely similar. The majority of the proof outlined in the rest of this section is adapted from Cohen (807-809).

Let us start by developing a numbering system for TMs. Any numbering system will suffice, as long as there exists a bijective mapping from a subset of the natural numbers to the set of all TMs. Now let us restrict our TM input string alphabet so that TMs take as input a single natural number. For an example to TM encoding, consult Brookshear (176-181).

Now we are set up very nicely to feed the encoding of a TM as input to another TM. In the spirit of Cohen (726), let us now define the language ALAN as the set of all TM encodings that either do not represent TMs or represent TMs that do not accept their own encodings as input.

A key point that will soon be a crux to our argument is the fact that ALAN is not recursively enumerable (abbreviated r.e.). To see this, consider the following argument quoted from Cohen (727-728).

Suppose there does exist some TM, say T, that accepts the language ALAN. (That is, suppose ALAN is r.e.). Now we ask if the encoding of T, code(T), is a member of ALAN:

Case 1: code(T) is in ALAN

CLAIM	REASON
1. T accepts ALAN	1. definition of T
2. ALAN contains no TM encoding that is accepted by the TM it represents	2. definition of ALAN
3. code(T) is in ALAN	3. hypothesis
4. T accepts code(T)	4. from 1 and 3
5. code(T) is not in ALAN	5. from 2 and 4
6. contradiction	6. from 3 and 5
7. code(T) is not in ALAN	7. rejection of hypothesis

Case 2: code(T) is not in ALAN

CLAIM	REASON
1. T accepts ALAN	1. definition of T
2. If a word is not accepted by the TM it represents it is in ALAN	2. definition of ALAN
3. code(T) is not in ALAN	3. hypothesis
4. code(T) is not accepted by T	4. from 1 and 3
5. code(T) is in ALAN	5. from 2 and 4
6. contradiction	6. from 3 and 5
7. code(T) is in ALAN	7. rejection of hypothesis

The contradictory results force us to reject our original hypothesis, that ALAN is r.e. Whence ALAN is not r.e., and no TM exists that accepts exactly those strings in ALAN.

Now we are prepared to suppose that there does exist some TM, say HPA (halting problem answerer), that takes as input the

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encoding for some other TM, say T (not necessarily the same T as from the previous argument), and input to T, say w. Let us define HPA to reach its halt state if w halts on T, else HPA crashes.

Now that we have HPA, we modify it to obtain a new TM, say NASTY, as follows: First change the halt state of HPA to an infinite loop. Next change all crashes of HPA to successful HALTs. The input to NASTY will be a single TM encoding. So now, in essence, NASTY runs the encoding of T on T itself and loops if T accepts its own encoding and halts if T does not accept its own encoding.

Note that NASTY accepts exactly those strings that are a member of ALAN. But because ALAN is not recursively enumerable, there cannot exist a TM that accepts exactly the language ALAN. Thus we have a contradiction. This forces our hypothesis, that HPA exists to be false. Therefore we have demonstrated the unsolvability of the Halting Problem.

LINKING THE THEOREMS

Both of the two aforementioned theorems are extremely important in that they assert truths concerning the foundations of mathematics and computer science. So now that we have acquainted ourselves with the nature of the theorems, let us continue by exploring links and key themes common to the two theorems (as promised in the title of the paper), first in the similarities in the proofs.

Formalization and Numbering

The first fundamental step in each proof is to formalize the context of the proof. For Godel this means first working in *Principia Mathematica*, a highly formalized system developed by Russell and Whitehead. Although Godel later generalizes to any sufficiently strong system, the system must be definable in a formal, typographical manner.

Similarly, when Turing first started his work on the halting problem, he had to set up a context in which to work. For Turing this meant developing Turing Machine Theory. Other sufficient, formal computational models have been developed such as Post Machines and Minsky Machines, but have since been demonstrated to have equivalent computational power as TMs.

The next crucial step is to develop a numbering or encoding system. Virtually any encoding scheme will work, so the details as to how to develop a scheme are omitted here. For encoding examples, consult Hofstadter (267-269), or a Theory of Computation Text such as Brookshear (176-177) or Cohen (721-726).

Self-Reference and Epimenides Paradox

Probably the most crucial aspect to both theorems is the method of self-referential contradiction. This is done rather easily in spoken language, with such statements as "This sentence is false," or "I am lying." But the pearl of Gödel's argument is his ability to "get arithmetic to talk about arithmetic"! (Hofstadter, 17-19). The details as to how this is done is beyond the scope of this paper, which is why we did not specify earlier in arithmetical terms exactly what G is. Then, not only is G self-referencing, but also contradictory in the spirit of Epimenides.

Similarly, once we are able to supply as input to a TM an image of itself, we have a self-referential mechanism for TMs. Then again we can use this self-reference in a manner to arrive at an Epimenides-style contradiction. Note that for the proof provided here of the Halting Theorem, the Epimenides Paradox rears its head in showing that ALAN is not r.e., ALAN being a language that bears self-referential properties.

Recursive vs. Recursively Enumerable

Recall that for a set of strings (in either a formal system or a language) to be r.e. means that the strings can be generated according to typographical rules or some grammar. The stronger condition of *recursive* means that not only is the set of strings r.e., but so is its complement. For a classic example of a r.e. language that is not recursive, consider the complement of ALAN.

Recall that ALAN is a classic example of a language that is not r.e. Therefore strings in the language cannot be captured precisely by a phrase-structure grammar. However, the complement of ALAN is r.e. Similarly for formal systems, just as with formal languages, "there exist . . . systems whose negative space (set of nontheorems) is not the positive space (set of theorems) of any formal system." (Hofstadter, 72) Consider the following pictorial representation (Fig. 1) of this scenario, taken from Hofstadter (71).

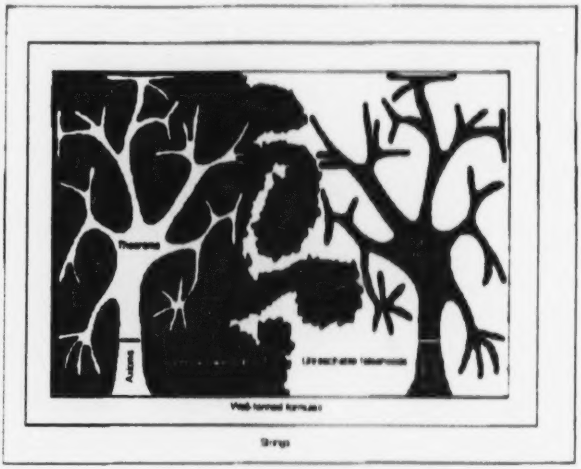

Figure 1

In terms of the figure, Godel's string G is contained in the 'unreachable truths' region. (Assuming TNT, or other sufficiently strong system, is consistent.)

CONCLUDING REMARKS

In this paper, I have explored in detail two foundational results to Mathematics and Computer Science. I have shown how many techniques, such as self-referential paradox, are used to arrive at both results. So, in essence, I have looked at one way to "Link the Foundations of Mathematics and Computer Science."

REFERENCES

Brookshear, J. Glenn. Theory Of Computation: Formal Languages, Automata, and Complexity. Redwood City, California: The Benjamin/ Cummings Publishing Company, Inc., 1989.

Casti, John L. Searching For Certainty: What Scientists Can Know About the Future. New York: William Morrow and Company, Inc., 1990.

Cohen, Daniel I. A. Introduction To Computer Theory. New York: John Wiley & Sons, Inc., 1991.

Godel, Kurt. On Formally Undecidable Propositions Of Principia Mathematica And Related Systems. Trans. B. Meltzer. New York: Basic Books, 1962.

Hofstadter, Douglas R. Godel, Escher, Bach: an Eternal Golden Braid. New York: Vintage Books, 1979.

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Java Security

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INTRODUCTION

In May of 1995 Sun Microsystems announced their new product, the Java language. This new language became very popular and widely used within a couple of years. The major reason for such high popularity was because the Java language enabled programmers to create real-time interactive programs that could be downloaded and executed on any computer regardless of the operating system. At the same time, the introduction of the Java language raised a lot of concerns about the security and safety of the network. This article will try to analyze and explain security problems associated with the Java language.

JAVA LANGUAGE

With the Java language it became possible to write programs that could be downloaded over the network as an already compiled code, and then executed on any computer that has a Java platform. Usually the programmers refer to the Java programs that have the above property as applets. First, let look at how the Java designers were able to achieve compatibility. In order to create a program a programmer usually has to do two things: first, write a program code, and second, compile it. The second stage will create a code that is usually understandable only for the machine that compiled the program. It is obvious that a program compiled on one machine usually won't run on another machine because of the differences in their architectures. The applet compatibility is achieved because of the so-called "Java Virtual Machine". After an applet is written in Java language, it is compiled to create a so-called bytecode, which is a sequence of eight-bit codes that can be executed only by the "Java Virtual Machine"(Yellin, 1996). So, in order for an applet to become an animation or real-time interactive program it has to go through a number of steps. First, a programmer should write a Java program. Then the program should be compiled and referenced in the HTML file. So, when the HTML file is accessed from the network, a compiled Java program will be downloaded on the computer along with it.

This obviously opens a lot of threats to the computer that downloads the applet. Usually an applet is downloaded behind the firewall (if there is one) and therefore it has the same permissions as any other regular process on that computer. Also, since an applet is downloaded as an already compiled program, it is impossible to predict what it will to do. It is obvious that such a policy is unsuitable or even dangerous for the networking, and that is why Java language needs special security restrictions on the action an applet can perform. The Java language designers included four security levels that make the language safer.

JAVA SECURITY LEVELS

The Java language has four distinguishing security levels. Those security restrictions help to stop applets from possible hostile actions, and limit the range of action that an applet can perform.

The first level of security is the Java language itself. The Java language was built on the C programming language base and as a result those two languages have a lot of things in common. However, the Java language is a well defined language. All of its primitive data type are of a specific size, and all of the operations in the Java language are performed in a specific order. In contrast to C, the Java language does not allow programmers to use pointers, forbidding straight references to the main memory. There are no pointers or any pointer arithmetic in the Java language. All the memory deallocation and allocation are done automatically by the Java language interpreter. The Java language has an automatic garbage collector that runs as a low priority thread. Also the Java interpreter and Java compiler source codes are available for inspection, so that they can be analyzed and verified (Frequently Asked Questions – Applet Security, 1997).

The second level of security is a bytecode verifier, that checks if the downloaded applet was created by a trustworthy compiler. This verification is performed during the Java runtime and is totally independent of the Java compiler. During this stage an applet downloaded from the net is checked to see if it obeys the Java language control rules. There is a small theorem prover inside the Bytecode Verifier that insures that the downloaded code:

- doesn't forge pointers
- doesn't violate access restrictions
- doesn't access objects improperly
- doesn't call methods with inappropriate arguments
- doesn't have stack overflow
- doesn't have illegal data conversions (Yellin, 1996).

The third level of the Java Security is a Class Loader, that defines a way of loading of the applets classes into the system. The Class Loader makes sure that each of the loaded classes works only within its own private namespace, and does not violate other classes' namespace limits. The Class Loader distinguishes between local Java defined classes and new downloaded classes and loads them into separate namespaces even if they have the same names. The class loading is also executed in a Java runtime and is used to ensure correct references to classes by determining whether a class is downloaded or Java local.

The last level of the Java security is a so-called access control list (ACL) which takes care of the file protection and the network access. In general applets downloaded over the network are not allowed to do any of the following things: read or write into the computer's file system, get system information, connect over the network to the other computers, execute native calls, and communicate with the other applet. On the other hand, applets loaded from the local drive, are permitted to do all of those things. However, all these properties can be modified by a user.

JAVA LANGUAGE SECURITY PROBLEMS

Despite Sun Microsystems's attempt to build a reliable security for the Java language, a number of bugs, design flaws, or other security breaches were found in the structure of the language. Most of the problems that were found were related to the improper implementation of the security policies, or simple design flaws, such as inadequate restrictions on the amount of the computer resources an applet can use. A careful examination performed by Princeton researchers shows a possible way to bypass security restrictions creating a class loader. A DNS bug that allows an applet to connect anywhere on the net it wants was also found. It violates one of the Java security policies which says that an applet can connect only to the computer from which it was downloaded (Drew, Felten, and Wallach, 1997).

Another type of security problem that Java has to deal with is a so-called Denial-of-Service attack. By definition, a Denial-of-Service is consuming computer resources with an intention of making them unavailable to others. Recently a Java source code of the hostile applets that perform Denial-of-Service attacks appeared on the net. Generally, those hostile applets are small and compact Java programs that consume CPU cycles and allocate memory until there is none left. As a result of such hostile actions, the user usually has to either quit browser or reboot the computer (LaDue,1996). There are couple of twists that make hostile applets even more dangerous. First, applets can wait a specified amount of time before starting to waste computer resources, which make it very difficult to trace applets' source. Second, instead of consuming all the computer resources, applets can cause degradation of service, meaning significantly slowing down performance of the browser without terminating its activity (Drew, Felten, and Wallch, 1997). Third, it is possible instead of wasting resources in a malicious way, simply to use them. In other words, since an applet has freedom to use as much computer as it wants, someone may use those computer resources for his/her own purposes (such as complex calculations that are performed on a victim's machine and reported back to the attacker's computer). Despite all that, Sun Microsystems considers Denial-of-Service attack a low priority problem.

DENIAL-OF-SERVICE ATTACKS

It was decided to research Denial-of-Service attacks more deeply and try to find how are they implemented in Java. First, hostile applets written by Mark LaDue were analyzed, in order to get a better understanding of how Denial-of-Service attacks work. It was found that usually hostile applets have a couple of similar characteristics. First, the actual hostile action is usually performed in a threads, and to make the thing work even faster, a hostile applet can run several thread that will consume resources or do other malicious actions. Second, Java stop() method should kill an applet and all its thread after leaving the homepage, but it is usually overwritten so an applet performs its action long after the user visited attacker's homepage. Third, usually an applet sleeps a specified amount of time before kicking in, so it is hard to trace where the applet came from. Fourth, hostile applets can catch OutofMemoryError, InterruptedException, ThreadDeath, or any other Java defined exceptions that are supposed to confront such malicious behavior, and handle them in their own way (LaDue, 1997).

So the structure of a hostile applet is rather simple. A hostile applet that executes denial of service attacks can consist only of three or four methods (Figure 1). First method is a init() method that will initialize all the variables. The second is a stop() method that actually does nothing but overwrite a Java default method that stops applet's actions after the user has left a homepage where an applet resided. The third method is the one that consists of hostile action. It, for example, can have an infinite loop that will repeatedly create threads that perform useless calculations, for example, the calculation of the factorial or Fibonacci number, or any other actions that waste computer resources. The part of the program that performs hostile actions is wrapped in a try{ <actions>} catch(<exception>) {<actions>} structure that will do "necessary" actions if a Java exception will be thrown. Certainly, this is only the sketch of possible Java based Denial-of-Service attack, and someone with a good imagination can find thousands of better ways to perform this type of attack. However, even such a simple program proved to be rather dangerous and very effective.

```
public class HostileApplet extends Applet implements Runnable{
        // define all the global variables
        ...
 public void init(){
        //initialize all the global variables and define local variables
        ...
        //call the resources consuming method
        ConsumeResources();
 }

 public void stop{
        //do nothing
 }

 public void ConsumeResources(){
    try{
    //do wasteful calculations
    ...
    }catch(...) //catch possible exception or an error that might occur
       {
       //perform actions that will take care of the exception or an error that
occured
       ...
       }//end of catch
  }//end of ConsumeResources()
}//end of an Applet
```

Figure 1: General Structure of a Hostile Applet.

Obviously, all of the troubles occurred because of the failure of the Java language to enforce a certain policy that would prohibit or at least restrict the overwriting of the stop() method or handling of vital exceptions by an applet. However, in all of the cases the target of a hostile applet that performs Denial-of-Service attack are computer resources. So the best way to fight the Denial-of-Service attack is by restricting the amount of computer resources that an applet can use. Certainly, every process requires a certain amount of computer resources, but it is impossible to predict before execution how much of a memory or CPU time a program will need. Therefore, instead of explicitly specifying the amount of the computer resources an applet can use, it would be a better idea to monitor the applets' activity. So, whenever an applet is on the edge of exhausting the computer resources, a user will have the possibility either to kill an applet or perform other actions that will prevent the system or browser from crashing. Currently, the ways of creating a program that will monitor the applet's activity and will prohibit wasteful use of computer resources are being investigated.

CONCLUSION

The Java language opened a range of new possibilities to improve the World Wide Web, but on the other hand it also created a variety of security problems. Although the Java language was designed to be safe in a network/distributed environment and allow users to run real-time applications, a number of flaws were found in its security design. This paper discusses the major security levels of the Java language and different types of security problems that were discovered, particularly the Denial-of-Service attacks. The Java language designers did a great job trying to make the language secure, but apparently it is not enough, and there is plenty of room for improvement.

REFERENCES

CERT(sm) Advisory CA-96.07 "Weakness in java Bytecode Verifier," ftp://info.cert.org/pub/cert_advisories/CA-6.07.java_bytecode_verifier(15 December 1997).

Dean, Drew, Edward W. Felten, and Dan S. Wallach, "Java Security: From HotJava to Netscape and Beyond," Secure Internet Programming:Publications, http://www.cs.princeton.edu/sip/pub/secure96.html (10 March 1997).

Deitel H.M., and P.J. Deitel, Java How to Program, Prentice Hall, 1997.

"Frequently Asked Questions – Applet Security," Frequently Asked Questions –Applet Security, http://www.javasoft.com/sfaq (3 March 1997).

Java Developers Reference, Sam.net Publishing 1996.

LaDue Mark "A collection of Increasingly Hostile Applets," Hostile Applets, http://www.math.gatech.edu/~maladue/HostileApplets.html (15 December 1996).

LaDue Mark "Hostile Applets on the Horison," Hostile Applets on the Horizon, http://www.math.gatech.edu/~maladue/HostileArticle.html (21 January 1997).

Tanenbaum Andrew S., Modern Operating Systems, Prentice Hall, 1992.

Williams, Eric "Java Applet Security: Sockets," Java Applet Security Issue, http://www.sky.net/%7Ewilliams/java/javasec.html (18 December 1996)

Yellin Frank, "Low Level Security in Java," Low Level Security in Java, http://www.javasoft.com/sfaq/verifier.html (20 December 1996).

DARWIN: Software to Identify Dolphins in Digital Images

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ABSTRACT

Groups of marine mammalogists in the Tampa Bay area use photo-identification to gather data about *Tursiops truncatus*, the common bottlenose dolphin. Hundreds of photographs are taken each year and manually identified by the comparison of the characteristic nicks, notches, and scars of the fins with those in previously identified photographs. A computer vision system is being developed which will match new fins with previously identified dolphins and organize the images in rank order based on the similarity of the new fin to the database fins. This Digital Analysis to Recognize Whale Images on a Network (DARWIN) software will eliminate the need for the tedious process of manual photo-identification. Previous work resulted in the creation of image processing routines that produce, with minimal user interaction, a list of 220 points that approximate the fin outline. In May of 1996, DARWIN was moderately successful at identifying dolphins by matching one dimensional mathematical representations of the fins known as centroid signatures. Analysis of matching results identified two major factors which degraded the quality of the match: displacement of the centroid due to variations in the user designation of the beginning and end of each fin outline, and distortion of the fshape caused by out-of-plane rotations of the fins. The focus of current research is to improve the accuracy of the matching system. A preprocessing step, which allows the user to modify the fin shape and orientation to compensate for in and out-of-plane rotation of the dorsal fin, has been added. A method has also been devised to correct the centroid during the matching process in a way that minimizes error by comparing the signed differences in the two signatures and estimating the shift necessary to bring the two fin outlines into closer correspondence. The software has been tested by using the preprocessing module to create a set of corrected outlines which are then used as inputs to the improved signature matching routine. These revisions produced a significant improvement in DARWIN's performance.

BACKGROUND

During the last three years, there has been an ongoing joint project in Eckerd College's computer and marine science departments, a study of *Tursiops truncatus*, the common bottlenose dolphin. The marine science students study association patterns, local population sizes, preferred habitats, behavioral tendencies, and other characteristics of the dolphins. To gather the data they need, the researchers use a system of photo-identification. They yearly take hundreds of photographs of the dorsal fins of Tampa Bay area dolphins and visually identify them by comparing the new photographs with previously identified ones. The researchers examine the characteristic nicks, notches, and scars of the fins to identify individual dolphins. Unfortunately, photo-identification is a very time consuming process. Photo-identification is also subject to human error. After many hours of tedious and repetitive photo-identification, researchers may become tired or bored, increasing the risk of misjudgments.

A group of Eckerd's computer science researchers have been working on computer applications that will automatically identify the dolphins from digitized images of their fins. This software will minimize the need for the tedious process of manual photo-identification. UNIX/X Windows and IBM PC/Microsoft Windows applications are being developed to provide networked access to a central database of dolphin images and related observational data. Current development is focused on the creation of computer vision systems that will match new fins with previously identified dolphins and organize the images in rank order based on the similarity of the new fin to the database fins. Previous work on both versions

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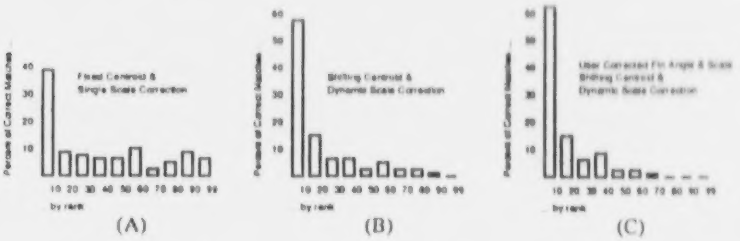
of DARWIN resulted in the creation of image processing routines that produce, with minimal user interaction, a list of 220 points that approximate the fin outline. These point lists are known as snakes because they are fit accurately to the fin boundary through an iterative process that makes them appear to slither (Kass, Witkin, and Terzopoulos 321). The X Windows version utilizes a number of image processing routines from the Vista software library (Pope and Lowe). In May, 1996, Mark Allen of Eckerd College finished matching process for the PC version of DARWIN that compares the overall shapes of dolphin fins by matching one dimensional mathematical representations of the fins known as signatures (Allen). A signature is a measure of the distance from the fin centroid to its outline as a function of angle, and is sampled for each degree in the range of 0 to 359. Allen's signature matching routine was tested on a set of one hundred dolphin fin images from forty-five dolphins found in Sarasota Bay. As shown in figure 1(A), for each of the one hundred dolphins, the other images that correctly matched it were listed in its top ten only forty percent of the time. The goal of current research is to improve the accuracy of DARWIN's matching system.



(A) (B) (C)

Figure 1: Signature Matching Performance by Rank Order of Correct Matches

RECENT DEVELOPMENTS

The first approach taken was an attempt to create an entirely new matching system that would focus on the nicks, bumps, and notches that humans use to identify the individual dolphins. A set of routines that creates a filled polygon from the snake points was implemented. Several of the routines used were adapted from Graphics Gems (Glassner). An implementation of the classical thinning algorithm, which was intended to produce the medial axis of the fin and a set of branches that point to each bump and notch on the fin boundary, was added to the DARWIN system (Pavlidis 200). Unfortunately, the thinning algorithm produced only a medial axis, a line from the tip to the base of the dorsal fin. The medial axis alone provided insufficient detail to uniquely characterize the fin shape, so this approach to improving DARWIN's matching results was terminated.

The focus of current research has been to find ways to improve upon Allen's centroid signature matching process. Allen's results are based on a matching process which compares scaled signatures. Each signature is scaled only once so that its mean value is 100 units. For two signatures, the error at a given angle is the difference in the corresponding distance measures. The quality of a match is defined as the mean squared error between the two signatures, considering only the range of angles across which both signatures are defined. Since rotating a signature simply shifts the distance values along the angular axis, the best match between two fins occurs at a relative rotation which minimizes this mean squared error. Figure 1(A) shows Allen's results on 100 fin images.

Analysis of matching results identified three major factors which degraded the quality of the match: movement of the centroid because of variations in the user designation of the beginning and end of each fin outline, sensitivity of signature scaling to these same terminal points, and the affects of out-of-plane rotations on fin shape.

A method has been devised by the faculty advisor to correct the centroid during the matching process, in a way that minimizes the mean squared error. The signed differences in the two signatures are compared and an estimate is made of the shift necessary to bring the two fin outlines into closer correspondence. Specifically, the signed differences between the two signatures is computed at corresponding angles in a twenty degree arc left and right of the centroids. The differences on the left are subtracted from those on the right of the centroid and an average is computed. This value gives an accurate estimate of how far to the left or right one centroid should be moved to improve the match.

$$Hshift=\frac{\sum_{a=170}^{190}((sig1(a)-sig2(a))-(sig1(a+180)-sig2(a+180)))}{21} \qquad (1)$$

A similar estimate is made for the amount of vertical shift. However, the base of the fin is open, so the signature is undefined there. The vertical estimate is made simply by averaging the signed differences between the two signatures at each angle in the upper hemisphere (0 to 180 degrees).

$$Vshift=\frac{\sum_{a=0}^{180}(sig1(a)-sig2(a))}{181} \qquad (2)$$

These shifts are only estimates, but work very well in an iterative process which brings the signatures into closer correspondence.

The scaling problem is minimized by scaling the signature based only on the region of signature overlap. This minimizes the differences due to signature values at the extreme ends of the fin outlines, areas where the two signatures rarely overlap, and where the signature values tend to be at a maximum. This matching process produced significantly improved results over the previous one. See Figure 1(B). Its greatest shortcoming is its exhaustive nature. Improvements to the algorithm efficiency are being developed.

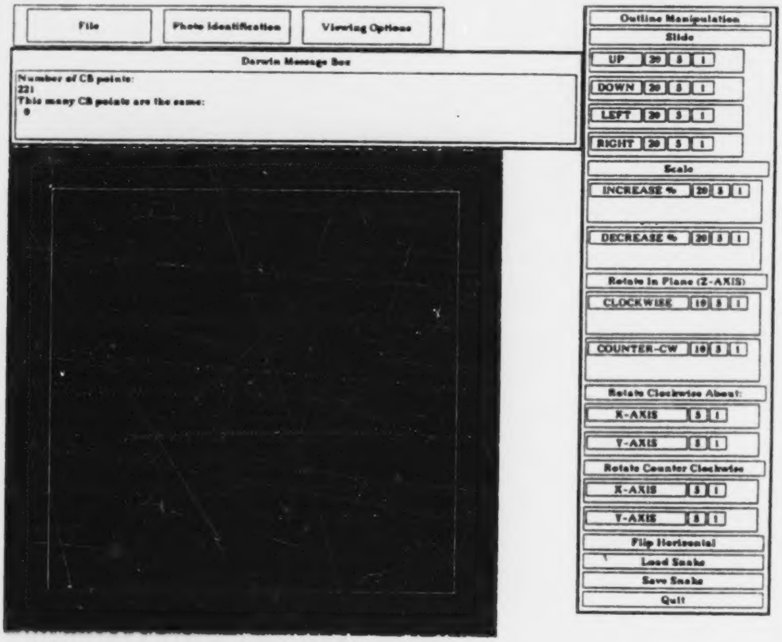
An ideal dorsal fin photograph is one taken with the fin perpendicular to the camera, and dolphin level at the water's surface. Unfortunately, the images taken by researchers are rarely ideal. When dolphins are photographed before they have quite surfaced, or after they have begun diving, the fin is rotated in the image plane. Dolphins are often swimming toward or away from the boat as they are photographed. Additionally, the dolphin may be rolled on its side or the photographer may be at high elevation relative to the dolphin. The foreshortening effects of perspective cause distortions of the dolphin fins and the snakes that are fit to their outlines. Distortion of the snakes produces dramatic changes in the signatures which represent the fins during the matching process.

A solution to this problem was implemented by the author in the X Windows version of DARWIN as a preprocessing step which allows the user to manipulate snakes in three dimensions, thereby correcting each of the rotational effects. The user loads a previously created snake from text-file storage, manipulates it, and saves the improved version. The user has the options of sliding, scaling, and rotating the snake so it more closely resembles one which would have been created from an ideal photograph.

To prevent shape degradation, a working snake array of floating point numbers is created. After each manipulation, the array is converted to integers for display purposes, but the next manipulation is always applied to the floating point array. This minimizes the rounding error, thereby allowing snakes to be loaded, manipulated, and saved with virtually no shape degradation. As the user applies incremental rotations using mouse selectable buttons, a sum of the rotations about the x and y axes are kept. X is the horizontal axis, y is the vertical axis, and the z axis points into the screen. After each rotation, a projection plane is rotated about the x and y axes based on the current sums. The original snake points are projected back from the image plane into the projection plane, which is the best estimate of the three dimensional plane that contained the fin when it was photographed. This projection plane is then rotated parallel to the image plane so that the user sees the fin as it would have appeared if the original photograph had been ideal. In-the-plane rotation corrections are applied immediately to the floating point array.

In the snake manipulation interface, shown in Figure 2, the user is provided with a large square that is used as a guide for resizing and repositioning the fin. The user scales the snake so that it nearly fills the box, and applies rotations until satisfied. The improved snake can be saved to a file.

These preprocessing routines were used to produce an improved set of Allen's original one hundred snakes. The original photographs were displayed simultaneously with the snake, so that the in and out-of-plane rotations could be accurately hypothesized. After the manipulation process was complete, the set of one hundred corrected snakes was fed through the improved signature matching routine. As indicated in figure 1(C), the user correction of angle and scale further improved the results of the matching process. It is especially important to note that seventy-seven percent of the correct matches were ranked in the top twenty. This means that the researcher will only have to search through one fifth of database to find the correct match for the fin in a new photograph every three out of four matches.


File
Photo Identification
Viewing Options
Darwin Message Box
Outline Manipulation
Slide
UP 20 5 1
DOWN 20 5 1
LEFT 20 5 1
RIGHT 20 5 1
Scale
INCREASE % 20 5 1
DECREASE % 20 5 1
Rotate in Plane (Z-AXIS)
CLOCKWISE 10 5 1
COUNTER-CW 10 5 1
Rotate Clockwise About:
X-AXIS 5 1
Y-AXIS 5 1
Rotate Counter Clockwise
X-AXIS 5 1
Y-AXIS 5 1
Flip Horizontal
Load Snake
Save Snake
Quit

Number of CB points:
221
This many CB points are the same:
0

Figure 2: Xdarwin Snake Manipulation Interface

CONCLUSION

The centroid signature matching scheme of DARWIN was greatly improved. The X Windows version of DARWIN was ported to an IBM PC with the Linux operating system. This will allow a greater number of users to access the software, and enhances its portability. In the near future, DARWIN will be made available to Eckerd College's dolphin photo-identification researchers for testing. This application of computer vision will help alleviate the problems of manual-photo-identification.

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REFERENCES

Allen, Mark. "The Development of DARWIN". Senior Thesis. Eckerd College, 1996.

Glassner, Andrew, ed. Graphic Gems. Boston: Academic Press, 1990.

Kass, Michael, Andrew Witkin, and Demetri Terzopoulos. "Snakes: Active Contour Models." International Journal of Computer Vision (1988): 321-331.

Pavlidis, Theo. Algorithms for Graphics and Image Processing. Rockville, MD: Computer Science Press, Inc., 1982.

Pope, Arthur R. and David G. Lowe. "Vista: A Software Environment for Computer Vision Research." Department of Computer Science, University of British Columbia. Internet. 1994. Available: ftp.cs.ubc.ca. /pub/local/vista.

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Wavelength Division Multiplexing Coupler Based on Talbot Self-Imaging in Planar Optical Waveguides

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INTRODUCTION

In the last century, scientists have theorized about the different possibilities and advantages in creating communications networks and devices (Willner, 1997); however, these theories often remained dormant until advances in technology allowed for their design and fabrication. This problem exists with the efficient use of the tremendous bandwidth available in fiber optic communications. Communication developments, such as the internet and video teleconferencing, have increased the demand placed on the current fiber optic network (Blumenthal, Shell, and Vaughn, 1997). As a result, the technical community is seeking an efficient device to transmit multiple wavelength information channels on a single fiber optic line.

Due to their low attenuation and excellent data transmission, the world currently uses the wavelengths of 1.31 μm and 1.55 μm to transmit data through fiber optic cables (Keiser, 1983). However, Figure 1 shows that 1.55 μm receives about half as many attenuation losses as 1.31 μm. Why use 1.31 μm? Originally, 1.31 μm demonstrated lower dispersion losses than 1.55 μm making it a better device for most types of transmission (Keiser, 1983). However, advances in fiber technology reduced the dispersion losses that 1.55 μm experienced, thus making it the best wavelength for data transmission. In order to utilize the current fiber optic cables originally setup for 1.31 μm transmission, the technical community developed fused fiber coupler (FFC) which multiplexed and demultiplexed these two wavelengths. However, FFCs do not accommodate the increasing demands placed on the current fiber system.

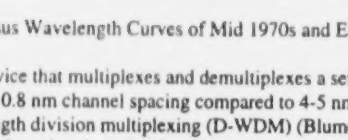


Figure 1: Attenuation versus Wavelength Curves of Mid 1970s and Early 1980s (Keiser, 1983)

Now consider a device that multiplexes and demultiplexes a set of closely spaced wavelength channels (e.g., 0.8 nm channel spacing compared to 4-5 nm channel spacing). This is known as dense-wavelength division multiplexing (D-WDM) (Blumenthal, Shell, and Vaughn, 1997). Such a device must have low insertion loss, low crosstalk, and be easily mass produced (Keiser, 1983). The novel device presented in this paper demultiplexes the communication wavelengths of 1.31 μm and 1.55 μm using the Talbot theory of self-imaging.

The following paper presents the theory and background of a novel WDM device, as well as preliminary experimental data from the first fabrication run. The conclusion will assess the potential product with regard to its performance requirements and its viability in the communications industry.

THEORY

Talbot Effect in Waveguides

The design of a wavelength division multiplexer (WDM) is based on the concepts involved in the Talbot effect. The Talbot effect in an optical waveguide is a process of self-imaging along the lateral direction of a Multi-Mode Interference Region (MMI Region) (Soldano and Pennings, 1995). Figure 2 shows a perspective view of a self-imaging waveguide device.

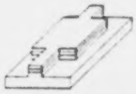


Figure 2: Perspective View of a One-to-One Self-Imaging Waveguide Device

Light entering the input rib decomposes into many lateral modes which propagate through the MMI region at different velocities. As the modes propagate through the MMI region, they will accumulate a phase difference. The modes will constructively interfere and reproduce the image when they accumulate a phase difference of 2π--a process known as self-imaging. The distance required to self-image at a certain wavelength is the self-imaging length. Figure 3 shows a numerical simulation of the self-imaging process.

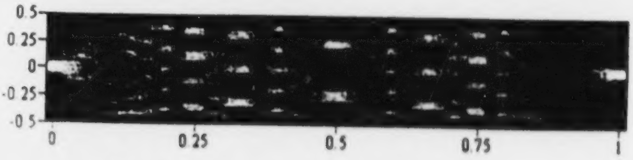


Figure 3: Numerical Model of the One-to-One Self-Imaging Process

Device Design

Producing a device which spatially separates two wavelengths requires offset and separated outputs, as shown in Figure 4a. The formation of a single self-image will form an image positioned diagonally from the offset input. This image is referred to as a "mirrored" image. The formation of two self-images produces an image directly across from the input as seen in Figure 4b. This image is referred to as a "direct" image. Figures 5a and 5b show the corresponding numerical models of the "mirrored" and "direct" images.

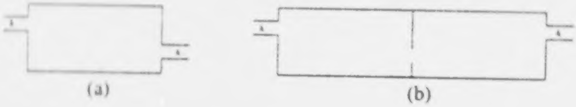
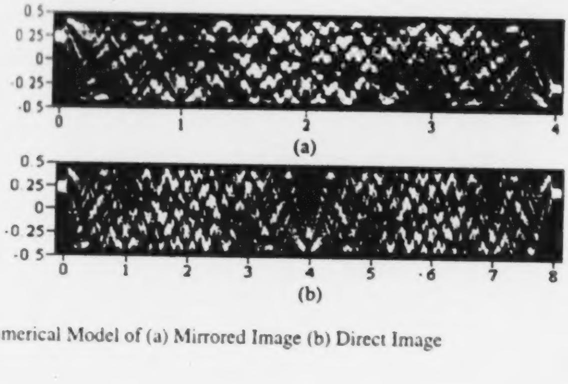

(a) (b)

Figure 4: (a) Mirrored Image (b) Direct Image



(a)

(b)

Figure 5: Numerical Model of (a) Mirrored Image (b) Direct Image

For the device to work, it required a common MMI length for both wavelengths. Mathematically manipulating the equations caused 1.31 µm to form an odd number of self-images (mirrored images); while 1.55 µm formed an even number of self-images (direct images). Several factors affected this modeling process; these include the MMI width, MMI length for each wavelength, and the effective index for each wavelength. In the model, a small difference between the effective width (Goos Haenchen effect) and the actual width exists. This is due to the large difference in the indices of refraction between our materials ($GaAs$ and $Al_{0.3}Ga_{0.7}As$) and air. Figure 6 shows the effective width and the actual width as part of the waveguide structure.

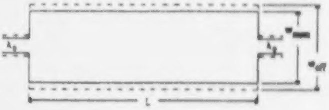


Figure 6: Waveguide Structure with Actual and Effective Widths

The different cases used the specified MMI region widths of 10 µm, 16 µm, or 20 µm and used the effective index method to determine the waveguide's transverse index of refraction at $\lambda_o = 1.55\mu m$ ($n_{mmi,1.55} = 3.3282$) and at $\lambda_o = 1.31\mu m$ ($n_{mmi,1.31} = 3.3590$). In order to obtain the MMI length at 1.31 µm, the following equation is used:

$$L_{1.31} = \frac{4n_{mmi,1.31}W_{mmi}^2}{\lambda_o}(2p-1), \tag{1}$$

where $L_{1.31}$ is the (2p-1)th self-imaging length at λ_o equal to 1.31 µm, and W_{mmi} is the width of the MMI region. For the wavelength of 1.55 µm, the following equation is used:

$$L_{1.55} = \frac{4n_{mmi,1.55}W_{mmi}^2}{\lambda_o}(2q), \tag{2}$$

where $L_{1.55}$ is the (2q)th self-imaging length at λ_o equal to 1.55 µm. To obtain the general equation for the MMI length from the equation determining the beat length of the region:

$$L_\pi = \frac{\pi}{\beta_0 - \beta_1} \cong \frac{4n_{mmi}W_{mmi}^2}{3\lambda_o}, \tag{3}$$

where β_o is the propagation constant at mode 0, β_1 is the propagation constant at mode 1, and L_π is the beat length (Soldano and Pennings, 1995). Three beat lengths equal one self-imaging length. After determining the MMI length for each wavelength, the most common match was found; five self-imaging lengths for 1.31 µm and six for 1.55 µm. Figure 7 provides an example of the matching process for both MMI lengths.

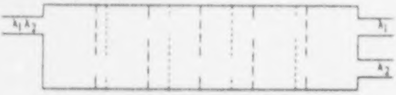


Figure 7: A Common MMI Length for the Mirrored and Direct Images

After mathematically determining the length for each wavelength, two computer programs simulated the performance of the device. These simulations examined the possible throughput efficiency (coupling efficiency), which aided in determining the optimum length for each wavelength. Table 1 provides the data used in modeling the devices. Figures 8a and 8b show the intensity profiles for 1.31 µm and 1.55 µm at the output of the MMI Region; the graphs show the crosstalk present. Of the cases modeled, Case 4 demonstrated the best throughput at 93% (0.3 dB excess loss).

Table 1: Predicted Values for 5 Case Studies

	Rib Width (μm)	MMI Width (μm)	$L_{mmi,1.31}$ (μm)	$\eta_{1.31}$ (%)	$L_{mmi,1.55}$ (um)	$\eta_{1.55}$ (%)	Δd (μm)	Average L_{mmi} (μm)
Case 1	2	10	5115	79.2	5133	70.5	18	5124
Case 2	2	16	13131	57.0	13190	59.5	60	13160
Case 3	2	20	20481	59.3	20606	46.1	125	20553
Case 4	4	16	13131	92.9	13188	93.2	57	13159
Case 5	4	20	20496	89.3	20611	83.0	115	20553

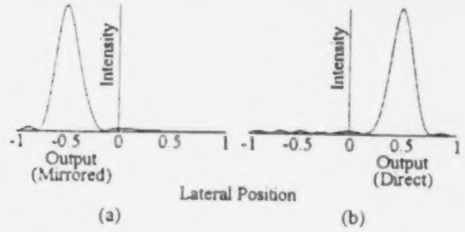


Figure 8: Intensity Profiles (a) 1.31 μm (b) 1.55 μm

After determining the dimensions, lay-out of the device structure followed. Several design configurations were used to minimize errors or loss in the system. The primary device averaged the lengths of the MMI region as shown in Figure 9a. The large depth of focus, approximately 10 μm, enables averaging the lengths. Another model staggers the outputs by using the optimum lengths of the MMI region for each wavelength. Figure 9b shows the staggered output MMI region. If the walls of the staggered output facet cutoff any modes, then additional losses may occur. The final model tapered the outputs, as shown in Figure 9c; losses may result from scattering in this model.

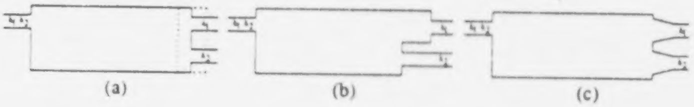


Figure 9: MMI Region with (a) Averaged (b) Staggered (c) Tapered Output Lengths

The optimization process also required consideration of the narrow MMI width. The fiber cladding is significantly larger than the lateral spacing between output ribs. Figure 10 shows the use of S-bends to separate the output rib spacing. S-bends allow for practical use of the devices by pig-tailing the ends. Variation in source wavelength also poses a potential problem. The design and fabrication of devices with varying MMI lengths aided in avoiding this problem.

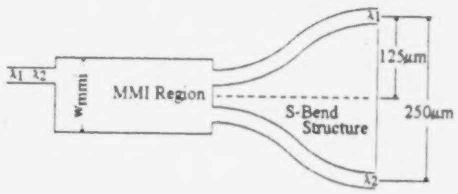


Figure 10: S-bends

Summary

The device is based on the Talbot effect in waveguide structures. The device will possess many more advantages than FFCs, such as a reduced fabrication cost due to mass production using existing integrated circuit fabrication processes. FFCs use a computer for fabrication of each individual device, making it a more costly device--approximately $300 each. In addition, a variety of device structures accounted for possible fabrication tolerances.

EXPERIMENT

The experiment began with device fabrication. The fabrication process involved molecular beam epitaxy (MBE), and magnetic-enhanced ion etching (MIE). Due to a long length of the devices and the space available on the wafer, many of the case 3 and case 5 device structures not fabricated. Of the fabricated devices, case 4, shown in Table 1, predicted the best throughput.

Time constraints only allowed for the testing of the open faceted device. Figure 11 shows and open faceted device. This device demonstrates whether the device actually works, which it did. Figures 12a and 12b show actual, experimental images and intensity levels versus the width of the MMI Region for both wavelengths. Figure 12 shows the working device; however, a lot of cross talk existed. The crosstalk may result from inaccurately positioning the device at the end of the MMI region.

Figure 11: MMI Region with Open Facet

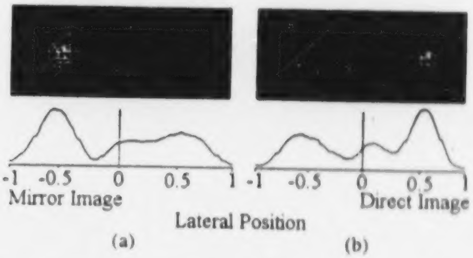


Figure 12: Output Images and Intensity versus Width Plots for (a) 1.31 μm (b) 1.55 μm

CONCLUSIONS

The need to expand the use of current fiber optic cables to meet the demands of more users on the system has led to the development of wavelength division multiplexing. The increasing need to expand and utilize more bandwidth requires a much improved solution to the current fused fiber couplers which only separate two wavelengths. One solution to this problem is to use D-WDM. The novel device presented only demultiplexes two wavelengths; however, it is a large stepping stone to the fabrication and utilization of D-WDM.

The first fabrication run resulted in a working device. Compared to the open faceted device, the remaining structures should yield positive and improved results. In addition, data obtained from the characterization of the first run devices will aid in the fabrication of improved and more efficient devices in the future.

ACKNOWLEDGMENTS

We would like to thank Dr. George F. McLane, U. S. Army Communications/Electronics Command, Fort Monmouth, NJ, for performing the Magnetic-enhanced Ion Etching (MIE).

REFERENCES

Blumenthal, Shell, and Vaughn, "Physical Limitations to Scalability of WDM All-Optical Networks," Optics & Photonics News, Feb 1997. pg. 17-22.

Keiser, Gerd, Optical Fiber Communications, 1983. pg. 6-8.

Soldano, L. and Pennings, E., "Optical Multi-Mode Interference Devices Based on Self-Imaging:
Principles and Applications," Journal of Lightwave Technology, Vol. 13, No. 14, Apr 1995. pg. 615-625.

Willner, Alan E., "Mining the Optical Bandwidth for a Terabit per Second," IEEE Spectrum, Apr 1997. pg. 32-41.

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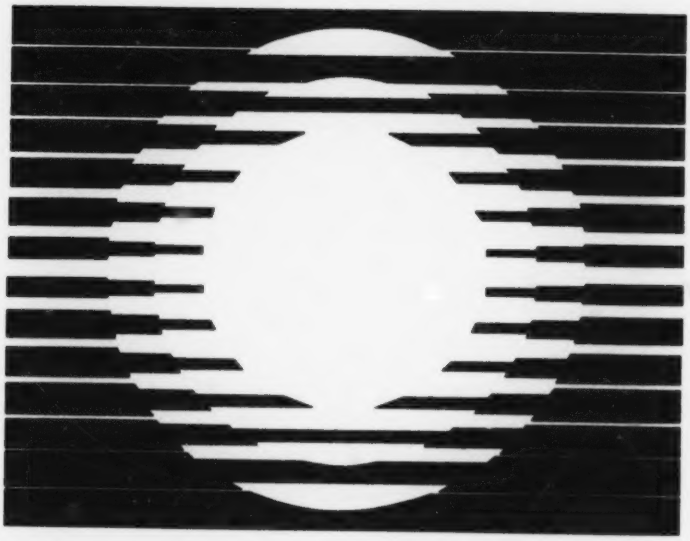

PROCEEDINGS
ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH
1997

Robert D. Yearout
Editor

Volume V

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1314

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VOLUME V

THE UNIVERSITY OF NORTH CAROLINA at ASHEVILLE
JULY, 1997

Foreword for the
Proceedings of the Eleventh National Conference on Undergraduate Research
University of North Carolina at Asheville
April 24-26, 1997

The University of Texas at Austin was pleased to host the 1997 National Conference on Undergraduate Research, affirming its commitment to excellence in undergraduate education and to the research experience in particular. Over 2100 students and faculty attended some 1500+ oral, poster and performing or visual arts presentations scheduled over April 24-26. A special feature of NCUR '97 was a series of more than 30 presentations by faculty members from all disciplines demonstrating the integration of research and teaching with the new technologies. These presentations were capped by a performance on Saturday night of "Ears and Feet," a concert of new interdisciplinary work by student and faculty composers, choreographers, dancers and performers from the UT College of Fine Arts. Electro-acoustic music and modern dance explored interactivity of disciplines and technologies by allowing dancers' movements to control electronic music and robotic lighting by way of a touch-sensitive computer dance floor.

President Robert M. Berdahl opened the conference quoting a Chinese proverb: "I hear and I forget. I see and I remember. I do and I understand." Berdahl praised the research experience as the most practical and potent method to provide students the perspective of inquiry, innovation and exploration as they prepare "for a future that is not so much known to be uncertain, but instead, certainly unknown." That facts and methodologies become obsolete in a world in which developments and advances occur with dizzying rapidity points to the importance of incorporating research activity into the undergraduate experience.

Dr. Berdahl also praised the student-faculty relationships that are fostered by the research process, congratulating the faculty mentor for serving the educational needs of the talented and motivated students by participating in the adventure of exploration and discovery, of cooperation and collaboration which characterize academic life.

Five distinguished plenary speakers addressed conference participants throughout the three days. Dr. Steven Weinberg, Nobel laureate in physics and professor at the University of Texas at Austin, challenged listeners to consider the future of science by posing the questions "The End of Science?". Dr. Robert Williams, Director of the Space Telescope Science Institute, dazzled the audience with the most recent images from the Hubble Space Telescope. From the vastness of space to the minute complexity of genetic research, Dr. Steven McKnight of the UT Southwestern Medical Center at Dallas introduced conference participants to the fascinating work being done in gene regulation and cell differentiation. Friday night's fete "Texas Culture Swing" featured, in addition to an outstanding sampler of culinary and musical styles of the Lone Star state, a mini-plenary address on the multifaceted aspect of Texas border cultures by Dr. Rolando Hinojosa-Smith, distinguished author and professor of Creative Writing. NCUR 97 closed with a resounding standing ovation upon conclusion of "The Challenge of Leadership" by Sarah Weddington, J.D., former Texas legislator and White House assistant, now author, lecturer and adjunct professor.

The University of Texas at Austin is proud of the privilege to share our campus for these few days with the distinguished group of students and faculty whose work is presented here in published form. We congratulate you for your accomplishments and encourage you to continue to participate in the challenge of research.

Susan Wells Howard, Chair, NCUR '97

PREFACE

The 407 papers published in these five volumes are representative of the approximately 1825 papers and posters presented at the celebration of undergraduate research that was NCUR '97'. The faculty, staff and students of the University of Texas at Austin are to be commended for making NCUR '97' such an enriching experience. The student authors deserve recognition for their hard work and for their persistence in seeing their research through to its final publication.

Special thanks are extended to Dr. Susan Howard, Ms. Kelly Johnson and other members of the NCUR '97' staff. Their help during the days of the Conference was invaluable. Many thanks also to the members of the National Board, who reviewed a large number of papers submitted to the Proceedings under time constraints. Their continued efforts to standardize has raised the Proceedings quality. This project would have not been successful without their assistance.

I would also like to thank the UNCA Editorial Board, who put in many long hours reviewing, checking and organizing papers, and Tracy Walker, and Adam Bradley, who did all the cutting and pasting necessary for these volumes. I owe a special debt of gratitude to Katherine Whatley, Tracy Walker and Mila Cleverdon for their support, encouragement, and mentorship during the entire process of organizing the Proceedings.

To all the students who submitted papers to the Proceedings go thanks for their participation and congratulations for their achievements. Your enthusiasm and achievement will serve as role models for the next group of student researchers - whom we look forward to meeting at the Twelfth National Conference on Undergraduate Research at Salisbury State University, Salisbury Maryland.

Robert D. Yearout
UNC at Asheville
1 July, 1997

PROCEEDINGS OF THE ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

CONTENTS

VOLUME I

FOREWORD iii

PREFACE iv

ARTS AND HUMANITIES

Collaborative Art: A Movement in the Twentieth Century 1
Kristen Jo Kerr (Jane-Allen Mckinney)

Nature and the Natural in the Paintings and Prints of Helen Frankenthaler 6
Danielle G. MacCartney (Debora Rindge)

A Comparison of Frank Lloyd Wright and Michael Graves: Furniture Influenced by Architecture 9
Nieya C. Wallace (Jane-Allen McKinney)

Art Education: Art is Underrated as an Instrument for Teaching Essential Learning and Cognition Skills 14
Jennimarie L. Ward (Jane-Allen McKinney)

Toontown: The Disney Tradition Continues 18
Jennifer Lugg (Dianne S. Macleod)

Political Ideologies of Harlaxton Gardens, Harlaxton, Lincolnshire, England 23
Nicole L. Stutzman (Shirley Schwarz)

Reminders of Death and Lessons for Life: Vanitas and Memento Mori Paintings of the Spanish Golden Age (1556-1700) 27
Wendy Singer (Susan V. Webster)

Visualizing the Human Form: Art and Anatomy in Eighteenth-Century England 31
Erin M. Loos (Philip Wilson)

The American Canon: Great Male Playwrights and Their Female Characters 34
Michelle McGovern (Mark Pizzato)

Henry Purcell's Dido and Aeneas: A 1689 Composition Endures Controversy 39
Stacy M. Dieckman (Patricia Kazarow)

Determining the Authorship of the Toccata and Fugue in D Minor, BWV 565 44
Aaron Juhl (Patricia Kazarow)

Plains Attire: The Individual Expression of Culture, the Cultural Expression of Identity 48
Sherri A. Mainord (Anne Guernsey Allen)

Victim vs. Participant: A Comparison of Dmitri Shostakovich's Lady MacBeth of Mtsensk and Katerina Ismailova 53
Heather Miller (Charles McKnight)

New Possibilities in Composition Through Computer Technology 56
Christopher Watts (Daniel Koppelman)

The Conception of "Poet" in the Work of Bei Dao 61
Jennifer L. Berry (Martin Backstrom)

BEST COPY AVAILABLE

1319

Bei Dao's Poet 66
Jennifer L. Berry (Martin Backstrom)

"There Is No Loneliness Like Theirs": James Wright's "A Blessing" and C.K. Williams' "On Learning of a Friend's Illness" Examined 71
Kirsten C. Bender (William Aarnes)

Embrace of Dionysus The Presence of African Art In D.H. Lawrence's Women in Love 76
Kristin A. Frey (Eric Chandler)

A Poststructural Analysis of Richard Wright's "Big Black Good Man" 80
James S. Guignard Jr. (Jill Sessoms)

William Shakespeare's Othello: The Moor of Venice A Case Study in the Thermodynamics of Evil 85
Roger A. Harris (Linda K. Barlow)

Wilde's Christ: Exemplifying Aesthetic Morality 89
Elizabeth M. Hendershot (Daniel Born)

Pearl's Scarlet Soul: The Influence of Spenser's Una on Hawthorne's Ideal Vision of Daughters 93
Tracy Ann Kennedy (John C. Bean)

Agrarianism in the American South: From the Vanderbilt Agrarians to Wendell Berry, A Shift from Regional Myth to Practicable Ideal 98
Robin Kidd (John Cawelti and David Hamilton)

Margaret Fuller's Women in the Nineteenth Century: An Appeal for the Inclusive Self 103
Jeanne Kolker (Sara McAplin)

The Paradox of the Crucifixion Allegory in Ben Franklin's "The Kite Experiment" 107
Sandra Argroves Watson (Steven L. Hamelman)

The Doorway to Wildness: Four Poems by Muriel Rukeyser and Adrienne Rich 112
Trace V. Wilson (Richard Chess, Michael Gillum, and Jeff Rackham)

The Relationship Between Cognitive Growth, Journal Writing, and the Development of Critical Thinking 117
Lynn Herink and Anna Long (Larry Nichols)

Images of Health in Health Magazines 122
Travis Behout (Sarina Chen)

Blissfully Rude: The Diatribe of ACT-UP 127
Mark S. Buchanan (Suzanne E. Lindsey)

Eyewitness vs. Pseudo Reality: A Comparative Analysis of Student's Accounts and the Media Reports of a University Disturbance 132
Ben L. Daniels (Sarina Chen)

Light in the Crevice Never Seen: The Indigenous Voice and the Rhetoric of Resistance Literature 137
Blayne M. Higa (Catherine A. Collins)

Marketer's Use of Semiotics and Symbolic Representation of Children's Packaging 142
Reagan Turok and Heidi Redeker (Lois Smith)

Same-Sex Marriage Politics: The Politicizing of Sexual Orientation 147
Kari Wagener (Phillip Voight)

"Do As Little As Possible" The Transformation of Film Noir's Myths in Chinatown 151
Karen Demski (Chris Hassold)

Outside Looking In: Sacred Space of Taos Pueblo 157
Brenda L. Hanson (Anne E. Allen)

Directed By and Starring Cindy: Sherman's Performance Photography 161
Jennifer Lemmer (Cris Hassold)

Reinterpreting Roman Morality 166
Ryan Pesch (Marleen Flory)

Edna St. Vincent Millay: A Feminine Perception of Love 170
Mandy C. Carlson (Lysbeth Em Benkert and Jay Ruud)

The Romantic Paganism of Niccolo Ugo Foscolo: Infancy, Greece, Venus, Exile, Pain, and Death in the Foscolian Artistic Sensibility 174
Mark Anthony Espinosa (Andrea Baldi)

Subject Pronoun Usage in Mexican Spanish in South Texas 179
Javier M. Morin and Carla Chapa (Sandra Baumel-Schreffler)

I, Tituba, Symbol of the Antilles 183
Debbie Officer (Margarite Fernandez-Olmos)

A Profound Cultural Exchange: The Mexican Muralist Movement and the Harlem Renaissance and its Modernist Descendants 187
Alice Psirakis (Raysa Amador)

The Issue of Status in Puerto Rico: Internal Strife in the Search for Status 192
Mandy Robinson (Paul Simon and Maria Dolores Goddard)

Multinational vs. Global Organizations: A Case Study of the Corporate Culture of IKEA 197
Katherine J. Ross and Saturnia Alcala (Peter Hackbert)

The Creation of Christianity: Exploring the Role of Women in the Development of the Ancient Church 202
Jennifer L. Borden and Kevin S. Minoli (John R. Lanci)

For Better or For Worse: The Case For Gay Marriage 205
Kathrine Ehrlich (Laura Purdy)

The Mother-Daughter Relationship of Harriet Taylor Mill and Helen Taylor 210
Amy M. Kuhl (Jo Ellen Jacobs)

Pragmatic Faith in John Dewey and Fyodor Dostoevsky 215
William D. McCracken (Stuart E. Rosenbaum)

Epistemological Conditions: How Plato Anticipates Gettier 220
Andrew T. Cronan (A.M. Weisberger)

Adversity and Sacrifices: The Examination of Two Lives 224
Patience Adibe (Harriette Pipes McAdoo)

The Acquisition of Knowledge According to the Theory of Jean Piaget 229
Donna M. Cain (Ralph Carlson, Dalinda Rodriguez, Raymond Welch, and Keith Turner)

A Descriptive Survey of the Three Contemporary Approaches to Fluency Disorders 234
Peter Golleck (Raymond Welch, Barbara Johnson , Teri Mata-Pistokache, Timothy Meline, and Keri Parchman-Gonzalex)

Cosmos and Chaos: An Analysis of Themes and Issues in Doris Lessing's The Fifth Child 238
Anna C. Long (Hamida Bosmajian)

Toni Morrison's Sula: The Pharmakos of Her Community 243
Joseph Van Mieghem (Hamida Bosmajian)

The Search for Innocence in the Art of Jean Cocteau 249
Erin Nicole Parisi (Alexandra Wettlaufer and Jonathan Bober)

Preferences of Positive Reinforcers Among Elementary Students 253
Kelly Schutte (Lian-Hwang Chiu)

Implementation of Civil Rights Policy in Education 257
Autumn Stewart (Carter A. Wilson)

Jewish Resistance to the Nazi Occupation of Lithuania and Belarus during World War II 260
Phillip C. Alloy (L. Wilcox)

Peddling Public Assistance: The Children's Bureau and the Aid to Dependent Children Program in the Social Security Act of 1935 263
Katherine E. Anselmo (Helen Wheatley)

A Case Study of the Tax Reform Initiative by Marylanders 268
Juanita Maria Banks (Abdul Karim Bangura)

Famous and Forgotten: The Life and Death of the Dubuque Dial, 1934-1935. 272
Katherine Dietrich (Michael Anderson)

The Stonor Letters and the Wars of the Roses: Violence and Politics in Fifteenth-Century England 276
Michelle Dowd (Richard Kaeuper)

Thomas Becket and King Henry II A Medieval Drama with a Contemporary Application 281
Lorie Fratz (George Sochan)

The Mushroom of Feeling: American Public Reaction to the Atomic Bomb, 1945. 285
Jason C. Gaskill (Larry Lipin)

Henry Laurens: The Making of a Revolutionary 289
James Hutchinson (Bruce Greenawalt)

Beyond the Imperialist V Anti-Imperialist Dichotomy: American Intellectuals and Fin De Siecle Expansionism 294
Robert James Kijewski, Jr. (David Worbel)

"Being Madame is a Miserable Job" The Letters of Liselotte von der Pfalz, 1672-1722 299
Christie King (Caroline Castiglione)

Fencing out the Foreigner: Influences on the Eighteenth Legislature of Wyoming and its Exclusion of Foreign Physicians 304
Susan Macki (Eric Kolher)

A Woman's Place: Female Tavern and Inn Keepers in Early Pennsylvania 310
Sarah E. Morgan (Larry Eldridge)

The Debates and Arguments Leading to the Passage of the Seventeenth Amendment 314
Tara M.E. Yencha (Deborah A. Rosen)

Jane Addams: Women-Based Political Actor as Role Model 320
Oona Besman (Susan Harrison)

Lesbian Perspectives on Love, Sex and Relationships: Adult vs. Youth 325
Angelica Victoria Hernandez (Mary L. Alpaugh)

Women's Body Image: Effects of Media Imagery and Anorexia Nervosa 330
Grace Lager (Susan Harrison)

Testing the Effects of Sample Composition and Context on Radiocarbon Dating from Mammoth Cave, Kentucky 335
Sarah McCloskey (Kenneth B. Tankersley)

BEST COPY AVAILABLE

Three-Dimensional Mapping of the Bluff Greathouse Archaeological Site 339
Natasha Psenicka (Lawrence B. Conyers)

Scholarly Sightseeing in Rome, Ravenna, and North Africa: The Differences in Early Christian Centrally Planned Vaulted Structures 344
Benjamin D. deLee (Christine Colley)

Self-Perceptions and Representations of Hawaiian Identity, Ke Kanaka and Ke Kane Ikaika 349
Cheryl Nohealani Olivieri (Margarite Fernandez-Olmos)

Mexican Catholicism: The Syncretic Result of the Spanish and Indigenous Religions in Contemporary Mexico 352
Helena E. Colyandro (Susan Deans-Smith)

Rocky Road: The Long Journey to Educational Freedom in Prince Edward County 357
Randy A. Jones (George Bagby and Lowell Frye)

VOLUME II

SOCIAL SCIENCES

Preclassic Maya Pottery From Colha, Belize 362
Sharon Hankins (Fred Valdez, Jr.)

Deciphering the Secrets of Skeletal Remains from Hellenistic Abdera, Greece 367
Thomas P. Bolioli and Tara M. Kirkpatrick (Anagnosti P. Agelarakis)

Japanese Unknown Women Under the Japan's Alliance Capitalism: The Complementarity of the Pre-Existing Structures and the Changing in Identity 373
Yumi Kobayashi (Jeffrey Broadbent)

Window Into the Past: Diachronic Aspects of Three Ancient Human Skeletal Populations from the Khao Wong Prachan Valley in Central Thailand 377
Anna Konstantatos (Anagnosti P. Agelarakis)

Whole Vessels from Kichpanha, Belize: Implications of Increasing Social Complexity 382
David A. McDow (Fred Valdez, Jr.)

Form and Function of Late Preclassic Maya Pottery 387
Angela Milliman (Fred Valdez, Jr.)

Southern Plains Powwow Culture: Exploring the Identity of the Drum 392
Cindy Stout (Sue Tuohy)

The Sexual Oppression of Women in South Korea 397
Tuesday M. Tamburri (Leslie Miller-Bernal)

Evaluation of a Summer Orientation Course for New College Students: Critical Reading and Reasoning 403
Hernan E. Diaz (Sharon L. Pugh)

The Association of Peer Acceptance and Social Behavior in Early Childhood 406
T. Gayle McLemore (Leslie Phillipsen)

The History of the Civil Rights Movement in Prince Edward County, VA (1951-1964) 411
Steven L. Turner (Susan H. Bagby)

Qualitative Research on the Teaching Methodology of Genetics 348: A Hands on Approach 416
Tia Fluegge (Sandra Tutwiler and Presley Martin)

Spatial Distribution and Socio-Economic Profile of Asian Indians 421
Aaron Otto (Jayati Ghosh)

Intra-Asian Direct Investment and Indian Economic Liberalization 426
Susanne Peters (Jayati Ghosh)

The Spatial Distribution of the Hispanic Population in the United States: An Analysis at Various Geographic Scales 431
Stephanie M. Sheetz (Robert Douglas)

A Quantitative Study of Communication Apprehension and Self-Esteem 436
Mattie Marie Butler (Abdul Karim Bangura)

Attraction Factors Involved in Internet Relationships 441
Karen Chain, Christopher Gill, and Dawn Kujawski (Dean Thomlison)

Wartime Benevolence: A Portrait of Northern Philanthropy During the Civil War 446
Kevin Davis (Bruce S. Greenawalt)

Media and the Construction of Identity: Young Women's use of "Friends" 451
Kristi L. Eaves (David B. McLennan)

Dress and Nonverbal Communications 456
Barbara Heinemann (Joanne B. Eicher)

Confronting Learning Disabilities: A Proactive Approach for Parents 461
Holly Kapp (George Sochan)

Public Perceptions of Television Versus Newspaper Credibility: A Local Study 465
Andrea Lawson (Mark D. West)

The Evidentiary Impact of the Likelihood Ration and Assessment of Diagnosticity 470
Nir Liberboim (Jonathan Jay Koehler)

Solitary Confinement: A Study of Prisoners' Access to the News Media 475
Michael O'Sullivan (Ann Marie Major)

The Conveyance of Socioemotional Cues in Computer-Mediated Communication: A Content Analysis of Internet Relay Chat 480
Kimberly K. Schaefer (Denise Bostdorff)

You Eat What You Are: An Investigation of Key Environmental Variables on Food Choice 485
Laurel Y. Shanaman (James Brancato)

The Nurse-Patient Continuum: A Nursing Model 489
Jackie Boak, Elizabeth Dickerson, Melissa Jackson, Teri O'Quinn, and Cathleen Fabiani (Margaret Erickson)

Assessing the Effects of HIV/AIDS Peer Education on High School and College Freshmen 493
Cara Catalino, Erin Clune, Megan Gordon, and Marie Neilan (Patricia A. Bailey and Donna R. Carpenter)

Relationships of Self-Perception of Balance, Technological Measures of Balance, and Fall Events Among Individuals with Parkinson's Disease 496
Kativa L. Leal (Nancy E. Dayhoff)

Depression: Prevalence, Causes, Manifestations, and Repercussions Associated with Elderly Disability 501
Nicole Lovell (Clyde B. Killian)

Medical Costs and Correlates of Gunshot Wounds in Travis County, 1995 506
Jennifer L. Moren (L. Michelle Issel)

Family Caregivers' Perceptions of Pallidotomy Surgery: Expectations, Satisfaction, and Health Dysfunction 511
Polly K. O'Brien (Jane Backer)

Living on the Health Care Drawing Board: An Analysis of the Availability of Health Care to Low-Income Families in Los Angeles 515
William Ortiz (Leslie Howard and Cheryl Swift)

Fathers, Food, and Fun: A Nutrition Education Program for Low-Income Urban Fathers and their Children 520
Donald C. Sweet, Lisa Gemlo, and Jennifer Ruffing (Debra Palmer Keenan)

Accounting for the Effects of Hurricane Hugo 523
Tulani Giscombe (Mary Jones Phillips)

Changes in Smokeless Tabacco Utilization Patters Among School-Aged Children 526
Mark A. Robinson (Don Lisnerski, Bob Yearout, and Cheryl McClary)

Detecting Hidden Periodicities in Business Cycles of Fifteen Countries Using Fourier Analysis 530
Peter Hlavaty (Edward Gamber and James DeVault)

Effects of Foster Care on Perceptions of Family and Family Functioning 534
Judy Meyer (Beverly Curry)

Retailer Country Bias Cues: An Experimental Approach 538
Erin C. Miller (Sherry L. Lotz)

Matching Cultural Value Orientations to Ad Appeals: Exploring the Role of Individualism-Collectivism in the USA Versus Mexico 543
Michael Mosley (James M. Munch and Gary D. Gregory)

Vertical Integration and Profitability 548
Cecelia Ruth Buchanan (Stephen Schmidt)

NAFTA and Jobs in the United States 553
Kristina Carrico (Rutilio Martinez)

Gender Differences in Investment Expectations 558
Teresa D. Harrison (Rosemary T. Cunningham)

Do Dollars Make a Difference? The Relationship Between Expenditures and Test Scores in Pennsylvania's Public Schools 563
Jonathan M. Klick (Charles Zech)

The Income Distribution Effects of IMF Balance of Payments Stabilization Tools: A Case Study of Monterrey, Mexico 569
Charlotte Opal (Perry Patterson, Michael Lawlor, and Dan Hammond)

Tests of the Induced Innovation Hypothesis in Indian Agriculture 574
Anthony Walsh (Kailash Khandke)

A Qualitative Study of the 1994 Voter Turnout in Prince George's County Executive Election 579
Kirk A. Gordon (Abdul Karim Bangura)

A Test of the Efficacy of the University of Maryland College Park Affirmative Action Program 584
Shamica Monique Jackson (Abdul Karim Bangura)

From Critique to Consensus: Stephen White's Pursuit of a Postmodern Politics 589
Ingrid A. Jendrzejewski (David Gugin)

A Quantitative Study of the High School Attrition in Prince George's County, Maryland 594
Dorothy Lyons-Wilson (Abdul Karim Bangura)

Race in the Balance: Case Study of Escambia Treating Company 599
LaRuby May (Carolyn Johnston)

Aid in Transition: Explaining Post Cold-War Trends in House Foreign Aid Voting 604
Scott R. Meinke (John R. Baker)

A Quantitative Study of the Essence of Federalism: Who Does it Benefit: 609
Kim Odoms (Abdul Karim Bangura)

The Concepts of Community and Individualism in Twentieth-Century Presidential Nomination Acceptance Speeches and Inaugural Addresses 614
Stephen V. Potenza (James E. Underwood)

A Comparative Study of the Levels of Political Socialization of Children in Two New Hampshire Towns 619
Kathleen M. Ridolfo (Clark Hubbard)

A Qualitative Study of Minority-Majority African-American Congressional Districts and African-American Representation in Congress 623
Marvin M. Silver (Abdul Karim Bangura)

A Quantitative Study of the Longevity of Vietnam-Era Disabled Veterans 628
Joseph L. Singleton, Jr (Abdul Karim Bangura)

The 1996 Albanian Elections: Corruption? Or a Catalyst for Democracy? 632
Christopher Thomas Johnson (Karen Vogel)

The Role of the International Law of the Non-Navigational Uses in International Watercourses in Resolving the Disputes Over Access to Freshwater in the Middle East 637
Jason Woolwine (Gary Prevost)

Trends in the Eisenhower Administration: A study of Inflation, Unemployment, and Presidential Popularity 642
Shadya Y. Yazback (James Lindeen)

Strategizing Advocacy: Theoretical Frameworks in Grass Roots Social Organization 646
Tamie M. Aceves (Manuel Carlos)

Peering into the Success of Peer Feedback: Understanding how Feedback Works in Elementary-Aged Writers 651
Laura Angyal (Matthew Olson)

The Impact of Acculturation Type, Stress, and Social Support Among Mexican-American Adolescents 655
Elsa C. Arroyos (Enedina Garcia-Vazquez)

Physiological Responses to Racist Stressors Among African-American College Students 660
Jamar Barnes, John A. Oliver, and Foye Smith (Vernessa R. Clark)

Gender Differences in Perceptions of Martial Infidelity: Sexual Versus Emotional Cheating 664
Anne-Marie Bartos and Allison D'Auteuil (Ralph J. McKenna)

Childhood and Adolescent Abuse, Fear of Negative Evaluation, and Social Interaction Self Statements: A Correlational Analysis 670
Patti Beth (Barbara Beaver)

Coping Strategies Among African-American and Caucasian Female College Students 675
Ayannah A. Brower, Afiya Ricks, and Foye A. Smith (Vernessa R. Clark)

The Effects of the Administration of Methysergide and Ritanserin, Two Serotonin Antagonists, on the Behavioral Repertoire of Zebra Finches (Taeniopygia guttata) 679
Megan B. Bruther (Wendy L. Hill)

Context and Quality of Social Interaction of Children with Severe Language Delays in a Full Inclusion Preschool Program 684
Amy Buchanan and Krista DeZerega (Lawrence V. Harper and Karen McCluskey)

Characteristics Associated with Premature Drop Out in Client-Centered Play Therapy 689
Valerie A. Campbell, and David B. Baker (Sue Bratton and Jennifer Cleveland)

Helping Behavior Rates and Demographics: A Comparative Analysis 694
Jennifer D. Carlson-Weiberg (Nancy Steblay)

Parents' Marital Status, Father-Daughter Intimacy and Young Adult Females' Dating Relationships 698
Kristen J. Clark (Korrel Kanoy)

Investigating Physiological Responses to Sexual Harassment 703
Shaunta K. Clark, Carina De Fazio, Jamar D. Barnes, and Foye A. Smith (Vernessa R. Clark)

Peace Builders Case Study: Combating Violence Through the Exercise of Positive Choices in an Elementary School in California 707
Charlotte M. Contreras (Manual Carlos)

BEST COPY AVAILABLE

The Psychobiological Effects of Narcolepsy: Its Causes and Treatments 711
Sara Cronin (Charles Kutscher)

Racial Similarity, Cost to Helper, and Sex as Determinants of Helping Behavior 717
Heather A. Dooner and Margaret M. Blake (Patricia Oswald)

Sex Role Type and Effectiveness of Women Speakers at a Religious Presentation 722
Catherine E. Dundas (Lynn New)

Alpha-Ganzfeld: An Experimental Study on Alpha Rhythms Under the Ganzfeld Condition 727
Darin Dutcher and Joshua Johnson (Dorothee Dietrich and Matt Olson)

The Relationship Between the Extent to Which Adolescents are Taught Not to Trust Strangers During Childhood and Interpersonal Skills 732
Laurie Harrier (Francis Terrell)

The Relationships Among Eating Attitudes, Loneliness, and Self-Monitoring 737
Patricia L. Hart (Cynthia Crown)

Readability of Websites with Various Foreground/Background Color Combinations, Font Types and Word Styles 742
Alyson L. Hill (Lauren F.V. Scharff)

The Relationship Between the Protestant and Catholic Religions and Guilt 747
Caramin C. Johnson (Emily Hause)

Locus of Control and Superstitious Behavior: A Visit to the Putting Green 751
Mark W. Jones (Ralph J. McKenna)

Effects of Long-Term Ad Lib. Feeding on the Weight and Health of Differentially-Reared Laboratory Rats 756
Gary L. Lawrence & Kimberly M. Murrell (Karen E. Brakke & Jeanne M. Stahl)

Drug State Dependent Performance of Rats on a Hampton Court Maze 761
Shawana N. Lewis and Gary L. Lawrence (Karen E. Brakke and Jeanne M. Stahl)

Child Abandonment in St. Petersburg, Russia: Effect of Early Intervention 766
Natalya M. Lvoff (H. Banis)

Parent and Adolescent Relationships as Predictors of Post Divorce Functioning 770
Marisa Manzi, Joan Garten (Michelle Wierson)

Doing Field Research in an Electronic Environment 775
Tracee S. Matlock (Manuel Carlos)

Irrelevant Speech Eliminates the Word-Length Effect 779
Rebecca Mazzorana (Ian Neath and Aimee Surprenant)

Activational Effects of Testosterone On Sound-Guided Spatial Navigation 782
Eric J. Moseley (Mark C. Zrull)

Effects of Employment on College Students' Academic Performance and School Involvement 787
Laura A. Schwarber (Cynthia L. Crown)

Gender Differences In Coping Strategies and Cardiovascular Responses to Stress 791
Eric Shaw and Foye Smith (Vernessa R. Clark)

An Extension of the "Two-Baskets' Theory of Self-Cognitions to Native Americans 794
Mandy D. Smith (David Trafimow)

The Relationship Between Self-Esteem and Extraversion 797
Wendy S. Peterson (Cynthia Crown)

1323

Chicano Gangs in California: Analytical Analysis of the Structure and Dynamics of Chicano Gangs from Street Corner to Prison Cell 801
Brenda J. Pobre (Ruben Mendoza and Manuel Carlos)

The Relationship Between Parents' and Adolescents' Values 807
Heather Reynolds, Corinne Auman, Ilona Teleki, and Laura Batz (Maureen Vandermass-Peeler)

Attitudes of College Students Toward Using Animals in Research 813
Katina V. Robinson and Lisa Harris (Karen E. Brakke and Jeanne M. Stahl)

Transitive Inference in Undergraduate College Students 818
Rhea Watson (Julianna Lancaster and John Batson)

Conflicts of Interest in the Early Stages of Intimate Relationships 822
Susan Russell (Renate Klein)

Social Adjustment of Children and Adolescents with Juvenile Rheumatoid Arthritis: Parent Report 826
Stacie M. Arthur (Robert B. Noll)

The Relationship Between Nicotine and Alcohol Dependence: Treatment Implications: 831
Meenakshi Garg (Barbara J. Mason)

Social Isolation of Nursing Home Residents and Their Perceived Health 833
Jennifer Langford (Jerry Pankhurst)

The Effects of Minority Influence on Group Polarization 838
Kelly Murphy (Jennifer J. Dose and Jeff Ratliff-Crain)

Scottish Soccer Violence and Religion 843
Megan O'Neill (Len Berkey)

A Content Analysis of Children's Television Commercials 848
Rachel D. Sgaglio (Michelle E. Barton)

A Critical Analysis of Current State Responses to the Problem of Child Maltreatment 852
Elise L. Siddell, Eileen T. West and Emma S. Gavino (Madeline Lovell)

The Assessment of College Students' Perceptions and Attitudes Towards Academic Dishonesty 857
Sarah Acton, Jennifer Thetford (Irene Staik and John Burling)

Changing Pedagogy: Using a Computer Simulator to Teach Ethnographic Methods 862
Gregory R. Blaza (Manuel L. Carlos)

The Influence of Pretrial Publicity on Juror Decision-Making: A Meta-Analysis 866
Jasmina Besirevic (Nancy Steblay)

North America by Bus: A Study of Interaction and Personal Space 871
Lisa Marie Bosner (Natalie Rosel)

The Assessment of College Students' Attitudes Toward the Social Aspects of Their Own Aging 876
April M. Chambers and H. Perry Swindall (John Burling and Irene Staik)

Exploring the "GenderedPerspective" in Early Adolescents' Interpretations of Popular Music 881
Anastasia M. Pharris-Ciurej and Kristine M. Ward(Jodi O'Brien)

An Examination of Gift Giving in Post-Modern Society 886
Megan Kathleen Donovan (Martha Huggins)

Learning to Hate Yourself: How Homophobia Teaches Girls to Devalue Women 889
Jennifer L. Engle (Harriet Adams)

The Effect of the "Year of the Woman" on the 103rd Congress 894
Emily C. James (Nadia Rubaii-Barrett)

Popularity: The Crisis and Culture of Adolescent Girls 899
Cinnamon Reiheld (Harriet Adams)

Production Scheduling of Flexible Manufacturing Cells 904
Jeffrey D. Erickson (Bijayananda Naik)

Physical Attributions of Racial Sterotypes 908
Lori Dixon (B. Runi Mukherji)

Proceedings — NCUR XI (1997)

Volume III

Mathematical and Engineering

Groundwater Nitrate Removal for the Main San Gabriel Basin, California 911
Chad Blais, Katina Burl, Adam Nazaroff, Peter Tonthat, Vinh Truong and Justine Yu (Julie Wei)

Occupant Dynamics in Stationary and Moving Vehicles Subjected to Vertical Impacts: An Experimental Study 915
Peter D. Layson (Toufic M. Hakim and Orion P. Keifer)

SubzeroCam: Design of a World Wide Web-Based Digital Camera for Sunrayce 97 920
James A. Johnson (Richard R. Schultz)

Using Java for Computational Electromagnetic Scattering 925
Jared Martin (Lyle Long)

Flat Oceans and Satellite Radar Anomalies 930
David L. Mickler (Chester J. Koblinsky)

Cyberprint: Creating Alternative Medical Visualization Tools Using Architectural Metaphors 936
Jim Agutter (Julio Bermudez)

Sustainable Building: Planning and Design of a Family Residence and Education Center Using Local Building Materials 940
Geoffrey B. Grace (Rebecca Fish Ewan)

An Analysis of Ancient Maya Obsidian Artifacts from Belize 946
Rissa M. Trachman (Fred Valdez, Jr.)

Effects of Detention Time on Sedimentation Performance 951
Ben Ehrhart (A.R. Jarrett)

Characterization of Waste Sites in Greater Newark Area Using Geographic Information Systems (GIS) 956
Jelena Balorda (Sima Bagheri)

Electrochemical AC Impedance Technique to Investigate the Inhibition Efficiency of an Inhibitor for Steel Rebar in Concrete 960
Octavio Cervantes, Elaine Lopez & Rudolph Martinez (Behzad Bavarian)

Prototype Designs of Concrete-Filled Steel Tube Composite Building Frames 965
Katherine Fetterer (Jerome F. Hajjar)

Removal of Ammonia from Contaminated Air Stream by Biofiltration 970
Annie W. Chou (Ruihong Zhang)

Comparison of Analysis Methods for Non-Classical Structures with Added Viscoelastic Damping 975
James P. Horne (Douglas K. Nims)

Field Testing of Stone Masonry Arch Bridge #143 in Chester County, PA 978
Allyson Karper (Thomas Boothby)

Determining Suitability of Irrigation in Developing Countries 983
Carl McGloughlin (Roger Ruggles)

Development of a Generic, Robust, and Reliable Networking Protocol for a Motorola Microcontroller 988
Mary Frances J. Austin (Charles Bennett)

Ideal Case Modeling of Optical Preamplifer Receivers at the 10Gb/s Data Rate 993
Deborah S. Hart (Y.K. Park, Lucent Technologies, Lightwave Subsystems)

BEST COPY AVAILABLE

Nonlinear Filtering and Enhancement of Digital Ultrasound Imagery 998
Melissa L. Kurtz (Richard R. Schultz)

Mathematical Modeling of a Fuzzy V-Chip 1002
Daniel J. Landherr (Marian S. Stachowicz)

Effect of Thin Film Disk Texture on Magnetic Recording Head-Medium Clearance Measurements 1007
Daniel Yau (Chorng H. Chang)

A Self-Evaluation Tool for Life-Cycle Cost Analysis 1012
Fabiola Gaytan and Pablo Santos (John Wilson)

Excessive Noise Levels Enhance Special Effects, Are You Aware? 1017
K. Osborne (D. Lisnerski and R. Yearout)

Surface Estimation of Machined Parts 1022
Gustavo Perez (Prasad Gavankar)

The Use of the GRAFCET Approach to Automation of PLC Programming & Control 1027
Janice R. Sansberry (Shueh-Ji Lee)

Counting Arrangements of 2's and -1's 1031
Robert S. Sielken (Donald Bailey)

Magic Squares as Matrices 1036
April Warn (Donald Bailey)

The Structural Design and Electronic Control System for a Large Segmented Space Reflector Test-bed 1041
Anibal Jaimes and Efrain Velazquez (Helen R. Boussalis, Maj Mirmirani and Khosrow Rad)

The Effects of Stretching and Aging on the Tensile Properties of A1-Cu-Li (2195) Alloy 1046
Michael C. Abernathy and Clarence Adkins (Reza Mirshams and Zhixian Li)

Resolvents of m-Accretive Operators in Banach Spaces 1050
Eric Lehr (David Kerr)

Numerical Model for Ice Melting in a Rectangular Enclosure with Density Extremum Effects 1055
Makeda Smith (Khoudir Medjani)

Nanofabrication and Resistance Testing of Metal Coated Silicon Microcontact Arrays 1060
Jeffrey A. Yap (Jack M. Blakely)

The Effect of Razor Notching Techniques on the Fracture Toughness of Polymeric Materials 1063
Dora C. Arevalo (Carlos R. Corleto)

Assessment of In-Plane Strength of Carbon/Epoxy Laminates 1067
Jill Hahl (Ronald Bucinell and Alan Nettles)

The Design and Development of a Phantom Model for Hyperthermia Cancer Treatment 1071
Jennifer Lelas (Ann Anderson)

International Virtual Design Studio: Design of a Vehicle Without Wheels or Wheel-like Contact with the Floor 1075
Carmen McMurtry (Ronald B. Bucinell)

Heat Transfer Enchancement on a Printed Circuit Board 1079
Gretchen R. Voegler (Ann M. Anderson)

A Study of Data Issues in the GIS Environment 1084
Jesus Acosta and Lori Alvarado (Ann Q. Gates)

Quick Write vs. Quick Run: Implementation Methods for Goal Definition 1088
Kellie Alexander and Yolanda McCullough (Scott Anderson)

A Study of Environments for Successful Component Reuse in System Development 1093
Debbie Bowles (Mary Lynn Manns)

Digital Simulation of the Acoustic Guitar: A Physical Model Abstraction 1098
Adam D. Bradley (Wayne Lang)

A Parallel Solution of a Second Order Elliptic System 1103
Andre Da Breau and Lwanga M. Phillip (Okon H. Akpan)

Formulation of a Parallel Recursive Substructuring Method for Finite Element and Finite Difference Solutions 1108
Derek O. Bruff (Hayden S. Porter, Jr.)

Comparing a Particle-System Based Simulation to Other Methods in Modeling Special Effects 1113
Joshua Buckner and Ryan Mitchell (Gerald N. Pitts)

An Examination of Mentoring Methodologies in Object Technology 1118
Janet E. Cody-Mehaffey (Mary Lynn Manns)

3D Special Effects: Modeling Reflective Surfaces In Real-Time 1123
Daniel P. Cornell (Gerald Pitts)

Formal Methods for Software Specifications: A Case Study 1128
Michelle Dillinger (Ken Abernethy)

Truth Maintenance Techniques for Verification of Knowledge Bases 1134
Mark R. Finn (Neli P. Zlatareva)

Computer Assisted Data Reduction: Optimizing the Astrophysicist 1139
Dan Greenspan (Karen Magee-Sauer, Michael Mumma)

Hierarchical Planning with Definite Clause Grammars 1143
Tarik Vance-Harris (R. Raymond Lang)

Algorithm Animation: Programming on the World Wide Web Using Java 1148
Stephanie Hitchcock (Kevin Treu)

Formal Methods for Software Specification 1153
Amanda Hoffman (Ken Abernethy)

RSL, A Language for Distributed Parallel Solution of Sparse Matrix Systems 1157
Chad Huneycutt (Hayden Porter)

A Parallel Solution of a Parabolic System on a SIMD Processor 1162
Adrain Ironside and Ramaiz Mansoor (Okon H. Akpan)

Evolutionary Confusion: When and How to Apply the Genetic Algorithm 1167
Michael G. Jones (Gerald Pitts)

Visualization of a Global Atmospheric Model with Iris Explorer 1171
Elizabeth C. McAliley (Hayden Porter)

Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity 1176
Ramgopal Mettu and Yuke Zhao (Vijaya Ramachandran)

An Implementation of Particle Systems for Special Effects 1181
Ryan Mitchell and Joshua Buckner (Gerald N. Pitts)

Parallel Programming: A Disparate Architectures Approach 1186
Jason Pounds (Maurice Eggen)

A Traceability Tool: Linking Knowledge Programs 1191
Francisco Saenz and Tom Watson (Ann Q. Gates)

Commonsense Knowledge Representation for Russian Folktales 1196
Damon Stewart (R. Raymond Lang)

Gödel's Incompleteness Theorem and Turing's Solution to the Halting Problem: Linking the Foundations of Mathematics and Computer Science 1201
Philip Rash (David B. Teague)

Java Security 1206
Hnatyshin Vasil (Bob Neveln)

DARWIN: Software to Identify Dolphins in Digital Images 1211
Daniel J. Wilkin (John H. Stewman)

Wavelength Division Multiplexing Coupler Based on Talbot Self-Imaging in Planar Optical Waveguides 1215
Cadet Diana Kuykendall and Cadet Christopher L. Reitsma
(Tristan J. Tayag, David M. Mackie, Lorna J. Harrison,
Gary W. Euliss, and Richard P. Leavitt)

VOLUME IV

BIOLOGY

In Search of Aspects of the Human Condition in Antiquity: The Case of A Hellenistic Population from Abdera, Greece 1220
Pia Economou (Anagnosti Agelarakis)

Abnormalities in Occlusal Surface Wear and Enamel Integrity in Tehuelche Dentition 1224
Alberto Silva (Silvia Dahinten and Daniel de Lamo)

Design of the Acetylcholinesterase Enzyme Using Brownian Dynamics Simulation: A Novel Therapeutic Approach to Alzheimer's Disease 1229
Brent A. Hanks (Walt Potter, Kerry Burns and Vicente Villa)

Postanesthesia Nausea and Vomiting 1234
Aaron Shaw III (Paul Loubser)

A Study of the Risk Factors for Cerebrovascular Accidents in African-Americans 1239
Tera R. Hurt (Dennis E. Daniels)

The Effect of Training Position on Leg Flexor Power in Untrained Males and Females 1244
Dawnelle Diedrich and Ryan H. Robinson (Anthony Caterisano)

Measurement of Anaerobic Power in Elite Wheelchair Athletes: Absolute Load Optimization of the Wingate Test Using the Monark 881 Arm Crank Ergometer 1247
Stephen E. Mercer (Pamela J. H. Beehler)

The Effects of the Raised Mutation of Sexual Behavior in Drosophila Melanogaster Females 1252
Jeannine Caesar and Joshua Bradner (Scott P. McRobert)

The Influence of Menstrual Cycle Phases on the Chaotic Behavior of Electrocardiograms in College-Age Women 1257
Maria M. Mountis, Meghan Ginty and Sharee Livingston (James J. Watrous)

Pollinated Maize Ovaries are Resistant to Infection by the Smut Fungus Ustilago maydis 1262
Margaret Carfioli (Karen Snetselaar)

Genetic Characterization of the AXR5 Gene 1267
Ibrahim Carvan, Donovan Chance, Joseph Mazzie, Rina Pineda and Shabnam Shah (Lawrence Hobbie)

The Competitive Relationship between the Perennial Cardaria draba and the Annual Lepidium virginicum 1272
Maria Conley (Steven Carroll)

Self-Incompatibility: a Model for Pollen- and Pollen Tube-Mediated Signal Transduction in Petunia inflata 1276
Chandreyee Das (Teh-hui Kao)

Investigating Temperature Sensitive Mutants of Ustilago maydis 1282
Janet Gervaiss, Jason Lotkowski (K. Snetselaar and M. McCann)

Partial Purification and Properties of Putrescine Oxidase from Candida albicans 1287
Uma Gunasekaran, Johnny Thomas, and Louis McDonald (Muthukumaran Gunasekaran and Elias K. Manavathu)

Role of Host Plants in Egg Hatching of the Soybean Cyst Nematode 1292
Renee Poupard and Lou Casta (Paul M. Tefft)

Coat Protein Analysis of Tomato Mosaic Virus (ToMV) 1297
Victor Huber, Nicole Kimmes and Jesse Barthel (N. Bharathan)

Feeding Behavior of the Tropical Stick Insect Extatosoma tiaratum: A Study in Palatability of Thirty-one North American Plants 1302
Karla J. Johannes (James Poff)

Monitoring the Release of Acid Phosphatase in Pitcher Plant Fluid after Feeding with Insects 1305
Matthew Jones (Diane Melroy)

Elucidating Mechanisms of Pulmonary Fibrosis: Intracellular and Extracellular Events when the Platelet-derived Growth Factor Receptor System is Up-regulated by Air Pollution Particles and Interleukin 1-beta (IL-1ß) 1309
Patricia O. O'Brien, Annette Badgett and James C. Bonner (Sandra Gilchrist)

Determination of RNA Binding Domains of the Nucleocapsid Protein of Tomato Spotted Wilt Virus 1314
Patricia M. Stickler (Sandra Gilchrist and Tom German)

Characterization of an Auxin-Resistant Mutant of Arabidopsis thaliana 1319
Shabnam Shah, Ibrahim Carvan, Donovan Chance, Joseph Mazzie and Rina Pineda (Lawrence Hobbie)

Comparison of Microbial Consortia and Environmental Condition of Two Granite Outcrop Plant Communities 1324
Keri Randolph and Lisa M. Knauff (Sandra T. Bowden)

Characteristics and Purification of Agkistrodon controtrix laticinctus Venom 1328
Xavier G. Aranda, Elda Sanchez (John C. Perez)

The Purification and Characterization of Crotalus Viridis Oreganus Venom 1332
Gloria R. Chapa and Elda Sanchez (John C. Perez)

The Purification and Characterization of Agkistrodon piscivorus leucostoma Venom 1337
Celia Garcia and Elda Sanchez (John C. Perez)

Purification and Characterization of Crotalus viridis lutosus Venom 1342
Maria Susana Ramirez and Elda Sanchez (John C. Perez)

The Use of Electrophoretic Titration Curves as a Tool in Predicting the Separation of Crude Crotalus atrox Venom by High Performance Liquid Chromatography 1347
Maria Elisa Perez-Johnson (John C. Perez)

Development of a Rapid Detection Method for Determining Bacterial Guild Structure in Mining-Impacted Freshwater Sediments 1352
Todd Christensen (Frank Rosenzweig)

Purification and Biochemical Characterization of Antibacterial Antibiotics Produced by Soil Streptomyces 1356
Victoria C. Heverly (Robert W. Morris and Richard T. St. John)

The Microbial Activity in Saltmarsh Tidal Creek Waters Determined by Oxygen Metabolism 1360
Kenneth C. Hayes and Alan J. Lewitus (Eric T. Koepfler)

Efficiency of Latex Gloves as Barriers to bacterial and Viral Pathogens 1365
Erica Jo Hughes (Robert McLean and Carolyn Benjamin)

Oyster Reef Impact on Microbial Food Web Dynamics in Tidal Pools in North Inlet Estuary 1369
LeRoy F. Humphries, Alan J. Lewitus, Leah L. Gregory and Bonnie M. Willis (Eric T. Koepfler)

The Molecular Evolution of HLA-A 1374
Kristie A. Mather (Carrie Grimsley and Carole Ober)

Restriction Endonuclease Analysis of Plasmid DNA from Methicillin Resistant Staphylococcus aureus 1379
Janey Phelps (Betsy Wilson)

Macrorestriction Patterns and Genome Sizes of Two Strains of Bdellovibrio 1384
Theresa Scognamiglio (John J. Tudor)

Effects of Specific and Non-Specific Transport ATPase Inhibitors on Gill and Rectal Gland Tissues of the Little Skate, Raja erinacea 1389
Tanisha Wilkins (Gregg Kormanik)

Effects of Wood Frog (Rana sylvatica) Predation on Spotted Salamander (Ambystoma maculatum) Oviposition Site Selection 1392
Joyce E. Cacka (James W. Petranka)

Consequences of Opportunistic Predation by a Primary Consumer (Rana) on a Predator (Ambystoma) 1397
Andrea Rushlow (James W. Petranka)

The Role of Visual Cues in Determining Recognition Behaviors in Poecilia Latipinna and Poecilia Velifera x Poecilia Latipinna 1402
Joshua Bradner and Jeannine Caesar (Scott P. McRobert)

The Effect of the Lipid Content of the Diet of Blue Crabs, Callinectes sapidus, on Osmoregulation 1407
Sarah E. Hazzard (Lee Ann Clements)

Short-Term Effects of UV-B Radiation on Salt Marsh Vegetation 1412
Christopher D. Raleigh (Eva Koch & Laura Murry)

The Study of the Oxidation of CZT with H_2O_2 Using XPS 1417
Brandy Granderson (De Tang Shi, W. Eugene Collins and Muthukumaran Gunasekaran)

The Effects of Precocene 2 on The Predatory Insect Tenodera aridifolia sinensis Saussure 1422
Emily C. Whiteley (Diane Melroy)

Interspecific Interference and Resource Partitioning Among Males of Three Dragonfly Species (Odonata: Libellulidae) 1427
Michael Wolyniak (Vicky McMillan)

Habitat Selection by American Kestrels (Falco sparverius) Wintering in Northwestern Ohio 1432
Tami L. Parker (J. Eric Juterbock)

The Role of Calcium in Wound-Induced Cell Proliferation 1437
Quoc-Huong Tran (Paul J. Sammak)

Isochore Related Amino Acid Substitutional Biases 1442
Allen J. York (Dan E. Krane)

Effects of Thallium on Inositol Polyphosphate Receptors and Nitric Oxide Synthase in Rat Cerebellum 1447
Chadrick Anderson and Tanya Wright (Chellu S. Chetty and Muthukumaran Gunasekaran)

Initiation of Expression and Cell-Specific Localization of Nitric Oxide Synthase (NOS) in Pre-Implantation Mouse Uterus 1452
Preeti Gupta (Yvette M. Huet-Hudson)

Characterization of Urethral Blockage in a New Mutant Diabetic/Obese Mouse 1456
Michael Villarroel (John G. Vandenbergh)

One-Dimensional and Two-Dimensional SDS-PAGE of Total Protein in the fungus Ustilago maydis 1459
John G. Devlin (Karen Snetselaar and Michael McCann)

Regulation of Superoxide Dismutase Synthesis in Candida albicans 1464
Uma Gunasekaran, Anita Austin and Louis McDonald
(Muthukumaran Gunasekaran, Elias Manavathu and C.S. Chetty)

Antifungal Resistance in Opportunistic Fungi: Isolation and Characterization of Amphotericin B-Resistant Mutants 1469
Uma Gunasekaran, Anjana Challa, Dinita Scurry and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

In Vitro Susceptibility of Clinical Isolates of Opportunistic Fungi to Antifungal Agents 1474
Uma Gunasekaran, Tanya Wright and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

Aye-Aye Gruel Presentation Preference 1479
Heather Ann Lynch (Joan H. Eisemann)

Modification of the Binary TBP-DNA Complex by Pluramycins 1483
Sameer Ambady (Lawrence Hurley)

Characterization of a Mutant dnaA-dnaN Gene Region that Suppresses a Temperature Sensitive Defect in the dnaX Gene of Salmonella typhimurium 1487
Farhang Amini (James R. Walker)

Conservation of Proto-Oncogenes, Tumor Suppressor Genes, and V (D) J Recombinase Genes Across Species 1492
Lucy A. Aplan (Rob Young)

An Analysis of Lipid Bilayer Studies of Single Ion Channels using M2 as an Example 1496
Erin E. Grimm (Carl Helrich)

Metal Regulated Gene Expression in Pseudomonas fluorescens 1501
Marsha L. Kukuk (Silvia Rossbach)

The Development of a PCR-Based Test to Identify the Red Factor Coat Color Genotype in Horses by RFLP Analysis 1506
Staci Murguia (Ann T. Bowling)

Differentiation and Classification of Bdellovibrio bacteriovorus using Random Amplified Polymorphic DNA (RAPD) Analysis 1509
Bao-Dan T. Nguyen (John T. Tudor)

QTL Mapping of a Genetic Marker for Longevity in Drosophila melanogaster 1513
Amy Resler (Jim Curtsinger)

Stability of Heterochromatin in Voles from Chernobyl 1518
Lara Wiggins (Robert J. Baker)

Isolation and Functional Analysis of three Non-Human Primate CXCR4 Genes 1521
Brigitta Zoltay, Jay Vasudevan and Greg Shaeffer (David Camerini)

Proceedings — NCUR XI (1997)

Volume V

PHYSICAL SCIENCES

Modification of an Interference Pattern Through Particle Statistics: Experimental Study 1526
Niranjan Sharma (Willard Fadner)

Nuclear Structure of the Stable Tellurium Nuclei 1531
Brian Champine, Peter Burkett, Christopher Davoren, Stephen Etzkorn, William Faulkner, Bernard Meehan, and Mark Skubis (Jeffrey R. Vanhoy and Sally F. Hicks)

Pulse Propagation in a 1-D Physical Lattice 1536
Jonathan Tuminaro and Joseph Winkler (H. David Sheets)

An Investigation to Measure Mechanical Strain in Structures using Optical Fiber Interferometry 1540
Satyender Mahajan (Zolili Ndlela)

CO Adsorption on Cobalt Particles Supported on Chromia - An FTIR Study 1544
Caribee Collier and Agegnehu Tsega (Murty A. Akundi and A.N. Murty)

Solar Cells Using Organic Pigment Nanoparticles 1549
D.J. Hilton and E.W. Forsythe (B.R. Hsieh and Y.Gao)

Calculating O_3 9.6 μm Absorption as a Function of Atmospheric 0_2 1553
Hilary L. Justh (James F. Kasting)

Electromagnetic Field Profiles Inside Biomaterials 1558
Pedro L. Melendez, Dimaries Nieves, Ramon A. Rivera (Idalia Ramos and Fredy Zypman)

Thermal Modeling of the Marcy Anorthosite Massif, Adirondack Highlands, New York: Implications for Depth of Emplacement 1563
Kevin M. Myer (J. Alcock)

Ultra Sensitive Diode Laser Based Monitors for Toxic Environmental Gas NO_2 1568
Jessica Owens (G.N. Rao and M.N. Reddy)

Sample Heating and its Effects on Diffusion Depth 1573
J. Reed Patterson (Peter A. Barnes)

The Hyperpolarizabilities of Phthalocyanines 1578
Tiffiani R. Williams (Beatriz H. Cardelino)

Simulated Super Resolved Imaging of Compact Radio Sources 1583
Erika Barth (David Hough)

A Study of the Lobe-Dominated Superluminal Quasar 3C263 1588
Philip J. Beyer (David Hough)

Global Imaging of the Cusp Region of the Earth's Magnetosphere 1593
John W. Colson (J.D. Perez)

3D Circuit Networks Simulate Biomaterials 1596
Edsel Ruiz, Pedro Melendez (Idalia Ramos and Fredy Zypman)

A Two-Year Climatology of Radiation Budget and Cloud Properties for the ARM SGP Site 1601
Stephen G. Strum (Thomas P. Ackerman)

Nonlinear Optical Properties of Halogenated Porphyrin 1606
Angela Benloss (Beatriz H. Cardelino, Craig E. Moore)

A Novel Method for Investigating Phase Disturbances 1611
Rex L. Blair Jr. (Thomas R. Moore)

An X-ray and Optical Study of Galaxies in Pairs 1616
Sarah Cousineau (Mark Henriksen)

Optically Driven Pendulum 1621
David Coy and Michael Molnar (Randall Peters and LTC Thomas Moore)

Surface Morphology of CdZn Te Crystals Grown by Physical Vapor Transport 1626
Montiquilla Davis (Arnold Burger, Henry Chen, Kuo-Tong Chen and Muthukumaran Gunasekaran)

Avalanche Segregation of Granular Media 1631
James Koeppe and Michael Enz (James Kakalios)

Magnetic Susceptibility (MS) and Visual Spectral Reflectance (VIS) Measurements: Paleoclimate Estimates for Pleistocene Europe 1636
James R. Marlatt (Brooks B. Ellwood)

Diamond Film Coatings on Titanium Alloy Using Chemical Vapor Deposition 1641
Andrea Nelson (John T. Tarvin and Yogesh K. Vohra)

Purification and Crystal Growth of Lead Iodide 1646
Danielle Robinson (Kuo-Tong Chen, Arnold Burger, Henry Chen and Muthukumaran Gunasekaran)

Recalibration of the Wilson-Bappu Effect Using the Singlely Ionized Magnesium k and h Lines 1651
Frederick Scoville (Jose Mena-Werth)

Analysis of X-ray Sources in Galaxy Clusters 1656
Dean Smith (Mark Henriksen)

Using FTIR-Reflection Absorbance Spectroscopy to Study the Structure of Thin Ice Films 1659
Jennifer L. Spillman, Govind Mallick and Robert M. deGroot (Marin S. Robinson)

CHEMISTRY

Large DNA Fragment Sizing by Flow Cytometry 1664
Angela R. Cameron (Jeffrey T. Petty)

Enchancement of Asymmetric Induction in the Aqueous Diels-Alder Reaction of (L)-Menthyl Acrylate with Cyclopentadiene by ß-Cyclodextrin 1669
Kristen Daniell, Terry E. McInytre, Poh Ai Ling (Moses Lee)

Effect of Lipid Peroxidation Products, 4-hydroxy-2-trans-Nonenal and Malondialdehyde, on Erythrocyte Membranes 1674
Michael Green, Ram Subramaniam (Allan Butterfield)

The Synthesis and Decomposition of Single Source CVD Precursors 1679
Tadd Kippeny (D.S. Amenta, J.W. Gilje, and T.C. DeVore)

Thermal Remediation of Model Chloropesticides Utilizing Reactions with Sodium Salts 1684
James W. Parrett, Jr. (Thomas C. DeVore)

Determining the Effect of Substitutions on the Hyperpolarizabilities of Tricyanoquinoline-Dimethanes 1689
Jamarcy L. McDaniel (Beatriz Cardelino)

Better Magnetic Resonance Imaging Contrast Agents for Tumor Detection 1694
Leah C. Saunders (Thomas R. Cundari)

Computational Analysis of the Electronics of Substituents on Aromatic Systems 1699
Lunelle A. Schmiedekamp (Judy L. Ozment)

Isolation of a Compound Responsible for the Biochemical Control of Dimorphism in Candida Albicans 1704
Joseph J. Tasto (Kate J. Graham)

Adsorption Behavior of NO and CO on Pd/Al_2O_3: An FT-IR and Mass Spectrometric Study 1707
Chad D. Marten and Barry W. Smith (Dilip K. Paul)

Structural Studies of a Modified Oligonucleotide using 2-D NMR Techniques 1712
Thanh Ta, Shannon Teeters and Brigette Semler (Dale G. Ray III, Mark McDougall, Jim Holecek, Lorraine Rellick)

Effects of Additives, pH, and Buffers on the Chemiluminescence of Phenyl Acridinium Ester 1717
Carolyn Snider, John Rollag (D.S. Hage)

Dynamic Surface Tension and Surface Adhesion Detection for the Rapid Analysis of Surfactants 1722
Dana Alloway (Robert Synovec and Kristen Skogerboe)

Interactions of the Domains of Myosin's Regulatory Light Chain with the Heavy Chain: A Photocross-linking Study 1727
Lisa Nguyen (Jennifer J. Olney and Christine R. Cremo)

Thermodynamic Melting Point Studies of a Native and Modified Thirteen Base Pair Oligonucleotide containing 5-Nitroindole using UV Spectrometry 1732
Jamie Doone and Chad Willis (Lorraine Rellick, Dale G. Ray, Jim Holecek, and Mark G. McDougall)

Chitosan-Porphyrin Films for NLO Applications and Optical Devices 1736
Celeste A. Roney (Rosalie A. Richards, Subhash C. Bhatia, Albert N. Thompson, Jr., and Beatriz H. Cardelino)

Biochemical Characterization of Amino Acid Uptake in Potential Vacuolar Mutants of Neurospora crassa 1741
Zeljka Basic and Jonathan Z. Tayco (Kelly Kennan)

Preparation of Co(PYAN)$^{-3}$ and Progress Toward the Separation of its Optical Isomers 1745
Lori Bigler (Susan C. Jackels)

Attempted Synthesis of a Precursor of an Anti-tumor Marine Alkaloid: Shermilamine B 1750
William Buitrago (Yvette Jackson and Michael Lyon)

Determination of the Vanadate-Mediated NAD(P)H or NADH Oxidation Mechanism in Biological Systems 1755
Carlos J. Olivo-Delgado (Ileana Nieves-Martinez and Ronald P. Mason)

Mobius Kekulenes: Semiempirical and ab initio Hartree-Fock Calculations of Their Structures and Properties 1760
Patricia L. Frisch (Robert W. Zoellner)

Synthesis of (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d Diisopropyl 4b,8b,8c,8d -tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate: A Project on Absolute Asymmetric Induction 1765
Kimberly Johnson and Jacob E. Simpson, Jr. (Moses Lee)

The Polymerization of Dicyclopentadiene for use in the Undergraduate Organic Laboratory Utilizing Computational Methods 1769
Jason Logan (James W. Hershberger)

Examination of the Decarboxylation of Ketoisovalerate Using Pyruvate Decarboxylase from Saccharomyces cerevisiae 1773
Michael B. Meek (Betty H. Stewart)

Synthesis, Purification, and Activity of Glutaryl-CoA Analogs 1777
Shannon L. McKinney, Carrie L. Donley, Gregory K. Sewall, Patricia L. Kultgen (Colleen M. Byron)

The Synthesis of Rigidin -- A Tetrasubstituted Pyrrole 1782
R. Jordan Shuford (Keith Krumpe and John Gupton)

Molecular Modeling of Vanadium-Oxo Complexes 1787
Laura L. Sisterhen (Thomas R. Cundari)

Characterization of Liquid Crystalline Thermoset Networks 1792
Jeffrey M. Valentine (Christopher K. Ober)

Faraday Rotation of a Photogenerated Organic Triplet Molecule in Polyvinyl Alcohol Films 1797
Paul Trotto (David Hall and David Dwyer)

HPLC Analysis of Eicosanoids in Response to Valproic Acid (VPA), Endotoxins (LPS) and Tumor Necrosis Factor (TNF) 1802
Matthew Thomas McKevitt (J.R. Stephens)

Preparation of an Iron Complex of Pyo$_2$[18]dieneN$_6$ 1807
Shane O'Mahony (Susan C. Jackels)

The Plasma Etching of Metals and Metal Compounds 1811
Gordon Shaw (Judity Halstead)

ENVIRONMENTAL SCIENCES

Pipelines and Potential Disaster: An Introduction to Cathodic Protection 1816
Joy J. Burwell (Brian Hale and Verne Lehmberg)

Twin City Water Quality Initiative Program 1821
Valerie Kuntz (Kenneth Brooks)

Lead Contamination of Canned Food Products from Argentina 1825
Margaret M. Ryan (Richard P. Maas)

Don't Die with TDI: Dynamic Calibration of MDA Isologgers for Toluene Diisocyanate 1830
Clare E. Smith (Herschel A. Elliott and V. Dharmarajan)

The Effect of Carbon Content on the Redox Potential and Fermentation Products of Wetland Soils 1835
Wendy Rash and David Cahan (Kevin K. Moorhead and Keith E. Krumpe)

The Invasion of Carrotwood (Cupaniopsis anacardioides): A Study Comparing the Impact of an Exotic Species on two Islands in Sarasota, Florida 1840
Lisa Downey (Sandra Gilchrist, John B. Morrill and Terry Palls)

Urban Forests and Wildlife: A Web Document 1845
Katrina M. Simon (John Bishop)

Effects of Stratification on Germination of Two Oak Species in Southeastern Arizona 1849
Kimberly Suedkamp (Guy R. McPherson)

Seasonal Fluctuations in Central Greenland Ice Sheet Radar Altimeter Return Characteristics 1853
Philip Dennison (Richard Alley)

Results of a Microseismic Survey of the Front Range of Colorado 1857
Noah Daniel Hughes (Anne Sheehan)

Atmospheric Teleconnections and United States Regional Climates 1862
Dana M. McCracken (Anthony J. Vega)

Extracellular Acid Phosphatase(s) Activity of the Protozoan Parasite Perkinsus Marinus 1866
Christine M. Forsythe (Aswini K. Volety, and Fu-Lin E. Chu)

Microhabitat use by Fish Populations within the Little Miami River 1871
Daniel J. McGarvey (Horton H. Hobbs III and John B. Ritter)

Water Chemistry Habitat Assessment in Eastern Tiger Salamander Ponds 1876
Sara E. Wirtz (Daniel M. Downey)

The Derivation of United States Temperature and Precipitation Regions 1881
Donna M. Fiscus (Anthony J. Vega)

Cloud Masing of Normalized Difference Vegetation Index (NDVI) Images 1885
Heidi Zeleznik (Barry Lesht)

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MODIFICATION OF AN INTERFERENCE PATTERN THROUGH PARTICLE STATISTICS: EXPERIMENTAL STUDY

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Using a green He-Ne laser (543.5 nm) as a light source, a double slit as an interference device and a photomultiplier tube as a photon counting apparatus, comparisons of the shapes and intensities of double slit interference patterns are made using differing intensities of incident laser light. Patterns with low intensity and long exposure are compared with those from high intensity and short exposure, as well as with the theory. A mismatch in the relative intensities, as a function of angle, of the bright versus dim patterns has been observed. A possible explanation is that the higher intensity regions could be the result of two-photon or three-photon counting instead of single photon counting. The experimental goal reported on here is to further examine the cause for the unexpected variations in intensity. This will involve modifying the discrimination level for the photo multiplier signals, using faster electronics to reduce any signal pileup, and carefully measuring the light intensities to be used.

INTRODUCTION

It has been shown (Demster and Batho, 1927) that photons passing through an interference device after long term accumulation produce the expected interference patterns. Quantum mechanics requires that the interference pattern produced should depend on the total number of photons events and not on the rate at which these events occur. So even when the intensity is so low such that only a photon at a time interacts with the slit, the wave theory predicts the correct average pattern after accumulation. Interference patterns produced from exposure to dim light after long periods of accumulation should be the same as those produced from exposure to bright light with relatively short periods of accumulation, provided the number of total photon events are the same for both cases. Quantum theory states this to be true because of the equal probability in each case. The original intent of the experiment was to test the patterns from short term bright light and those from long term dim light accumulations, as well as to compare them with the theoretical pattern. The previous experimental results[5] did confirm that the location of the double slit peaks agreed with the theoretical prediction. However the shapes of the envelopes were not consistent for the patterns obtained for different intensities of light. Patterns of relatively dim light had a good theoretical fit, but for relativity bright light the sides of the central maximum and the first order maximums were far too low. My intention in writing this paper is to explore the proposed model of multiple photon events as a possible cause of the mis-match between theory and experiment formed in the previous work. The goal of further experimentation is to investigate the mismatch in the pattern envelope for the different intensities of light by using different levels of discriminator settings applied to the signal. By adjusting the lower level discriminator settings we are able to discriminate against signals with certain pulse heights coming out of the amplifier. In this process by increasing the discriminator we are trying to eliminate signals resulting from multiple-photon events which have relatively higher pulse height than the single-photon events.

EXPERIMENTAL PROCEDURE

The basic setup of the experiment remained essentially unchanged from earlier work. The laser light is transmitted through removable neutral density optical filters and then a double slit (see Figure. 1).

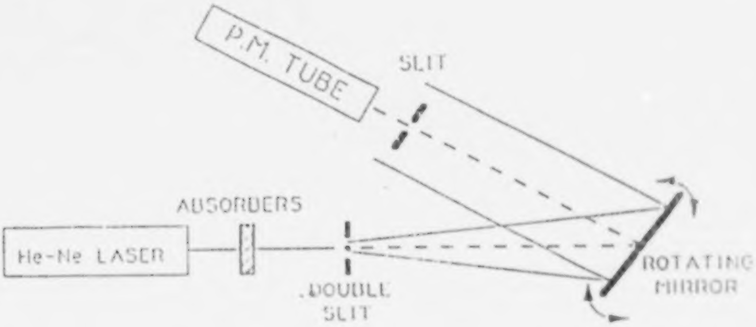
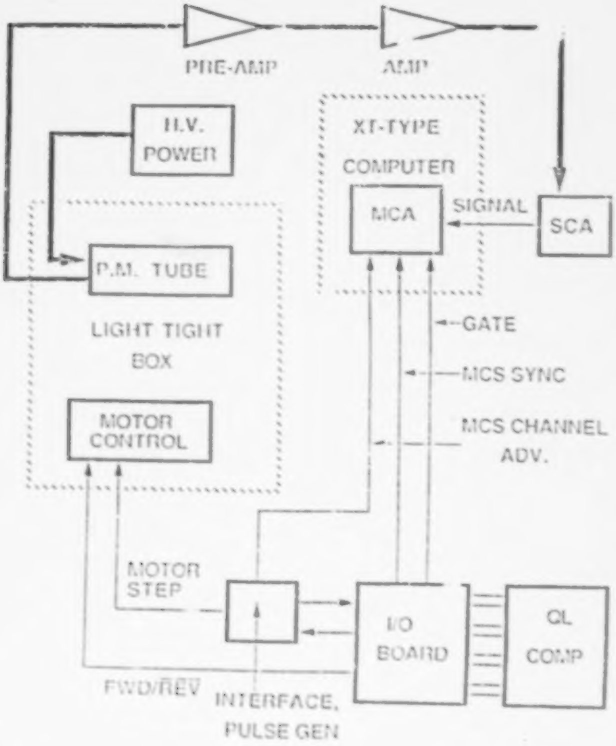


Figure 1. Basic Experimental Setup.

The desired intensity of light is obtain through appropriate use of filters of various densities. Photons emerging through the double slit are reflected off a rotating mirror to a photomultiplier tube with an adjustable detector slit. The rotating mirror is driven by a stepper motor where each step of the motor corresponds to 2.63 x 10^{-4} radians. The mirror steps the interference pattern counterclockwise through 255 channels (6.68 x 10^{-4} radians) of the photomultiplier tube. After the data has been accumulated in all 255 channels, the mirror is stepped clockwise in reverse, without accumulation, 255 channel to the original starting position. We are using a Hamamatsu R1463-01 1/2 inch diameter photoelectric tube (with multialkalai cathode) as the detector. This has an advertised quantum efficiency of 10% at 543.5 nm (Hammamatsu, 1984). The photomultipler tube is cooled by placing it in a Thron EMI cooler to reduce the dark count as much as possible. All background light is essentially eliminated by placing this entire system in a light-tight box.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MCS CHANNEL
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BOARD
QL
COMP
FWD/REV
INTERFACE,
PULSE GEN

Figure 2. An electrical schematic of the experiment.

An electrical schematic of the experiment is shown in Figure 2. The photomultiplier tube is powered through a 1000 volt bias supplied by a Tennelec TC 952 High Voltage supply. Signals out of the PMT are processed with an ORTEC 9301 fast preamplifier and then through an ORTEC 570 shaping amplifier. The signal from the shaping amplifier is then sent to an ORTEC 551 timing single channel analyzer (SCA) with discriminator. At this stage various discriminator settings are applied to the incoming signal from the shaping amplifier. From the SCA, a TTL signal for each pulse is sent to a multichannel analyzer (MCA). The MCA was manufactured by The Nucleus, and contains in one of the abus boards for an IBM compatible computer. Synchronization between the mirror movements and data acquisition is controlled by a BASIC program, developed locally, employed on a Sinclair QL computer. When taking data at different incident light intensities, the only changes made to the experimental apparatus were in the filters providing absorption before the double slit, and in the number of passes.

RESULTS & DISCUSSION

The patterns obtained through exposure to dim light after long accumulation had a good theoretical fit for different discriminator settings (see Figure 3). The vertical axis represents the number of counts and the horizontal axis represents the channel number.

Patterns at three different lower level discriminator setting is shown, at 0.15 volts, 0.34 volts and 0.5 volts. The curve superimposed on the pattern, represents the theoretical single slit envelope and it is scaled in height to best match the data in the center of the pattern for each of the settings. The dim light plot for a low discriminator level of 0.15 volts shows a considerable amount of background noise; the signal rests above the noise. The theoretical fit is reasonably good at all the discriminator levels for patterns of dim light. Therefore, the discriminator setting has little effect upon the interference pattern for dim light. This is consistent with the idea that dim light results in mainly single photon events.

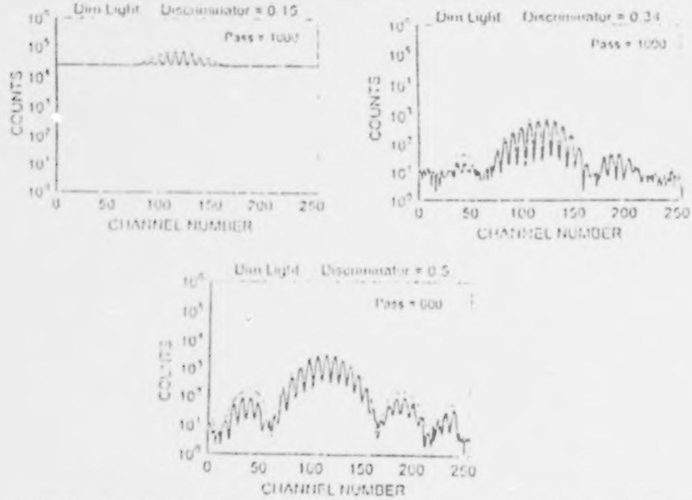

Figure 3. Dim Light Patterns for various discriminator settings.

Puzzling results were obtained for patterns of medium light (see Figure 4.). The intensity of light here is about 100 times brighter than dim light. The central region of the pattern is a closer fit to the theoretical for lower level discriminator setting, this is as expected since at lower level mostly single-photon events dominate. As the discriminator level is increased the first order maximum deviates from the theoretical curve, this is consistent with the idea that as the lower level discriminator is increased multiple-photon events become more prominent. However, this observation should have increased as the discriminator setting is increased, but as seen in Figure 4, for discriminator settings of 0.5 volts and above, the pattern is a good fit to the theoretical. The 543.5 nm He-Ne laser that was used for the experiment began pulsing during these later runs. We have since found out that the power supply for the laser was damaged, causing this pulsing. At this point we believe the effects seen for the medium light could be caused by the malfunction of the laser. And further experiments are currently being done with a new 543.5 nm laser to reproduce different patterns seen for medium light. The bright light runs not shown here, fit the model well. At lower discriminator levels for the bright light the theoretical was a good fit to the experimental result and at higher discriminator levels the inconsistency was seen between the theoretical and the first order.

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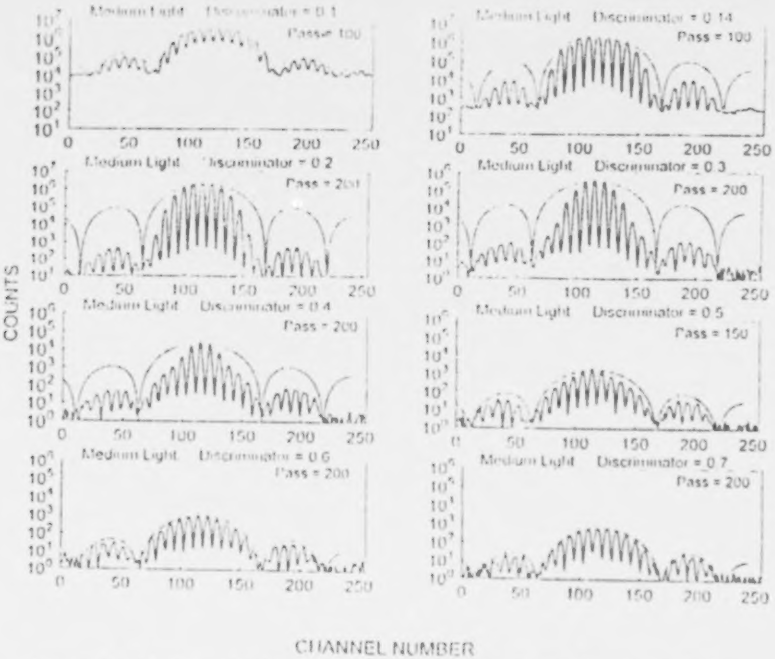

Figure 4. Medium Light patterns for various discriminator settings.

CONCLUSION

The discriminator setting does have an effect on the interference pattern of relatively medium and bright light. It however does not effect the pattern accumulated through exposure to dim light. This is consistent with the idea that for relatively dim light, single-photon events are more probable. Since the interference pattern for medium light deviates from the theoretical envelope for the values in the mid range of discriminator setting, the pattern is being affected by the discriminator. But since this behavior is not seen at higher settings of the discriminator further experimentation is needed before a definite conclusion is drawn.

REFERENCES

1. A. J. Demster and H. F. Batho. *Physics Review*. 30: 644 (1927).

2. R. I. Pfleegor and L. Mandel. *Physics Review*. 159: 1084 (1967).

3. P. A. Tipler. *Elementary Modern Physics* , Chapter 3. Worth Publishers, New York(1992).

4. P. G. Merli, G. F. Missiroli and G. Pozzi. *American Journal of Physics*. 44: 306 (1976).

5. Orosz and Fadner, *Bulletin of American Physics Society* 34: 1 52 (1989).

Nuclear Structure of the Stable Tellurium Nuclei

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The level schemes of the even mass tellurium nuclei A=124, 126, 128 and 130 have been constructed by measuring the de-excitation gamma rays following excitation of a target nucleus by inelastic neutron scattering. Level schemes were developed by identifying gamma-ray cascades with a multiple detector arrangement. Combined with additional information obtained from gamma ray angular distribution data, the evolution of nuclear structure across an isotope chain becomes apparent. Results are compared with IBM-2 and PCM model calculations.

INTRODUCTION

There are 8 stable tellurium isotopes. This number of isotopes is exceeded only by the 9 of Xenon and the 10 of Tin. This great number of isotopes allows one to examine the evolution of nuclear structure for a near continuous range of neutrons.

Two fundamental difficulties arise in constructing the perfect theoretical description of nuclear structure. First, unlike atomic structure, an exact form for the interaction potential cannot be constructed. Second, the sheer number of particles involved, on the order of 130, makes the full calculation intractable. Different techniques of handling these two fundamental difficulties lead to different nuclear models. There are two basic nuclear models, the independent particle shell model and the collective model.

The most rigorous treatment is the independent particle model. It is observed that there are significant jumps in the values of binding energy per nucleon at neutron or proton numbers = 2, 8, 20, 28, 50, 82, and 126. This is analogous to the shell model of atomic structure, and these so called "magic numbers" represent major shell closures. Simplifications can be made by assuming that all the properties of the nucleus come from the valence particles/holes beyond the closed shells. Calculations become unmanageable for nuclei with many particles occupying ≥6 orbits. The independent particle model is very effective for nuclei with lower mass numbers.

Collective models are based on motion of the nucleus as a whole rather than individual particle motion. These models attempt to account for general properties that vary smoothly across a range of mass numbers. For near-spherical nuclei, energy added to a nucleus excites surface oscillations about the equilibrium shape. The fundamental vibrational modes are referred to as phonons. This has been effective in predicting many low lying levels. For deformed nuclei, rotation of the static nuclear shape leads to a level scheme well described by a classical rotor. Historically (Bohr 1969, Novarov 1987) the general situation is modeled by constructing a Hamiltonian to describe the motion of interspersed neutron and proton fluids. Most modern calculations use an algebraic treatment known as the Interacting Boson Model-2 (Iachello 1984, Otsuka 1985) because of its ease of use and the ability to describe intermediate situations between vibrations and rotations.

Hybrid models have been constructed which combine features of the collective and particle models. The Particle-to-Core Coupling models (PCM) (Heyde 1967) treat states in the tellurium nuclei as a valence pair of protons orbiting a Sn nucleus which is allowed to undergo vibrations. One can then introduce additional terms in the Hamiltonian to allow interactions between the valence particle-pair and the phonon vibrations.

All the different models are capable of placing some energy levels, but none are capable of placing all of them. Through experimental determination of what levels actually exist, it can be seen in what regions each model is effective, and possible improvements to the current models can be postulated. There is no perfect unified nuclear model.

EXPERIMENTAL PROCEDURE

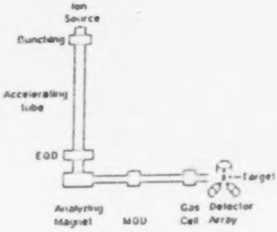

Figure 1. Layout of the University of Kentucky's 7.0 MV Van de Graaff accelerator and beamline used for coincidence measurements.

Data used in this investigation were taken during the summers of 1994-1997 at the Nuclear Structure Laboratory at the University of Kentucky. This Van de Graaff facility (Fig. 1) is capable of accelerating protons, deuterons, ^{3}He, and alpha particles in either a continuous or pulsed beam mode. In pulsed beam mode, a Klystron terminal bunching system produces beam bursts with pulse width less than 1 ns with 531 ns spacing between pulses, and can deliver greater than 2 μA of protons on target. The use of pulsed beams allows one to significantly reduce background in the detector spectrum, improving the signal-to-noise ratio. Protons of a specific energy are selected by passing through a 90° analyzing magnet. Electric and magnetic quadrupole doublet lenses focus the beam. The protons then strike a gas cell filled with tritium to produce neutrons with the $p + {}^3H \rightarrow n + {}^3He$ reaction with a Q-value of -0.76 MeV. The sample of interest is hung in the emerging cone of neutrons.

With the normal operating limits of the accelerator being ~1.5 MeV to ~6.5 MeV, neutrons are available from ~0.7 MeV to ~5.7 MeV. The gas cell is cylindrical, 1 cm in diameter, 3 cm in length, and lined with tantalum to suppress background (p,n) or (d,n) reactions. The tritium gas is separated from the beam line by a 7.6 μm Mo foil. The emerging neutron beam then passes through a paraffin shielded collimator and strikes the target. The use of pulsed beams allows one to significantly reduce background in the detector spectrum, improving the signal-to-noise ratio.

Samples were ~100 gm of natural tellurium chips and ~30 gm of isotopically enriched ^{124}Te powder. The containers were suspended in front of the neutron beam and surrounded by lead shielding and three detectors. Each detector was placed approximately four centimeters away from the sample. Two of the detectors were n-type Ortec high-purity Ge detectors of 51% and 57% efficiency with a resolution of about 2.1 keV at 1332 keV. The third detector was an n-type PGT HPGe detector of 32% efficiency with a resolution of about 2.5 keV.

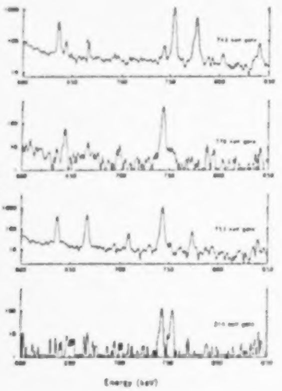

Figure 2. A portion of the γ-ray coincidence data gated on the low lying levels of ^{128}Te.

To identify the gamma-ray cascades, data was taken in "event mode" -- when at least two detectors fire, the energies from all detectors are written to disk for later off-line analysis. A correlation matrix is then constructed which correlates the energy in one detector to the energy in another. Cascade sequences are discovered by slicing rows out of the matrix and observing which γ-rays occurred in the other detectors. This projection is referred to as gating.

Level schemes were built by constructing 1-D histograms (projections) for the four known low lying transitions ($2_1^+ \rightarrow 0_1^+$, $4_1^+ \rightarrow 2_1^+$, $2_2^+ \rightarrow 2_1^+$, and $6_1^+ \rightarrow 4_1^+$) in each nucleus. All states in nuclei tend to cascade down to the ground state through these four levels. These four histograms can be displayed as a graph of yield versus gamma ray energy (Figure 2).

Lifetimes of the tellurium excited states are determined with the Doppler Shift Attenuation Method (Belgya 1994). When a nucleus is struck by a neutron, it recoils accordingly. If the lifetime of the excited nucleus is short, it can decay while it is still moving. If it does, the observed energy of the resulting γ ray will be altered by the Doppler effect. The size of the Doppler effect depends on two factors: the decay-weighted average velocity and the angle of detection relative to the recoil. For the neutron energies available at the University of Kentucky, lifetimes in the range of a few femptoseconds to a few picoseconds can be determined. The uncertainties, however become quite large near the limits.

Angular distributions of de-excitation γ rays were measured at a neutron energy of 2.60 MeV. The angular distributions were fit to even-order Legendre polynomial expansions and compared to theoretical calculations from the statistical model code CINDY (Sheldon 1966) in order to deduce level spins and parities and to extract multipole-mixing ratios.

DISCUSSION

The anticipated structural concerns are readily apparent when one examines the mass dependance of selected levels (Fig. 3). The 2_1^+,4_1^+, and 2_2^+ states show the parabolic increase expected of vibrational states as the neutron number varies from mid-shell. For neutron numbers above mid-shell, the 6_1^+ state remains a constant excitation energy indicative of the added neutrons going into a single particle orbit.

Vibrational models are constructed from the creation-annihilation operator formalism. A creation operator d^+ is defined which creates a (quadrupole) phonon containing two units of angular momentum (i.e. d denotes a d-state). The IBM-2 (Otsuka 1985) Hamiltonian is of the form:

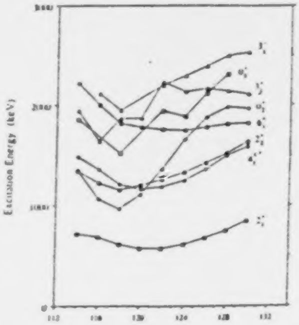

Figure 3. The mass dependence of selected energy levels in the Tellurium nuclei.

$$\mathcal{H} = \hbar\omega\, d_\pi^+ d_\pi + \hbar\omega\, d_\nu^+ d_\nu + KQ_\pi \cdot Q_\nu + V_{\nu\nu} + M_{\pi\nu} \qquad (1)$$

where the first two terms are readily recognizable as that of the standard simple harmonic oscillator. Protons and neutrons are distinguishable particles and thus there exists two types of phonons in the system; π (protons) and ν (neutrons), hence the name Interacting Boson Model-2. The phonon energy ħω is taken to have the same value for both types. Multiple phonon states are possible, forming degenerate states. If the nucleus is not spherically symmetric, these degeneracies will be broken. The remaining terms in the IBM-2 Hamiltonian have the effect of describing non-spherical vibrations. The third term is an interaction between the quadrupole moment of the protons and the quadrupole moment of the neutrons. The fourth term splits the degeneracy in the two-phonon multiplet. The last term serves to differentiate states which are symmetric or asymmetric under interchange of neutron and proton labels. The effects of the last term are not considered in this paper.

In the mid-neutron-shell Tellurium-120, the splittings between members of multiplets are reasonably small ($V_{\nu\nu} = 0$) which suggests that a spherical vibrational model would provide a good description of the nuclear properties. As one moves away from the mid-shell ^{120}Te, anharmonicities ($V_{\nu\nu}$) should grow as the nucleus becomes (γ-) softer and more prone to deformation. The 0_2^+ state should rapidly rise to join the 3_1^+ state. This is observed.

The explanations above are based only upon level energies. Often level energies are more important for evaluating whether a model has sufficient built-in complexity rather than distinguishing between alternate physical descriptions. Transition rate information is crucial to revealing the absolute amplitudes of particle and collective components in the wavefunctions. Selected transition rates for the tellurium nuclei are given in Table I.

Table I. Selected experimental transition rates. Values are given in Wu (Weisskopf units). Quadrupole moments are taken from Firestone (1996). Uncertainties given in parenthesis are those in the last digits.

Transition	124Te	126Te	128Te	130Te
E2: 2_1^+-gs	31(1)	25(1)	19(1)	15(3)
E2: 2_2^+-gs	2.9(2)	1.23(12)	0.67(23)	1.3(2)
E2: 2_3^+-gs	0.30(4)	0.60(35)	<0.01()	0.050(5)
E2: 2_4^+-gs	0.28(4)		0.56(7)	0.26(9)
E2: 2_2^+-2_1^+	80(5)	25(2)	0.56(20)	10(5)
E2: 4_1^+-2_1^+		34(17)		
E2: 0_2^+-2_1^+	7(5)	24(17)	8.7(110)	3.2(30)
M1: 2_2^+-2_1^+	2.4(2)E-1	3.6(4)E-1	6.2(24)E-3	<2.3E-2
M1: 2_3^+-2_1^+	9.8(11)E-3	7.5(48)E-3	5.3(20)E-3	8.4(8)E-2
M1: 2_4^+-2_1^+	1.3(20)E-2		1.4(2)E-1	7.5(27)E-3
Q (b)	-0.45(5)	-0.20(9)	-0.06(5)	-0.15(10)

Using the parameter set of Sambataro (1982), IBM-2 model calculations for transition rates were made and are presented in Table II.

Table II. Selected IBM-2 Transition rates using the parameter set of Sambataro (1982). Values are given in Wu (Weisskopf units).

Transition	124Te	126Te	128Te	130Te
E2: 2_1^+-gs	29.1	23.1	17.4	12.6
E2: 2_2^+-gs	0.71	0.51	0.29	0.10
E2: 2_3^+-gs	0.00	0.00	0.00	0.00
E2: 2_4^+-gs	0.00	0.00	0.00	0.00
E2: 2_2^+-2_1^+	31.7	23.2	13.7	12.1
E2: 4_1^+-2_1^+	44.7	33.6	23.1	15.0
E2: 0_2^+-2_1^+	28.7	19.8	13.4	7.8
M1: 2_2^+-2_1^+	1.7E-2	2.6E-2	3.9E-2	4.4E-2
M1: 2_3^+-2_1^+	3.0E-2	2.2E-2	1.2E-2	2.4E-2
M1: 2_4^+-2_1^+	6.3E-4	1.9E-3	1.6E.3	2.1E-3
Q (b)	-0.29	-0.21	-0.13	-0.05

The measured quadrupole moments observed are reasonably small (as expected for spherical nuclei), and increase when going toward the mid-shell ^{120}Te. The IBM-2 calculations naturally indicate a vibrational structure. The single-phonon component of a excited state's wave function is indicated by the strength of the E2 ground state transition. The 2_1^+ state has a strong single-phonon character with little single-phonon character in the higher 2^+ states. With the exception of the results for ^{128}Te, the 0_2^+, 2_1^+,4_1^+ triplet of states have reasonably strong decays into the single-phonon 2_1^+ state as is expected from a two-phonon excitation. The IBM-2 calculation is in fair agreement with the measured 2_1^+ --> 0_1^+ and 0_2^+ --> 2_1^+ transitions.

The tellurium nuclei will not provide information on the mixed symmetry states unique to the IBM-2 model. There are no anomalously large M1 transitions which are signatures of these mixed symmetry states. This is consistent with the IBM-2 model calculations which indicate that the mixed symmetry strength is spread over all the low lying 2^+ states.

Using the PCM model, Lopac (1970) has examined the level sequence in the telluriums as a function of the particle-to-phonon coupling strength. Near A=120-122 (mid-shell) the trends toward γ-soft deformation were reproduced using smaller particle-phonon coupling strength.

Degrieck (1974) repeated similar calculations and made predictions of a few M1 and E2 transition rates. Although his model parameters are based on refined experimental information in Sn, Sb, and Te, the mass behavior of the particle-phonon coupling strength appears diametrically opposed to that suggested by Lopac (1970). Degrieck's calculation reproduces the excitation energies of the 2_1^+, 4_1^+, and 6_1^+ states, all others are forced out of their "natural locations".

In both PCM model treatments, only 60-75% of the wave function is accounted for in terms a readily identifiable components; this is actually on par with most shell model calculations. Examination of the transition rates predicted by the Lopac and Degriek revealed the complete failure of both calculations. The simpler IBM-2 treatment produces more reliable explanations than these two "more advanced" PCM calculations.

Younes (1993) has re-examined the heavier Te isotopes through the PCM. The calculations indicate the 6_1^+ state has more single particle structure as one moves from lighter to heavier isotopes. This increasing particle-character for the higher spin states in heavier isotopes is consistent with the dropping of the $g_{7/2}$ and $h_{11/2}$ orbits suggested by the odd mass Z=51 (Sb) nuclei.

SUMMARY

The excited levels of ^{124}Te, ^{126}Te, ^{128}Te and ^{130}Te and the electromagnetic transitions between these levels have been studied using the (n,n'γ) reaction. Using a recently developed γ–γ coincidence technique, the level schemes were constructed up to approximately 2800 keV for each nucleus. Angular distributions and Doppler shifts were measured at an incident neutron energy of $E_n = 2600$ keV. This data allowed extraction of level spins, parities, and lifetimes of the states. Transition rates between levels were calculated for comparison to nuclear models. A standard IBM-2 treatment produced moderate agreement with measured level energies and transition rates. Two implementations of the more refined PCM treatment were completely unable to adequately describe these nuclei. The simpler IBM-2 treatment produces more reliable explanations than these two "more advanced" PCM calculations. An explanation of the nuclear structure of the 6_1^+ state remains elusive.

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REFERENCES

Bohr, A. and Mottelson, M., 1969, Nuclear Structure, Advanced Book Program, W.A. Benjamin, New York, NY.

Belgya, T., Fazekas, B., Molnar, G., Gatenby, R.A., Johnson, E.L., Baum, E.M., Wang, D., DiPriete, D.P., and Yates, S.W., 1993, In Proceedings of the 8th International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics, Fribourg, Switzerland, edited by J. Kern (World Scientific, Singapore, 1994), p. 878.

Firestone,R.B., Shirley,V.S., Baglin,C.M., Zipkin,J., and Chu,S.Y.F., 1996, Table of Isotopes 8th edition, Wiley-Interscience, New York, NY 1996

Heyde, K. And Brussard, P. Nuclear Physics, Vol. A104, 1967. pg. 81

Nojarov, R. and Faessler, A., J. Phys. G, Vol. 13, 1983. pg. 337

Iachello, F. Phys. Rev. Lett., Vol. 53, 1984. pg. 1427

Otsuka, T. and Yoshida, N., Japanese Atomic Energy Research Institute Report, No. 85-094 1985.

Sheldon, E. and Van Patter, D.M., Rev. Mod. Phys., Vol. 38, 1966. pg. 143.

Younes,W., Cizewski,J.A., Bernstein,L.A., Jin,H.Q., Henry,R.G., Bull. Amer. Phys. Soc., Vol. 38, 1993, pg. 980

Pulse Propagation in a 1-D Physical Lattice

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A mechanical system of coupled harmonic oscillators provides a practical simulation of a one-dimensional crystalline lattice. Using this system, the decay of a wave packet and the speed of sound in the physical lattice model were measured. This was done through the use of an ultrasonic position monitor and computer software to record the position of a lattice element as a function of time as a pulse moves through the lattice. We compare the observed experimental results with the theoretical predictions.

THEORY

The position of a particle, x_n, of a one-dimensional linear lattice of coupled springs and equal masses with fixed endpoints, is described by:

$$m(d^2x_n/dt^2) = f(x_{n+1} - x_n) - f(x_n - x_{n-1}) \qquad (1)$$

Let u_n be the separation between lattice points. Then

$$u_n = x_{n+1} - x_n . \qquad (2)$$

Rewriting equation (1) in terms of u_n:

$$m(d^2u_n/dt^2) = m(d^2x_{n+1}/dt^2) - m(d^2x_n/dt^2) = f(u_{n+1}) - 2f(u_n) + f(u_{n-1}) \qquad (3)$$

Assuming the force will be of the form of a linear spring force, then:

$$f(z) = -\mu z . \qquad (4)$$

where μ is the spring constant. To obtain the wave equations for the lattice, a change from a discrete to a continuous variable is necessary. Replacing this discrete model by a continuous one yields

$$u_n(t) = u(x,t) \qquad (5)$$

Following Jackson (Jackson, 1991), the Taylor series expansion of equation (5) becomes,

$$u_{n\pm1}(t) = u(x,t) \pm h(\partial u/\partial x) \pm (h^2/2!)(\partial^2u/\partial x^2) \pm \ldots \qquad (6)$$

Here h is the equilibrium separation between lattice elements. The solutions of the differential equation resulting from inserting (6) into (3) will be traveling waves, of the form

$$x = A(k) \sin(kx-\omega t) , \qquad (7)$$

where A(k) is dependent on the nature of the excitation and $\omega(k)$ must satisfy the dispersion relation:

$$\omega = 2 (\mu/m)^{1/2} \sin(kh/2) . \qquad (8)$$

In equation (8), ω is the angular frequency, μ is the linear spring constant, m is the mass of each lattice element (cart), k is the wave number, and h is the equilibrium separation between lattice elements.

Now that the dispersion relation is known the condition that a wave packet will break up in a lattice will be discussed. The pulse will travel at the "group velocity", v_{group}. The equation for v_{group} is:

$$v_{group} = (d\omega/dk)|_{ka} = h(\mu/m)^{1/2} \cos((ka)h/2) \tag{9}$$

where ka is the average k value of the traveling waves (equation 7) making up the pulse. (For a more complete derivation of the group velocity see Crawford, 1966). From equations (7), (8), and (9) it can be shown that a wave packet will break up if there is a variation in wave speeds in the packet over $\Delta\omega$, the range of frequencies making up the packet.

The theoretical breakup of the wave packet is as follows.
A minimum Gaussian packet has the property that:

$$\Delta\omega\, \Delta t_o \approx 1\ , \tag{10}$$

where Δt_o is the initial temporal width of the pulse. The spatial width, ΔL as a function of time, is given by:

$$\Delta L = \Delta v\, t = \Delta k(\partial v_g/\partial k)|_{ka}\, t = [\Delta k\ (\partial^2\omega/\partial k^2)|_{ka}]\ t\ , \tag{11}$$

where Δv is the variation in the velocities over the frequencies present in the wave packet, t is the time, and Δk is the range in wave numbers corresponding to $\Delta\omega$. The temporal width, Δt, is given by:

$$\Delta t = \Delta L/v_g = [\Delta k\ (\partial^2\omega/\partial k^2|_{ka})/v_g]\ t \tag{12}$$

If v_{group}, given by equation (9), is relatively constant over the range of k values then $\Delta\omega/\Delta k$ can be approximated by:

$$v_g = (d\omega/dk)|_{ka} \approx (\Delta\omega/\Delta k) \tag{13}$$

Substituting the solution obtained for Δk from equation (13) into equation (12) yields the following equation

$$\Delta t = [\Delta\omega\ (\partial^2\omega/\partial k^2|_{ka})/v_g^2]\ t \tag{14}$$

From equation (10) it can be shown that equation (14) can be written as:

$$\Delta t = [\partial^2\omega/\partial k^2|_{ka}/(\Delta t_o\, v_g^2)]\ t \tag{15}$$

The temporal width of the pulse increases linearly with time.

EXPERIMENT

An air track was set up with twelve individual lattice elements (carts) coupled together by springs. The average mass of the carts was 0.3 kilograms and the average spring constant was 26 N/m. The carts were set in motion from one side by using a magnetic solenoid pulser. The data recording system was triggered by this pulse. The position of each of the carts was obtained by use of an ultrasonic sensor, Migatron Corporation RPS-401A-40 (Cascio and Sheets, 1995). The sensor works by sending out an ultrasonic signal, which bounces off the cart and returns to the sensor, at which point a voltage is assigned to the distance of the cart and converted to digital data which the computer records at a sampling frequency of 70 Hz. All data was manipulated and interpreted using the student version of Matlab and QBASIC.

To experimentally find the dispersion relation, the following procedure was used. First, a pulse was sent through the lattice and the resulting motion was recorded over a 50 second time interval. A Fast Fourier Transform was then performed on the data to extract the resonant frequencies of the lattice (Runk, Stull, and Anderson, 1963, or Cascio and Sheets, 1995). These resonant frequencies were then matched with their corresponding modes of oscillation to generate the dispersion curve, ω versus k. Figure 1 shows this graph which corresponds to equation (8).

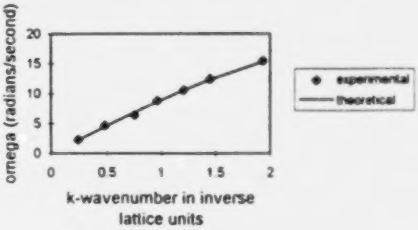

Figure 1: Dispersion curve for the system

The group velocity was then determined. The arrival of the pulse was measured at each of the lattice sites, then the pulse shape at each of the lattice sites was graphed. The full width at half maximum was calculated from each of these pulse shapes. Only the first eight lattice sites were used, as the pulse shape was distorted by waves reflected off the end of the lattice for the ninth through twelfth carts. The time for the peak excursion to reach each of the lattice sites was calculated from the experimental data, where the peak excursion corresponds to the time when the 'middle' of the wave packet reaches each of the lattice sites. From the arrival time of the peak excursion the group velocity of the wave packet can be experimentally calculated. The slope of the lattice distance against the elapsed time yields the group velocity. Figure 2a shows the graph of the lattice distance as a function of time, and Figure 2b shows a typical pulse shape measured at one of the lattice sites.

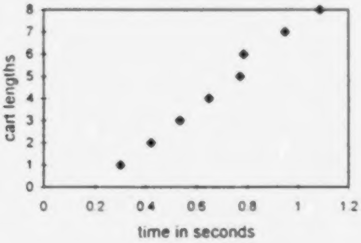

Figure 2a: Lattice distance vs elapsed time

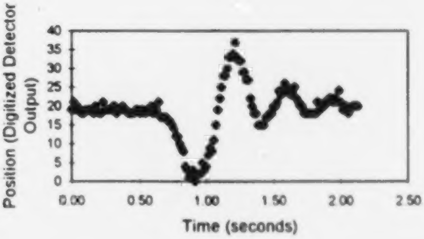

Figure 2b: Typical Pulse Shape

The numerical value of slope of the line of Figure 2a was found to be 9 lattice sites per second. This corresponds to an experimentally calculated group velocity or speed of sound of 9 lattice sites per second. From the group velocity the velocity of the pulse was obtained, since the velocity of the pulse is the group velocity evaluated at the average k value. The average k value was obtained by substituting the experimentally derived group velocity into equation (9) and solving for k_{ave}. The value of h was taken to be 1 since the group velocity was obtained in terms of lattice sites per second. From this k_{ave} was found to be 0.6 (lattice units)$^{-1}$.

The full width at half maximum (FWHM) was measured directly from the graph of the pulse shape at each lattice sites. The FWHM was then graphed against the arrival time of the peak of the pulse at each of the lattice sites. Figure 3 shows the measured FWHM versus arrival time, and the predicted FWHM from equation (15) versus arrival time.

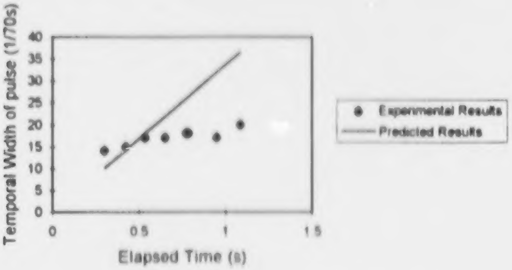

Figure 3. Predicted and Observed FWHM of Pulse

CONCLUSION

From Figures 1 and 2a it can be seen that the dispersion and the group velocity are consistent with the theory. Figure 3 shows that the pulse breaks up, but not at the rate predicted by the theory. The simple theory used was not sufficient to model the system studied. A more plausible theory could contain terms connected to friction, air drag on the cart, or variations in the k values. If this is the case, questions about the amount of friction needed to match the measured results, or how much variation in the k values would be required to match the measured results would have to be answered. Further research will involve experimentation with friction in the lattice, such as a magnetic frictional force in the physical lattice. Another approach is to observe the rate of pulse breakup as a function of the initial temporal width, Δt_0. A computer simulation will be done to test the amount of friction or variation in the k values needed to obtain the observed results.

REFERENCES

Cascio, J. and Sheets, H. D., "Computer Monitoring and Analysis of Classical Oscillators", Proceedings of the Eleventh Annual Eastern Small College Computing Conference, (1995). Edited by George A. Benjamin, Muhlenberg College, Allentown, Pennsylvania.

Crawford, Frank S. Jr, 1966, Waves and Oscillations. Vol. 3. New York: McGraw-Hill Book Company.

Jackson, E. Atlee, 1991, Perspectives of Non-linear Dynamics. Vol. 2. New York: Cambridge University Press.

Runk, R. B., Stull, J. L., and Anderson, O. L. "A Laboratory Linear Analog for Lattice Dynamics." American Journal of Physics 31.12 (Dec. 1963).

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AN INVESTIGATION TO MEASURE MECHANICAL STRAIN IN STRUCTURES USING OPTICAL FIBER INTERFEROMETRY

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A knowledge of strain measurement is extremely important for the evaluation of civil and military structures (especially for new composite materials used in airplanes). The strain gauge is commonly used to perform such measurements. We investigate an alternative method of measuring strain using optical fiber sensors. Optical fibers have some physical and technical properties that offer some advantages over strain gauge technology.

In this investigation, a Fabry-Perot fiber optic interferometer is used to measure the strain in a vibrating aluminum beam. A data acquisition system was built using LABVIEW™ to acquire and analyze, in real time, data from the interferometer. Strain measurements with the fiber optic interferometer compared favorably with a conventional strain gauge and theoretical values.

INTRODUCTION

Strain in materials and reproducible structures is measured using strain gauges. Although strain gauge technology is well understood and this method for measuring strain yields fairly accurate results, other technologies such as fiber optic sensors can offer some competetive advantages. We investigate an alternative method to measure strain using optical fibers. We believe this method when fully developed can provide a more accurate and efficient way of measuring strain. The on site measurements of strain are often transmitted to the central processing unit as electrical signals over metallic (usually copper) wires. The proposed approach transfers the strain measurement from the site to the central processing unit as optical signals using optical fibers. This approach has many distinct advantages. Optical fibers are low-cost, and are able to carry large amounts of information over long distances.

Optical fibers also have many physical properties that make them desirable. Optical fibers are generally non-corosive and light weight. Optical fibers have more appeal in areas where space, weight, and hazardous environments are issues. Because optical fibers are usually made from glass, which is a dielectric material, they are unaffected by electromagnetic interference. This is an advantage over copper in places where extra shielding might be necessary to yield accurate results.

Fiber transmitted signals may be easily multiplexed using a variety of methods. Multiplexing is already being implemented in phone lines. When applied to measuring devices such as a strain gauge, the technology of multiplexing of signals allows one to make a large number of local measurements.

BACKGROUND

The basis for the measurement of strain in the present approach is the phenomenon of interference of light waves[1]. Two light beams, obtained from a single coherent light source (a Helium-Neon laser) are brought together after having traveled different path lengths. Dark or bright fringes result depending on the difference in their path lengths.

Minute changes, on the order of a wavelength of light (632 8 nm in the case of the Helium-Neon laser) can be measured in terms of the number of fringes that move past a fixed point of reference[2,3] In other words, change in distances of about 0 6328 μm could be detected

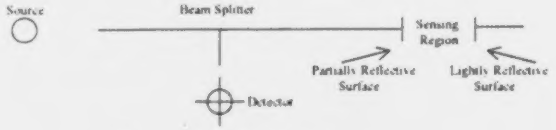

Figure 1 - Fabry-Perot Interferometer

We use the Fabry-Perot interferometer, Figure 1, in our investigation The Fabry-Perot Interferometer has a sensing region composed of the ends of fibers with partially and lightly reflecting surfaces A change in the environment of the sensing region such as an increase in strain, produces a change in the path length The increase in path length causes a shift in the fringe pattern of the interfering beams The number of fringes that shift during the changes in optical path lengths introduced by the strain is counted using a solid state photo detector In our set up the strain in an aluminum beam is measured A Fabry-Perot interferometer is expoxied onto the aluminum beam along side a conventional strain gauge The bending of beam caused by stress results in a change in the path length of the interfering beams Thus we measure the strain caused by the stress

THEORETICAL BACKGROUND

Bending of a Mechanical Beam

We assume that the bending of the beam is uniform Figure 2 defines the coordinate system and the relevant parameters of a uniformly bent mechanical beam We assume small amplitude bending for the following discussion

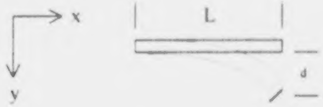

Figure 2 - Mechanical Beam

The deflection d is given by[4]

$$d = \frac{FL^3}{3EI}, \qquad (1)$$

where,
F = applied force
E = Young's modulus
I = area moment of inertia about z – axis

The longitudinal strain ε_x is given by[4]

$$\varepsilon_x = \frac{F(L-x)\left(\frac{t}{2}\right)}{EI} \qquad (2)$$

Substituting (1) in this expression yields

$$\varepsilon_s = \frac{3}{2}\frac{d(L-x)}{L^3}t, \qquad (3)$$

where d is the deflection, L is the total length of the beam, x is the distance fixed end of the aluminum beam to the fiber, and t is the thickness of the beam

Interference

The phase difference ϕ, between the two interfering laser beams is given by

$$\phi = (2nL_g)k \qquad (4)$$

$$\frac{\Delta\phi}{\phi} = \frac{\Delta L_g}{L_g}, \qquad (5)$$

where n is the refractive index of the fiber, L_g is the gauge length of the fiber, and k is the wave vector of the laser light.

We assume that bending of the fiber does not introduce any significant changes in its refractive index. In addition, the temperature of the equipment and surroundings were constant throughout the experiment.

SET-UP

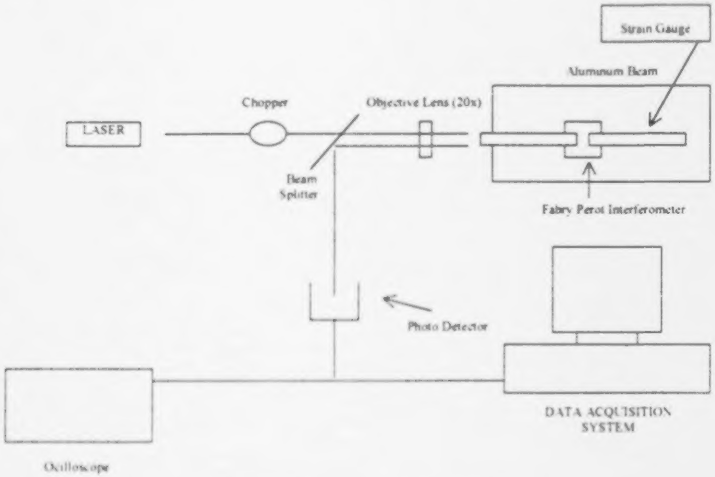

Figure 3 - Set-up used in Investigation

A Helium-Neon laser (λ = 632.8 nm) was used as the coherent light source. The beam is chopped to enhance the signal amplitude. The beam was split into two nearly equal intensity parts using a 50% reflective beam splitter. One beam, after focusing, was sent into the Fabry-Perot Interferometer, bonded by epoxy to the aluminum beam. This beam was reflected off of the partially reflective surfaces of the interferomenter and then interfered with the second beam. The resulting inteference pattern was detected by a solid state photo detector. The photo detector converted the light signal into an electrical signal. The electrical signal coming from the photo detector was monitored in real-time by the ocilloscope and data was stored by the Data Acquisition System that was built using LABVIEW[a].

RESULTS AND CONCLUSIONS

The apparatus and set-up used in the present investigation is shown above in Figure 3. The data was displayed both by the ocilloscope and the LABVIEW® data acquisition system. A controlled amount of stress was put on the aluminum beam by a translation stage that was mounted just above the aluminum beam.

The photo detector which detects the maximum (bright fringes) and minimum (dark fringes), sends an electrical signal to the data acquisition system and the ocilloscope.

The values were stored and then analyzed. The value of strainwas determined for the aluminum beam. This measurement of strain was compared with the measurement reading on the strain gauge.

Table 1 - *Key Parameter Measured Values*

L	Total Length of Aluminum Beam	**464.5 mm**
L_g	Gauge Length	**2.25 mm**
t	Thickness of Aluminum Beam	**2.50 mm**
x	Distance from Fixed end of Aluminum Beam to the Fiber	**109.8 mm**
$L-x$	Distance inbetween fiber and point of pressure	**354.7 mm**
n	Refractive index of fiber	**1.465**

The theoretical value calculated for strain with a deflection of 6.968 mm is

$$\varepsilon_s = \frac{3}{2} d \frac{(L-x)}{L^3} t = 92.48 \times 10^{-6} = 92.48 \mu\varepsilon$$

The experimental value calculated using equation (4) is

$$\Delta L_g = \frac{\lambda}{2}$$

$$\frac{\Delta L_g}{L_g} = \frac{\lambda}{2nL_g} = 95.99 \mu\varepsilon$$

These preliminary results show a close agreement between theory and experiment. The small difference between the theoretical and experimental values could be caused by low precision distance measurements. We plan to improve upon the present measurement accuracy in the next phase of research.

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REFERENCES

[1] Butter, C.D., & Hocker, G.B., 1978, Fiber optics strain guage, Applied Optics, p. 2897 Vol. 17 No. 18, September 15.

[2] Serway, R. A., 1990, Physics For Scientists and Engineers, Saunders College Publishing, Holt, Rinehart and Winston, Inc., Orlando, Florida.

[3] Moller, K.D., 1988, Optics, University Science Books, Mill Valley, California.

[4] Gere, J.M., & Timoshenko, T. P., 1997, Mehanics Of Materials, PWS Publishing Company, Boston, USA.

CO Adsorption on Cobalt Particles Supported on Chromia - An FTIR Study

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Transition metals cobalt and copper play significant roles in the conversion of syngas (CO + H_2) to liquid fuels. With a view to examine the nature of interaction between CO and metal, the FTIR spectra of CO adsorbed on Co-Cr_2O_3 composites were investigated. The results indicate that as cobalt loading increases, the intensity of the CO adsorption bands increase and several vibrational modes seem to be promoted. Heat treatment of the sample revealed two distinct processes of adsorption. Bands due to physisorption disappeared while bands due to chemisorption not only increased in intensity but persisted even after desorption. It seems that the physisorption process is more active when the catalyst is fresh and is hindered when carbidic/carbonyl formations occur on the metal surfaces.

INTRODUCTION

The study of CO adsorption on Co-Cr_2O_3 alloy by infra-red spectroscopy and magnetic methods is of interest for various reasons.

(i) A complete description of gas-metal interactions requires information on both the adsorbate and the absorbent, and this can be achieved by using simultaneously these two techniques.
(ii) CO is a good probe molecule for chemisorption studies because of its associative or dissociative nature when adsorbed on metal. This study could provide information on the electron charge transfer mechanism of the probe molecule.
(iii) Magnetization studies provide information on the changes in the metallic charge distribution character of the composite sample.

Very little work [Mohana Rao, 1988; Sato, 1984] has been done on infrared spectra of carbon monoxide adsorbed on cobalt. To our knowledge no FTIR studies of CO adsorption on Co-Cr_2O_3 have been made nor any correlation results reported between magnetization and FTIR data. This paper presents the results of the magnetic and FTIR measurements on Co-Cr_2O_3 metal composite.

1362

EXPERIMENTAL METHODS

Magnetic measurements of the composite sample were made using a Digital Measurement Systems (Boston, MA) DMS-880 vibrating sample magnetometer and Zero-field NMR spectra were obtained using a modified WILK's NQR spectrometer described else where [Murty, 1988].

The FTIR Spectrometer and DRIFT System consists of Mattison Research series FTIR spectrometer, equipped with an MCT detector operable in the mid IR region (4000-600 cm^{-1}), a diffuse reflectance accessory, an environmental chamber and an automatic temperature controller.

An optical diagram of the diffuse reflection attachment is shown in Figure 1. The praying mantis design incorporates two 6:1 90° off -axis ellipsoidal mirrors, M_3 and M_4, which subtend 20% of the 2 pi solid angle. These ellipsoids are arranged with a common focal point S. Mirrors M_1 and M_2 transfer the IR beam from the spectrometer to the first of these ellipsoids M_3. This ellipsoid focuses the beam onto the sample, S. The second ellipsoid collects the radiation diffusely reflected from the sample. This radiation is then directed by mirrors M_5 and M_6 towards the detector. The environmental chamber (Figure 2), a stainless steel reaction chamber, consists of a sample cup to load the sample, two windows at the entrance and exit positions for the incident and reflected infrared radiations. A third window is provided at the back of the chamber to illuminate or view the sample. In addition two entry ports are provided for vacuum and gas and another set for water circulation. The environmental chamber is connected to an automatic temperature controller that can be raised up to 600°C.

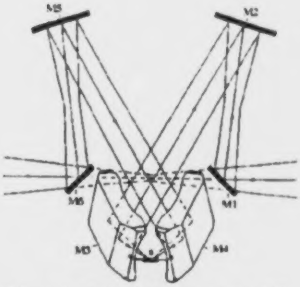

Figure 1 Optical Arrangement of the DRIFT System

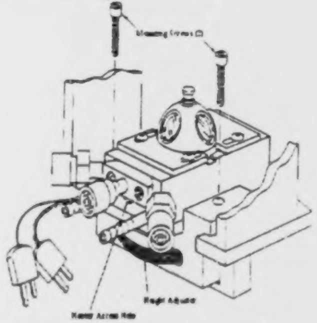

Figure 2 Environmental Chamber

Sample preparation:

All the samples were prepared by co-precipitation of nitrates in a 7-8 pH sodium hydroxide solution at 80°C. The precipitate is washed, dried at 80°C for 18 hours, calcined at 350°C for 18 hours and reduced in a flowing stream of hydrogen at 350°C for 18 hours. Hydrogen was out gassed while reducing the temperature to 250°C. At this temperature carbon monoxide was admitted for 30 minutes and then while continuously flowing carbon monoxide the temperature was reduced step wise to 25°C and spectra were taken at each temperature. At 25°C CO was out gassed and the temperature was increased in reverse order to obtain the desorbed spectra of CO. Four different samples ($0.5 < Co/Cr < 16.0$) were used in this investigation to study the effect of metal ratio on the CO stretching frequencies. FTIR spectra for each sample were taken three times for reproducibility of the results. All the spectra obtained were recorded with 500 scan accumulation at a resolution of 4 cm^{-1}.

RESULTS AND DISCUSSION

Magnetization studies made on three samples $Co/Cr \leq 2.0$ indicate that about 75% of cobalt is locked in $Co\text{-}Cr_2O_4$ type spinel structures. Only 25% of the loaded metal appears to be amenable for reduction. NMR spectra did not reveal any inter-metallic interaction between cobalt and chromium. NMR lines occurred in the expected positions for pure cobalt [Murty, 1991].

FTIR results are presented in Table 1 and Figures 3-5. Frequency measurements are accurate within ± 4 cm^{-1}.

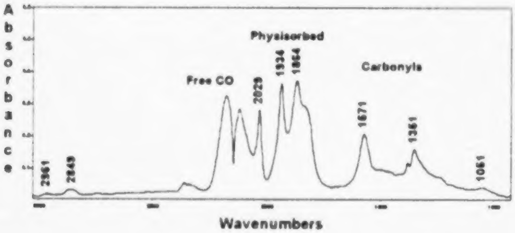

Figure 3 Co/Cr (16.0) + CO @250^{0}C

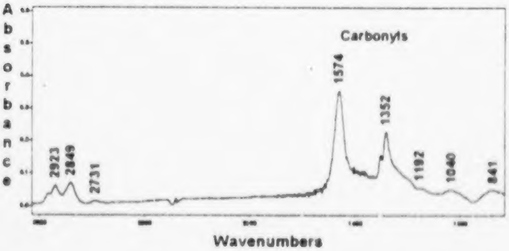

Figure 4 Co/Cr (16.0) CO Desorbed @ 250^{0}C

In all the spectra recorded we did not observe any significant changes due to temperature variation.

The observed spectra fall in to three distinct regions.

A. 2900 - 2750 cm^{-1} B. 2000 - 1650 cm^{-1} C. 1600 -850 cm^{-1}

Table 1
Vibrational Frequencies (cm^{-1}) of Cobalt-Chromium

0.5		3.0		8.0		16.0	
Adsorbed	Desorbed	Adsorbed	Desorbed	Adsorbed	Desorbed	Adsorbed	Desorbed
2957	2960	2954	2963		2960	2962	2962
2870	2874	2861	2879				
2848	2854		2846		2838	2846	
2803		2803					
				2031(PA)		2028(PA)	
2002(PA)		2004(PA)					
				1959(PA)		1932(PA)	
				1902(PA)			
						1863(PA)	
1657(PA)		1645(PA)		1635(PA)			
1599	1605	1585	1597	1549	1561	1576	1580
1364	1343	1371	1362	1354	1368	1369	1352
1064	1053	1065	1054	1056	1056	1049	1043
849	844	846	851	849	846	858	846

PA- Physisorbed Bands Weakly Bonded to Metallic Co

The two sharp peaks (Figure 3) at 2170 and 2117 (P and R branch heads of 2143cm^{-1} of CO band) are due to free gaseous CO molecule. The bands in the region 2000 - 1650 cm^{-1} region seem to be due to CO linearly bonded to Cobalt [Hollins]. Desorption of CO causes the disappearance of these bands. Figures 3 and 4 clearly illustrate this effect of CO-desorption. These lines could be due to physisorption processes ranging from weak electrostatic interaction to bonding with one, two, or three surface cobalt metal atoms. The physisorbed bands seems to be dependent on temperature, metal ratio and the time of CO flow. The bands in the 1600 - 850 cm^{-1} region are persistent even after desorption of CO. This might be, as suggested by earlier investigators (Little [2], Nakamoto [6]) due to the formation of CO_2 which is stabilized in the matrix as a CO_3^{2-} species. The bands in the region 2900 - 2750 cm^{-1} are also persistent after desorption and may result due to different chemical interactions between CO and Co-Cr_2O_3 matrix. We noticed that carbonyls formation takes plece when the catalyst is exposed to CO even at room temperature. Though this retards physisorption process, deactivation of the catalyst may not occur and the metal carbonyls formed might play active roles in the catalytic process.

The 1600 cm^{-1} band seems to be sensitive to the metal ratio and shows a downward trend as Co content increases up to a certain point. Further increase of Co metal in the sample Co/Cr = 16.0, this band became sharper and more intense and shifted back to higher wavenumbers (Figure 5). It is difficult to ascertain whether it is a frequency shift in the stretching frequency of a a specific carbonyl band or different carbonyl structures occur as more cobalt appears in the matrix. Metal ratio appears to have no significant effect on the other bands in this region.

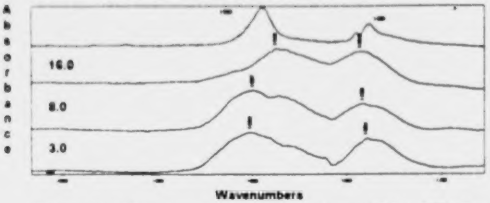

Figure 5 FTIR Spectra: Comparison of Metal Ratios @ 25°C

CONCLUSIONS

Our NMR studies show no noticeable shift in the NMR lines of cobalt indicating that no significant intermetallic interactions occur between metal and support. Magnetization studies indicate that at lower metal loading Co/Cr ≤ 2, most of the cobalt could be locked in spinel structures and only the metal appears to be amenable for reduction. IR spectra on all the samples studied ($0.5 < Co/Cr < 16.0$) show no measureable changes due to temperature variation either in the absorption or desorption process. At low Co ratios physisorption bands formed could be due to weak linear CO - metal bonding. Increase in cobalt metal content seems to enhance the physisorption process and CO bonding might be occurring with multiple surface metal atoms. In all the samples studied we have observed metal carbonyl bands indicating that a chemical reaction occurs and CO_2 formed may be stabilized in the matrix as CO_3^{2-} species. Further studies might provide better insights into the catalytic mechanisms involved.

ACKNOWLEDGMENTS

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REFERENCES

Hollins, P., and Pritchaard, J. in: Vibrational Spectroscopy of Adsorbates, ED R.F. Willis, Vol 15 of springer series in chemical physics (Springer, Berlin, 1980) p. 125

Little, L.H. Infrared Spectra of Adsorbed Species (Academic press, New York, 1966) p.76

Mohana Rao, K., Scarano, D., G. Spoto and Zecchina, A. Surface Sci. 204, 319 (1988)

Murty, A.N., Williams, A.A., Obermyer, R.T., Rao, V.U.S. and Gormley, R.J." NMR Studies of Cobalt-Thoria-ZSM-5 catalysts" Catalysis p 73-80, 1987, J.W.Ward Ed. Elseiver, Amstredam 1988

Murty, A.N., Seamster, M. and Paulson, D. LAS conference, Baton Rouge, La Feb. 91.

Nakamoto, K. Infrared Spectra of Inorganic and Coordination Compounds (Wiley-interscience, New York, 1970) p. 169

Sato, K. , Inoue,Y., Kojima, I., Miyajaki, E., and Yasumori, I.J. Chem soc. Faraday Trans I. 80, 841 (1984)

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SOLAR CELLS USING ORGANIC PIGMENT NANOPARTICLES

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Organic-based solar cells have been shown to be a promising clean, regenerating, and inexpensive energy source. Research into the Grätzel-style solar energy conversion cell has focused on several classes of water soluble, osmium and ruthenium-based photosensitizers absorbed onto titanium dioxide(TiO_2) thin films[1,2]. These dyes absorb in the visible portion of the solar spectrum and have limited light fast properties, which compromises the design and overall efficiency of the cell. The film is composed of nanostructured, TiO_2 particles with a high degree of surface roughness, increasing the surface area of the film and providing more area for the TiO_2/sensitizer interface.

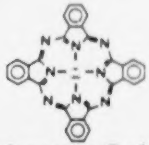
In order to enhance the efficiency and the stability of the solar cell, we are investigating the use of photosensitive pigments, such as phthalocyannines, that absorb in the visible and infrared and have excellent light fast properties. Using Lewis Acid Pigment Solublization(LAPS), cells can be easily sensitized to a wide variety of photosensitive pigments. Application of a LAPS solution of hydroxygallium phthalocyannine to nanostructured TiO_2 thin films has achieved a maximum open circuit voltage of 0.347 Volts, a closed circuit current of 0.0188 mA/cm^2 under an irradiance of 0.726 W/m^2 with a conversion efficiency of 9.0% .

INTRODUCTION

The desire for a cheap, environmentally friendly source of energy has renewed interest in solar energy conversion. Despite their commercial availability, expense has limited the general appeal of silicon-based solar cells[3]. Recent research into photosensitized, nanocrystalline titanium dioxide thin film solar cells, pioneered by Dr. Michael Grätzel of the Swiss Federal Institute of Technology, has resulted in comparable conversion efficiencies at a significantly lower cost than conventional silicon-based solar cells. The cells are sensitized with Cis-dithiocyananto-N-bis(2,2'-bipryidyl-4,4'-dicarboxylic acid) ruthenium(II) dihydrate, ($[RuL_2(NCS)_2]\cdot 2H_2O$), a water soluble dye. These Grätzel-cells primarily absorb in the visible portion of the spectrum, have produced a current of 12 mA/cm^2 and conversion efficiency of 12% in natural sunlight. Much research has focused into extending the sensitivity of the photosensitizers into the infrared to increase the conversion efficiency of the Grätzel -style solar cell[4].

Kajihara *et. al.* recently demonstrated energy conversion using vacuum deposited zinc phthalocyannine on TiO_2 and ITO[5]. Phthalocyannine pigments, which are both visible and infrared sensitive, would extend the spectral sensitivity of the Grätzel -cell into longer wavelengths. The main phthalocyannine thin film fabrication method to date, vacuum deposition, is, however, an expensive procedure relative to the dye-soak method employed by Grätzel and would increase the costs of these devices.

Using Lewis Acid Pigment Solublization(LAPS) allows for solutions of previously insoluble photosensitizers, including phthalocyannine pigments, and thin film production at a relatively low cost. Prior to this, phthalocyannine thin films were primarily manufactured with vacuum deposition[6]. The LAPS method has allowed for the use of phthalocyannine pigments to construct nanocrystalline solar cells without sacrificing the overall cost of the cell. Since phthalocyannine's are sensitive primarily from the red wavelengths of the visible into the infrared, phthalocyannines absorption will closely match the actual spectral characteristics of the sun. In addition, since these pigments are insoluble to nearly all common solvents, substitution of acetonitrile in the electrolyte with a different solvent that would allow for easier sealing may eliminate the need for advanced sealants[7].



Phthalocyannine (Pc) Ligand

EXPERIMENT

Production of the phthalocyannine sensitized solar cells follows closely the methods used by A. Hagfeldt, et al[7]. A colloidal solution of 12.0 g TiO_2, 20 mL water, 0.2 mL acetylacetone, and 0.1 mL Triton X-100 is ball milled overnight to produce nanoparticles of

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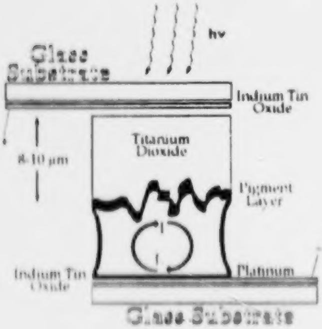
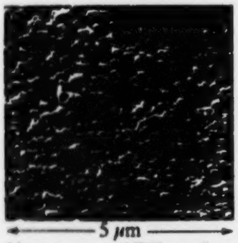
TiO_2 in solution. An 8 to 10 µm film is spun onto a 10 Ω/☐ Indium-Tin Oxide(ITO) coated substrate and then annealed at 450 °C under nitrogen for one hour.





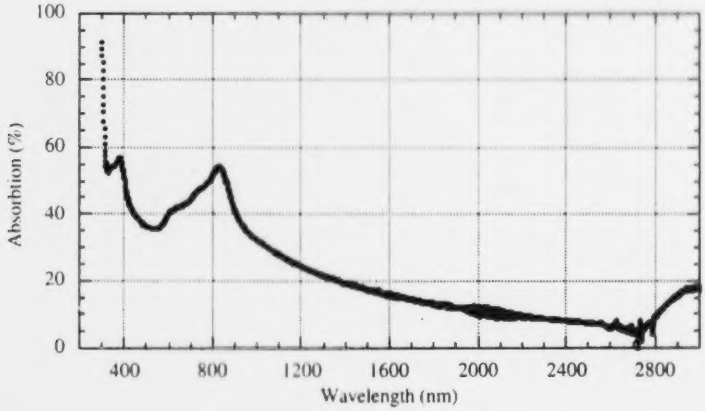
Nanostructured TiO_2 surface

The ITO-TiO_2 substrate is immediately removed from the oven and placed into a LAPS-pigment solution for four hours. The LAPS-pigment solution is produced by mixing a 6:1 ratio of aluminum chloride($AlCl_3$) atoms to hydroxygallium phthalocyannine(HOGaPc) in at least 50 mL nitromethane per gram of $AlCl_3$ for one hour on a magnetic stirring plate.

The ITO-TiO_2 coated substrate is allowed to soak for four hours to photosensitize the thin film with HOGaPc and then rinsied with water to remove the $AlCl_3$ from the cell. A second platinum/ITO substrate, coated in a dilute solution of hydrogen hexachloroplatinate under 5 mA of current for three seconds, forms the counterelectrode for the solar cell.

Approximately 0.5 mL of a solution of 0.3 mM I_2 and 0.3 M LiI in acetonitrile is placed on top of the ITO-TiO_2-HOGaPc substrate and then covered with the second, platinum-coated ITO substrate. The acetonitrile prevented any attempt to seal the cell with hot glue, since the solvent prevented the glue from adhering. A solution of 0.3 mM I_2 and 0.3 M LiI in water was also prepared and tested on solar cells to study the effects on cell sealing.

A silver conducting epoxy forms the electrical contact with the ITO substrate, completing the circuit. The cell was irradiated with 0.726 W/m^2 from a 150 W tungsten bulb in an integrating sphere.

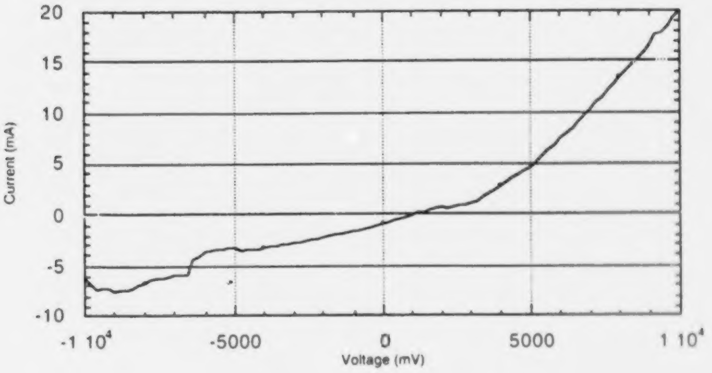


Absorption of HOGaPc on Quartz

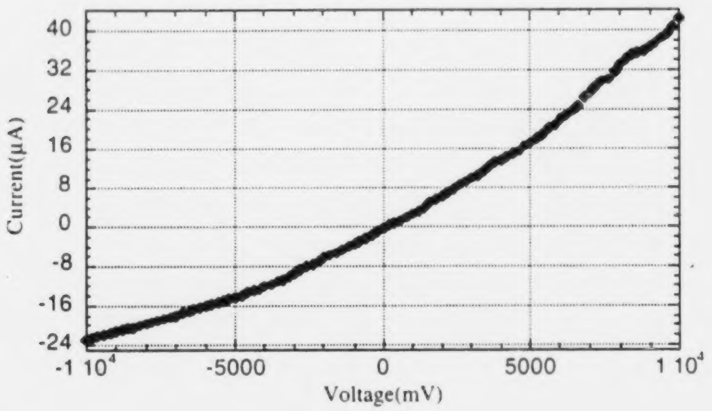
RESULTS

The absorption of the HOGaPc on quartz was measured using a Perkin-Elmer spectrometer and is plotted above. Absorption of HOGaPc is strongest in the visible and infrared. It is not expected that different phthalocyannines should have significantly different absorption characteristics than HOGaPc[9].

The demonstrated cell efficiencies of 9.0% were achieved using a tungsten filament. The cell was irradiated with 0.726 W/m^2 , and produced an short circuit current of 0. 0188 mA/cm^2, and an open circuit voltage of 0.347 V. The current- voltage characteristics for both illuminated and for dark cells are plotted here. The dark current is nearly three orders of magnitude lower than the corresponding cell under illumination.



Characteristics of HOGaPc
Sensitized Cell with Illumination



Dark Characteristics of HOGaPc
Sensitized Cell

Substitution of a similar solution of I_3 /I in water to that of the solution in acetonitrile provided for a cell that could be sealed with hot glue, and did not measurably reduce cell efficiency. Long term stability tests with water-based electrolyte solutions have not been attempted, but intact hot glue seals on the cells have lasted at least several hours, an improvement over similar cells with acetonitrile, where hot glue sealing was not possible.

CONCLUSIONS

Lewis Acid Pigment Solublization provides an effective means of photosensitizing titanium dioxide based photoelectrochemical solar cells. Open circuit voltages of 0.347 V and short circuit currents of 0.0188 mA/cm^2 corresponding to a conversion efficiency of 9.0% were observed with hydroxygallium phthalocyannine sensitized under illumination by 0.726 W/m^2 from a tungsten filament. Phthalocyannine solutions from the Lewis Acid Pigment Solublization process provide for an effective, inexpensive way of photosensitizing Grätzel - cells. Elimination of water soluble dye's also provides for a possible inexpensive sealing method for cells, since solvents such as acetonitrile, which were the primary limiting factor to sealing a dye-based cell, are no longer necessary.

ACKNOWLEDGMENTS

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REFERENCES

[1] O'Regan, B. and Grätzel, M., *Nature* **353**, 737-739 (1991).
[2] Knodler, R. *Solar Energy Materials and Solar Cells* **30**, 277-281 (1993).
[3] Hagfeldt, A., *Solar Energy Materials and Solar Cells* **31** 481-488 (1994).
[1] O'Regan, B. and Grätzel, M., *Nature* **353**, 737-739 (1991).
[5] Kajihara, K. *Japanese Journal of Applied Physics* **35**, 6110-16 (1996)
[6] Hsieh, B. U.S. Patent Number 5,449,583 (1995)
[7] Hagfeldt, A., *Solar Energy Materials and Solar Cells* **31** 481-488 (1994).
[8] Hagfeldt, A., *Solar Energy Materials and Solar Cells* **31** 481-488 (1994).
[9] Law, K., *Chem. Rev.* **93** 453-473 (1993).

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CALCULATING O_3 9.6 μm ABSORPTION AS A FUNCTION OF ATMOSPHERIC O_2

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In the past year, several stellar planetary systems have been discovered. Planets of Jovian mass have been detected around stars suggesting that these or other planetary systems may also contain terrestrial planets. A space-based interferometer project has been proposed as a new detection method that is sensitive enough to discover terrestrial planets. The space-based interferometer would first detect these terrestrial planets through their radiated heat and then spectroscopically analyze them in the same spectral range (the thermal infrared, 7μm - 17μm). This research focuses on how one might eventually evaluate the spectroscopic data returned to Earth. If other Earth-like planets do indeed exist, the interferometer should be able to detect the spectral signatures of H_2O, CO_2, and O_3. Of these, O_3 is the most interesting because it is formed photochemically from O_2, and O_2 is almost exclusively a byproduct of the biological process of photosynthesis. This research is aimed at calculating the expected strength of the O_3 9.6 μm band as a function of atmospheric O_2 level on a planet like Earth. By inverting these results, it may ultimately be possible to infer atmospheric O_2 levels on extrasolar planets and to determine if they harbor terrestrial-type life.

BACKGROUND

In the past year, several extrasolar planetary systems have been discovered. Planets of Jovian mass have been detected around nine different, main sequence stars, suggesting the possibility that these or other planetary systems contain terrestrial planets. Until now, these new planets have been detected by ground-based telescopes by measuring the reaction motions of the stars they orbit. This method can detect giant planets, but it is not sensitive enough to detect less massive terrestrial planets. The physical conditions present on a particular extrasolar planet, including atmospheric composition, can, in principle, be measured by infrared spectroscopy. Based on this knowledge and the need for a new detection method that is sensitive enough to discover terrestrial planets, an idea has been proposed of utilizing a space-based interferometer (Angel and Woolf, 1996). The space-based interferometer would first detect these terrestrial planets through their radiated heat and then spectroscopically analyze them in the same infrared spectral range. This research focuses on the determination of a method that could be used once this space-based interferometer is operational to evaluate the spectroscopic data returned to Earth. Through this evaluation method the atmospheric oxygen concentration of the extra-solar planet and thus its life sustaining probability could be determined.

METHOD

In the infrared spectrum, the Earth uniquely shows ozone at the 9.6 μm band. This is of interest because ozone is formed from oxygen and oxygen originates from photosynthesis. Detection of oxygen on a terrestrial planet within an extrasolar planetary system would be of great interest since it would show that the planet could support life. To successfully use the results returned from the space-based interferometer, it is necessary to determine the ozone concentration and temperature as a function of atmospheric oxygen concentration on an Earth-like planet. The Chapman mechanism is one example of the relationship between oxygen production and ozone via the reactions:

$$O_2 + h\nu \rightarrow O + O \quad (\lambda \leq 200 \text{ nm})$$
$$O + O_2 + M \rightarrow O_3 + M \quad \text{(M is a random molecule)}$$

$$O_3 + h\nu \rightarrow O_2 + O \quad (\lambda \leq 700 \text{ nm})$$
$$O + O_3 \rightarrow 2O_2$$

The model used in this study also includes many other reactions that cause the catalytic destruction of ozone by HO_x, NO_x, and Cl_x.

To make this calculation, a coupled photochemical/radiative transfer model was used. By decreasing the oxygen concentration from the present atmospheric level of .21 to $.21 \times 10^{-5}$ within the photochemical model, the profiles of temperature and ozone concentrations for various atmospheric oxygen concentrations were determined for an earth-like planet.

MODEL DESCRIPTION

The calculations of surface temperatures were performed utilizing a one-dimensional radiative-convective model developed previously (Kasting et al., 1984; Kasting and Ackerman 1986). Originally, the atmospheric composition was assumed to be that of present Earth: 78% N_2, 21% O_2, 1% ^{40}Ar, and 330 parts per million CO_2 with a total surface pressure (excluding H_2O) of 1 bar. The radiative-convective model is based on a steady state method, which uses Newton's method to achieve convergence. The stratosphere was assumed to be in radiative equilibrium, and the troposphere was convectively linked using the moist adiabatic lapse rate. The boundary between these regions moved up or down as individual layers became convectively stable or unstable.

The photochemical model used for this study is an expanded version of a model used previously to simulate possible primitive terrestrial atmospheres (Kasting, 1985). Combined vertical transport and continuity equations are solved for 20 different species: O, O_2, O_3, H, OH, HO_2, H_2O_2, H_2, H_2O, CO, H_2CO, CH_4, CH_3O_2, CH_3OOH, N_2O, NO, NO_2, HNO_2, HNO_3, and HO_2NO_2. Seven additional species, including $O(^1D)$, $N(^4S)$, $^1CH_2$, $^3CH_2$, CH_3, HCO, and H_3CO, were assumed to be in photochemical equilibrium at each height step. A CO_2 mixing ratio of 340 parts per million was assumed in all cases. The numerical grid of the model extended from the ground up to 64 km in 1-km increments. The equations were solved using an implicit, time-stepping routine based on the reverse Euler method (Dahlquist and Bjorck, 1974). Zero flux was assumed for most species at the upper boundary. An upward flux of CO_2 required to balance photodissociation was assumed to be balanced by equivalent downward fluxes of CO and O. At the lower boundary, constant deposition velocities were assumed for the more reactive species O, H, OH, H, H_2O, CH_3O_2, HNO_2, HNO_3, HO_2NO_2, NO, NO_2, O_3, H_2O_2, H_2CO, and CH_3OOH. In the standard, present-day model atmosphere the volume mixing ratios of relatively long-lived species (CO, CH_4, N_2O, CH_3Cl, and H_2) were fixed at their observed global mean values (Logan et al, 1981 and Crutzen and Schmailzl, 1983). At lower O_2 levels, we assumed constant upward fluxes for these species, corresponding to those calculated in the standard model.

RESULTS

Ozone mixing profiles for atmospheres containing from 10^{-5} to 1 PAL (Present Atmospheric Level) of oxygen are shown in Figure 1. At O_2 levels below 1 PAL, the peak ozone

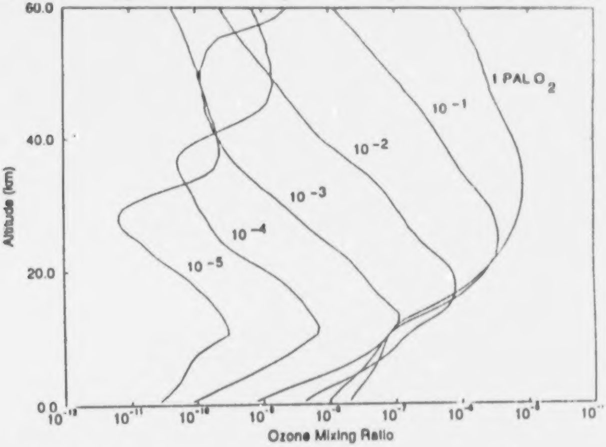


Figure 1 Ozone Mixing Profiles

mixing ratio decreases in magnitude and moves downwards in the atmosphere as a result of the increased depth of penetration of the solar ultraviolet radiation. At 10^{-1} PAL and below, the peak ozone mixing ratio is found at approximately 10 km. This corresponds to the height of the tropopause in our model. This peak in ozone is prevented from moving still lower by the presence of abundant hydrogen oxides that result from the rapid photolysis of water vapor in the troposphere. The maximum ozone mixing ratio occurs at 1 PAL of O_2.

The ozone column depth that corresponds to these profiles is shown in Figure 2. The ozone column depth increases monotonically with oxygen content. As this figure shows, the ozone column depth values that were found by this study closely resemble the values found by Kasting et al. (1985). The observed present global mean column depth of 320 D.U. (Dobson Units) (McClatchey et al., 1971) is within 5% of our calculated value at 1 PAL. The column depth at the equatorial region varies from about 250 D.U. to about 270 D.U. in an annual cycle. For Figure 2, a mean value of 260 D.U. was used for the equatorial column depth. As Figure 2 shows, the predicted global average ozone column depth exceeds the modern equatorial value for O_2 levels ≥ 0.2 PAL. Because modern organisms can unquestionably survive UV exposure under these conditions, we conclude that a biologically effective ozone screen was almost certainly established by the time atmospheric O_2 reached this level. Kasting (1987) concluded that UV shielding was probably effective at a lower O_2 level, ~ 10^{-2} PAL, based on previous Kasting et al. (1985) results. Since our results are not much different, this conclusion remains unchanged.

Figure 3 shows temperature profiles of atmospheres containing from 10^{-5} to 1 PAL of O_2.

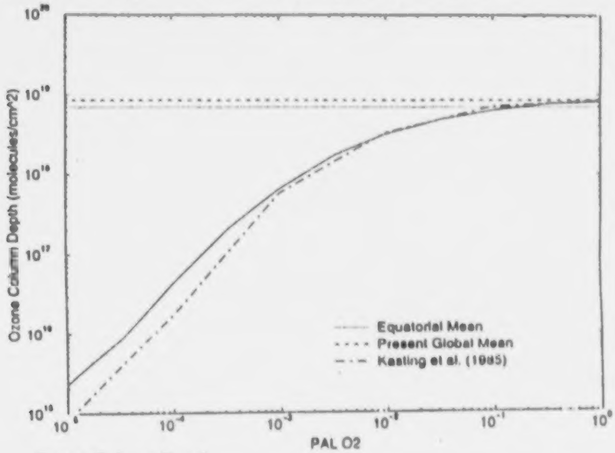


Figure 2 Ozone Column Depth

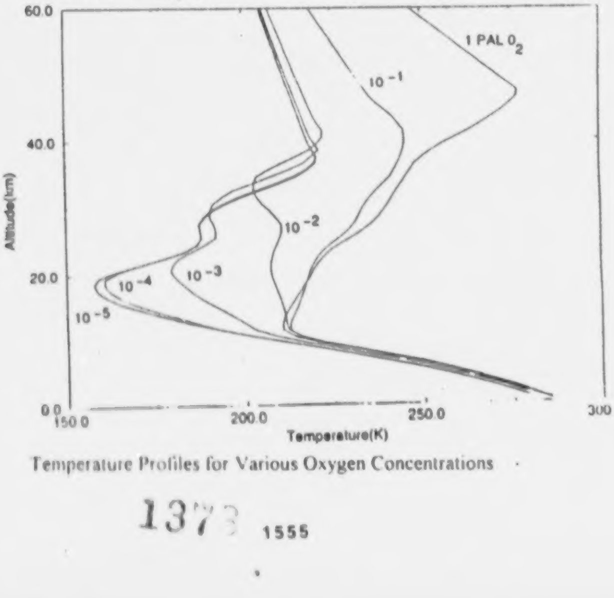
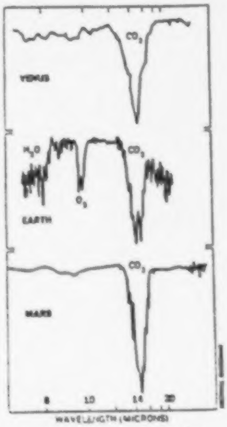


Figure 3 Temperature Profiles for Various Oxygen Concentrations

At O_2 levels below 1 PAL, the temperature profile decreases in magnitude as expected based on the results shown in Figure 1 for the ozone mixing ratios. The surface temperature decreases by 4 K as the oxygen level decreases from 1 PAL to 10^{-5} PAL. The temperature profile continues to decrease with a decrease in the O_2 level until 10^{-5} PAL of oxygen is reached. At this point the changes in the temperature with decreasing O_2 level are negligible. It is hoped that future studies can determine more accurate temperature calculations for the stratospheric region. The possible error in temperature values for the stratospheric region of the atmosphere should not affect the ozone column depth data since column depth is not sensitive to these minor details.

Following these calculations, a separate radiative transfer code (HITRAN) will be used by a future study to calculate the absorption spectrum of ozone for the various atmospheric oxygen concentrations. Of great interest in these absorption spectra is the depth of the 9.6 μm band for the various atmospheric oxygen concentrations. Venus, Earth and Mars all have atmospheres rich in CO_2, but only Earth possesses abundant H_2O and O_3. The presence of O_3 on a particular planet implies that O_2 is also present on that planet. If O_2 is indeed present on a particular planet this implies that photosynthesis is occurring. It is the biological process of photosynthesis that implies the presence of life on a particular planet. As shown in Figure 4, the infrared signature of life, the 9.6 μm ozone band, can only be seen on Earth. Thus the infrared signature that this space-based interferometer will be looking for in its hunt for worlds similar to our own in other solar systems is the 9.6 μm band.



SOURCE: R. Hanel, Goddard Space Flight Center

Figure 4 The Infrared Signature of Life (Angel and Woolf, 1996)

Based on the absorption spectrum for differing atmospheric oxygen concentrations calculated by the HITRAN code, the depth of the 9.6 μm ozone band for various concentrations of oxygen can be determined. These depth values for the 9.6 μm ozone band can eventually be compared with the absorption spectrum returned by the space-based interferometer. If the returned values are similar to those calculated for present atmospheric oxygen concentration of the Earth, it can be inferred that the extra-solar terrestrial planet in question also contains a level of atmospheric oxygen concentration that is similar to the Earth's. More generally, the O_2 level on the extrasolar planet can be inferred by comparing the observed 9.6 μm absorption band with those predicted at different O_2 levels. Detection of the 9.6 μm absorption band on another planet would be very significant since it would raise the possibility of life existing on that extrasolar terrestrial planet because O_2 originates on a planet through the photosynthesis process, a process of living things.

CONCLUSIONS

The ozone mixing profiles and the temperature profiles were shown to decrease with decreasing O_2 concentrations. These values upon inclusion into a separate radiative transfer code will be able to calculate the absorption spectrum of ozone for various atmospheric oxygen concentrations. This is a critical step in the utilization of the space-based interferometer to detect planets similar to ours that display the 9.6 μm band ozone signature that is only found on the Earth.

REFERENCES

Angel, J. R. P. and N. J. Woolf, 1996: Searching for Life on Other Planets. *Scientific American*, Vol. 274, No. 4, 60-66.

Crutzen, P. J. And U. Schmaizl, 1983. Chemical Budgets of the Stratosphere, *Planet. Space Sci.*, 21, 925-939.

Dahlquist, G., and A. Bjorck, 1974. *Numerical Methods*, translated from Sweedish by N. Anderson, 573 pp., Prentice-Hall, Englewood Cliffs, NJ.

Kasting, J. F., 1985. Photochemical Consequences of Enhanced CO_2 Levels in Earth's Early Atmosphere, in *The Carbon Cycle and Atmospheric CO_2*: Natural Variations Archean to Present. *Geophys. Monogr. Ser.*, Vol. 32, edited by E. T. Sundquist and W. S. Broecker, 612-622.

Kasting, J. F., J. B. Pollack, and T. P. Ackerman, 1984 Response of Earth's Atmosphere to Increases in Solar Flux and Implications for Loss of Water from Venus. *Icarus*, 57, 335-355.

Kasting, J. F., H. D. Holland, and J. P. Pinto, 1985. Oxidant Abundances in Rainwater and the Evolution of Atmospheric Oxygen. *Journal of Geophysical Research*, Vol. 90, No. D6, 10497-10540.

Kasting, J. F. and T. P. Ackerman, 1986. Climatic Consequences of Very High Carbon Dioxide Levels in the Earth's Early Atmosphere. *Science*, 234, 1383-1385.

Logan, J. A., M. J. Prather, S. C. Wofsy, and M. B. McElroy, 1981. Troposperic Chemistry: A Global Perspective, *Journal of Geophysical Research*,86, 7210-7254.

McClatchey, R. A., R. W. Fenn, J. A. E. Selby, F. E. Volz, and J. S. Garing, 1971. Optical Properties of the Atmosphere, *Tech. Rep. AFCRL-71-0279*, Air Force Cambridge Reserarch Lab, Bedford, MA.

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Electromagnetic Field Profiles Inside Biomaterials

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The improvement of the information rendered by Magnetic Resonance Imaging (MRI) depends critically on the knowledge of the behavior of radio frequency (RF) electromagnetic fields inside the human body. The behavior inside gelatins that mimic the electrical properties of human tissues was studied. The gelatins were fabricated and their electrical properties were measured as a function of saline concentration and frequency. Then, phantoms were built using patches of those gelatins and the field profiles and temperature changes were measured as they were exposed to electromagnetic radiation. Results from the electrical characterization of the samples, a map of the electrical field and temperature changes are shown.

INTRODUCTION

MRI is a technique used to obtain pictures of the inside of the human body. It is particularly useful in imaging soft tissue. In fact, what is imaged, is not the tissue itself but the nuclei of a given chemical species contained in that tissue. This chemical species could be hydrogen, sodium, potassium (G.N. Holland, P.A. Bottomley and W.S. Hinshaw , 1977), phosphorus (P.C. Lauterbur, 1973), fluorine (P. Mansfield, P.K. Granell, 1973), and others. Due to the high content of water inside the human body, hydrogen is the most common element imaged.

Under the application of a strong external static uniform magnetic field (~1T=10,000 Gauss) along the z-axis, the spins of these nuclei will be aligned along z. The spin orientation can be manipulated (rotated) and, in particular be taken away from the z-axis by means of radio-frequency (RF) electromagnetic fields in the x-y plane. The maximum efficiency of this rotation happens when the frequency of the RF field and the magnitude of the static field are related through $w = g B$, where g is the gyromagnetic ratio of the proton (26000 1/Gauss). This is called the resonance condition. Off resonance rotation can also exist but it is far less efficient.

A slice of human body to be imaged is obtained in the following way: a "linear gradient" static magnetic field is superimposed on top of the uniform field. This produces a static magnetic field which is different in different slices of the body, thus the resonance condition is met only at one slice (actually a small slab). The rest of the image appears black. A gradient also exists inside the slice, in order to encode the various parts of the region (A. Abragamn, 1961, E.R. Andrew, 1969). The angle by which those spins are rotated depends on the strength of the RF magnetic field and on the time it remains turned on. Knowledge of these angles is crucial in obtaining the images (the closer the angle to 90°, the stronger the radiated signal from that point). The fact is, that the mere presence of the object being imaged (the human body in our case) modifies the RF field. In other words, the RF field depends not only on the field-generating antenna that we have but also on the electromagnetic properties of the material into which these fields are penetrating. In order to obtain sharper images in MRI, one needs to improve the signal-to-noise ratio. This can be done by increasing the static magnetic field, and consistently the MR frequency (A. Abragamn, 1961 and E.R. Andrew, 1969).

Many different systems have been studied and published in the literature (P.A. Bottomley, E.R. Andrew, 1978, F.R. Zypman, R.W. Brown, E.M. Haacke, 1987, F.R. Zypman, E.M. Haacke, R.W. Brown, J.L. Patrick, 1987, F.R. Zypman 1988, A. Jasinski, T. Jakubowski, M. Rydzy, P. Morris, I.C.P. Smith, P. Kozlowski, J.K. Saunders, 1992, C.J. Scheider, N. Engelberts, J.D.P. Van Dijk, 1991, T.K.F. Foo, C.E. Hayes, Y. Kang, 1992).

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Among them, the most popular ones are spherical, cylindrical and planar models. The first one is well suited for studies of MRI of the head, the second for whole body imaging and the third in flat regions of the body, its strengths being in simplicity and possibility of accounting for multiple-layer systems. Also, many different coil geometries have been considered, from simple loops to more complicated shapes, trying to uniform the RF fields inside the imaged bodies.

A systematic study of radiofrequency (RF) penetration in biomaterials for Magnetic Resonance Imaging (MRI) applications is complicated for various reasons. First one does not have easy mechanical access (like to introduce electric probes) to the inside of the human body without producing damage. Second, the theory cannot be exactly defined given the variety of geometries produced by each particular individual (for example hearts are not all of the same size). Third, the electrical properties of the organs imaged are not always very well known.

In our laboratory a variety of systems that mimic the human electrical properties but that are electrically well characterized, and can be mechanically intervened, are studied. For that purpose saline gelatins are made. They are electrically characterized, that is, their conductivity and permittivity are measured as functions of frequency. Then, phantoms were built with patches of those gelatins. Those phantoms could be spheres embedded in a larger medium or just human-like. The phantom is radiated from coils (see Figure 1) and then we measure field profiles from small loops. Also SAR (specific absorption rate) can be measured using thermocouples.

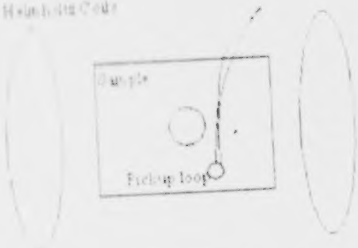

Figure 1. Experimental Model

EXPERIMENTS

Synthetic Biomaterials

Our goal is to fabricate gelatins that mimic the electrical properties of human tissue. Basically we say that a gelatin is a good model for a certain biological tissue if the dielectric constant and the conductivity between the two objects is the same. In order to simulate this properties we vary the saline concentration of the gelatin.

To fabricate the samples we use a solution of H_2O, Agarose 8%, and NaCl. To simulate real tissue the amount of NaCl is varied as 0.8%, 0.9% and 1%.

Conductivity Measurements

To measure the conductivity a sample of the gelatin was cut of 2cm x 1cm x 0.3cm. A constant current source (LakeShore 120) is used to apply a current of 10 µA to the sample. This current is small enough to avoid over heating the sample. Using an electrometer (Keithley 610C) we monitor the change in voltage across the sample as a function of time during a time period of 3000 seconds. This procedure is repeated for samples with 0.8%, 0.9%, and 1% NaCl.

To obtain the conductivity (σ) of the gelatins, the definition of resistance for the sample and Ohm's Law were used

$$\sigma = \frac{Il}{AV} \qquad (1)$$

where I is the applied current, V is the measured voltage, l is the length, and A is the cross sectional area of the sample.

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Dielectric Constant Measurements

To measure the dielectric constant of the gelatins a sample of 5mm x 7mm x 1.5mm was used. A parallel plate capacitor was fabricated using silver paint to create two metal plates with the sample as the dielectric material. The capacitance of the samples was measured as a function of frequency and time using an impedance bridge (HP4274A). The dielectric constant (k) is obtained using the definition of capacitance for a parallel plate capacitor and the dimensions of the sample:

$$k = \frac{C\,d}{A\,\varepsilon} \qquad (2)$$

where C is the capacitance, d is the distance between the plates, A is the area of each plate, and ε is the permittivity of free space (8.85 x 10^{-12} F/m).

Electromagnetic Field Profiles

MRI could provide unreliable information if not enough care is taken regarding the interaction between the radio frequency fields and the object under study. A well known example of this is the presence of a black spot in pictures showing the brain. The spot does not represent a real hole in the brain but rather an absence of fields there. Our objective is to produce two and three dimensional maps of electric fields inside the tissue like gelatins as a function of frequency.

For the experiment, a tank (20cm x 27cm x 40cm) filled with gelatin (0.9% NaCl) as in Figure 1 was used. Initially, the voltages in points (x, y, z) were measured separated by 1mm through the tank. A three dimensional map of the equipotential lines in the tank were made to verify that the effect of the probe is negligible. Then, the tank was filled again introducing a metallic sphere (radius 2cm) inside, as shown in Figure 1. A RF signal generator is used to apply an electrical field to the system. To measure the electrical field inside the tank we fabricated a 20cm probe. The probe is connected to a digital multimeter to monitor the voltages inside the tank. The voltages were measured in a two dimensional plane across the tank.

Temperature Measurements

MRI has a reputation for been one of the safest diagnostic techniques. However, one of the main concerns regarding safety is related to tissue heating. Federal standards establish the maximum allowed temperature variation under different conditions. These changes in tissue like gelatin as they are exposed to electromagnetic radiation were studied.

To study the changes in temperature as they are exposed to electromagnetic radiation we use the tank in Figure 1 connected to a RF signal generator. To monitor the temperature changes a thermocouple is inserted in to gelatin. The data acquisition process is controlled by a PC computer with the software LabVIEW. The interface between the thermocouple and the computer is provided by a data acquisition card and a signal conditioning card (National Instruments SCXI 1200).

In this study we concentrated in monitoring the temperature increase during the first 30 seconds after the RF signal generator is activated. The measurements are performed as a function of the frequency of the applied field.

RESULTS

Conductivity Measurements

The results of the conductivity measurements for the samples with 0.8%, 0.9%, and 1% NaCl are shown in Figure 2. The results were of the order of 1 S/m and the conductivity increases with an increase in saline concentration. The conductivity for the samples increases during the first 2000s and then it reaches a stable value.

The exception is the sample with 1% NaCl that is very unstable after 2000s. This behavior is probably because the concentration of NaCl is too high.

Dielectric Constant Measurements

First, the dielectric constant was measured as a function of frequency for a sample with 0.9% NaCl. The results obtained are in the desired order of magnitude of 10 and decrease as a

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function of frequency. In the experiment the frequency range is limited to that provided by the impedance bridge (100 - 100KHz).

Figure 3 shows the results of the dielectric constant measurements as a function of time. The measurements were performed at a frequency of 100kHz during 2000s. The results show that the dielectric constant decreases as a function of time.

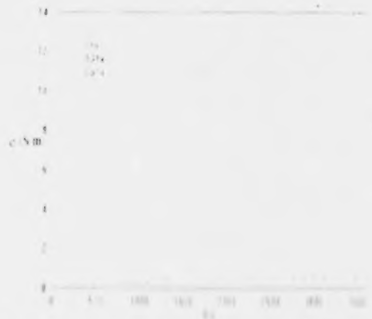

Figure 2: Conductivity of Tissue Like Gelatin.

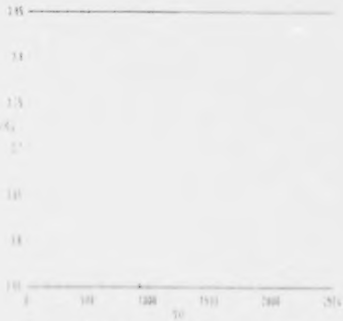

Figure 3: Dielectric Constant of Tissue-Like Gelatin

Electromagnetic Field Profiles

The results of the three dimensional map for the tank filled with 0.9% NaCl gelatin show that the effect of the probe is negligible (i.e. parallel equipotential lines were obtained).

The results of the measurements with the sphere inside the tissue-like gelatin are shown in Figure 4. The shapes of the equipotential lines demonstrate the presence of the sphere at the center.

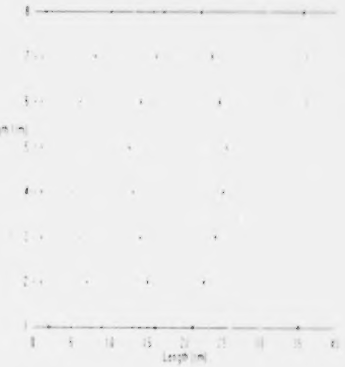

Figure 4: Equipotential Map for Metallic Sphere Inside Tissue Like-Gelatin

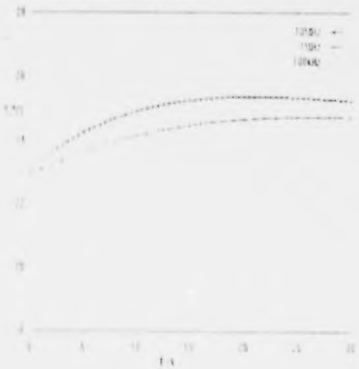

Figure 5: Tissue Like-Gelatin Heating

Temperature Measurements

The results of the temperature measurements as a function of frequency are shown in Figure 5. When the RF electromagnetic field is activated, there is an increase of a few degrees C and then the temperature becomes stable. Also the temperature increases with an increase in the frequency of the applied field. A similar behavior is expected until a resonance frequency is reached. Future experiments are needed to test this statement. The initial increase in temperature with time (ΔT/Δt) is proportional to the Specific Absorption Rate

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(SAR), the rate of energy deposition in a unit of mass of tissue due to exposure to a time-varying field.

$$\frac{\Delta T}{\Delta t} = \frac{(SAR)}{C} \qquad (3)$$

where C is the specific heat capacity.

CONCLUSIONS

By varying the saline concentration, samples of gelatins with electrical properties (conductivity and dielectric constant) similar to those of human tissue were fabricated. Mapping the electrical field inside the tissue-like gelatins allow us to obtain information about the object under study. Finally, monitoring the temperature changes in the samples we can obtain information about the SAR in gelatins.

ACKNOWLEDGMENTS

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REFERENCES

G.N Holland, P.A. Bottomley, W.S. Hinshaw, J. Magn. Resn., 28, 133 (1977).
P.C. Lauterbur, Nature 242, 190 (1973).
P. Mansfield, P.K. Granell, J. Phys. C6, L422 (1973).
A. Abragamn, "Principles of Nuclear Magnetism", Oxford University Press, Oxford, 1961.
E.R. Andrew, "Nuclear Magnetism Resonance", Cambridge University Press, Cambridge, 1969.
P.A. Bottomley, E.R. Andrew, "RF Magnetic Fields Penetration, Phase Shift and Power Dissipation in Biological Tissue: Implications for NMR Imaging", Phys. Med. Biol. 23, 630 (1978).
F.R. Zypman, R.W. Brown, E.M. Haacke, Proceedings, Sixth Anual Meeting of the Society of Magnetic Resonance in Medicine, New York, August 17-21, 1987, p.839.
F.R. Zypman, E.M. Haacke, R.W. Brown, J.L. Patrick, "Radiofrequency Penetration at High Frequencies in the Human Body", Proceedings, 73rd Scientific Assembly and Annual Meeting of The Radiological Society of North America, Chicago, November 29-December 4, 1987 p.130.
F.R. Zypman, PhD Thesis, "High Frequency Electromagnetic Fields in Magnetic Resonance Imaging", Case Western Reserve University, 1988.
A. Jasinski, T. Jakubowski, M. Rydzy, P. Morris, I.C.P. Smith, P. Kozlowski, J.K. Saunders, "Shielded Gradient Coils and Radiofrequency Probes for High-Resolution Imaging of Rat Brains", Mag. Res. Med. 24, 29 (1992).
C.J. Scheneider, N. Engelberts, J.D.P. Van Dijk, "Characteristics of a Passive RF Field Probe with Fiber-Optics Link for Measurements in Liquid Hyperthermia Phantoms", Phys. Med. Biol. 36, 461 (1991).
T.K.F. Foo, C. E. Hayes, Y. Kang, "Reduction of RF Penetration Effects in High Field Imaging", Mag. Res. Med. 23, 287 (1992).

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Thermal Modeling of the Marcy Anorthosite Massif, Adirondack Highlands, New York: Implications for Depth of Emplacement

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Traditional inverse geology techniques have most often been applied to identifying key events in the Grenvillian metamorphic, magmatic and tectonic history of the Adirondack Mountains in New York. This study is the first study to employ the forward technique of modeling the thermal effects of intrusions as a method for providing insight into this history of the Adirondacks. As the correct model for the Grenvillian history of the Adirondacks is currently under debate, mainly as to the depth of anorthosite emplacement, this study provides important constraints to the depth of emplacement and ultimately to which model of the Grenvillian history of the Adirondack Mountains is more viable. To develop these constraints, a two-dimensional finite difference algorithm was written to solve the equation for conduction of heat in solids. The effects generated by single and multiple intrusions at shallow (<10 km) and deep (>25 km) were modeled to determine the plausibility of the Marcy massif as a composite pluton. In addition, two different initial thermal structures were used: a typical continental thermal structure and a hotter continental thermal structure, to simulate a doubly-thickened crust. Results largely suggest that the Marcy massif was intruded deeply in multiple events, in a thickened crust. Significant additions can be made to the model to more accurately simulate the process of magma emplacement and cooling and it is suggested that numerical modeling be used in further study of the Adirondacks.

BACKGROUND

In recent years Valley and O' Neil (1982), Valley (1985), Bohlen et al. (1985), and McLelland and Chiarenzelli (1990) have employed the polymetamorphic model to explain the Grenvillian metamorphic, magmatic and tectonic history of the Adirondacks. Central to the polymetamorphic model is the emplacement at shallow depth (<10 km) of large volumes of anorthosite. However, evidence presented by Florence, et al. (1995) and Alcock and Muller (1997) suggest another model for the Grenvillian history of the Adirondacks, that of crustal thickening followed by anorthosite emplacement at depths greater than 20 km. Field and petrographic evidence suggest high-temperature, and moderate to high pressure metamorphism were a result of anorthosite intrusion at depth.

All previous work in the Adirondacks has used traditional geology techniques to determine the geologic history. Field, petrographic, and petrologic studies employ inverse methods to determine the past history. However, this study provides the first forward technique as applied to the study of the Adirondacks. This study uses thermal modeling of intrusions to determine constraints for the depth of emplacement of the Marcy Anorthosite massif. By estimating the effects at different depths, the two models of deep and shallow emplacement can be tested to determine which is more viable.

MODELING HEAT TRANSFER IN SOLIDS

Using basic principles of heat conduction in solids (see for example, Peacock (1989) or Furlong, et al. (1991), both discuss the basis of thermal modeling), a two-dimensional finite difference computer model was developed. Variables used in the following equations are defined in Table 1. The first equation used is Fourier's law:

$$q = -k\nabla T. \qquad (1)$$

The equation for heat conduction in solids is given by:

$$-\int_a q\,da + \int_v A\,dv = \int_v \rho C \frac{\delta T}{\delta t}\,dv. \qquad (2)$$

133

Table 1: List of symbols used in text

Parameter	Definition	Units
A	Volumetric heat production	µW m
C	Specific heat capacity	J kg^{-1} C^{-1}
K	Thermal conductivity	W m^{-1} C^{-1}
κ	Thermal diffusivity	m^2 s^{-1}
L	Thermal length	m
q	Heat flow	mW m^{-2}
ρ	Density	kg m^{-3}
t	Time	s
T	Temperature	°C
∇T	Temperature gradient	°C km^{-1}
x	Horizontal component	m
z	Vertical component	m

Suitably combining equations 1 and 2 yields:

$$\nabla^2 T + \frac{A}{K} = \frac{1}{\kappa}\frac{\delta T}{\delta t}. \tag{3}$$

Using a two-dimensional finite difference approximation of equation 3 yields:

$$T_{i,j}^{n+1} = T_{i,j}^{n} + \kappa\Delta t\left[\left(\frac{T_{i+1,j}^{n} - 2T_{i,j}^{n} + T_{i-1,j}^{n}}{(\Delta x)^2}\right) + \left(\frac{T_{i,j+1}^{n} - 2T_{i,j}^{n} + T_{i,j-1}^{n}}{(\Delta z)^2}\right)\right] + \frac{A}{K}. \tag{4}$$

Here the subscripts i,j refer to spatial grid points in a finite difference grid and the superscript n refers to the time grid points. Therefore, the temperature of a grid point after one time step of Δt, $T_{i,j}^{n+1}$, equals the temperature of that grid point at the initial time $T_{i,j}^{n}$, plus a weighted combination of the temperature of all the neighboring grid points. For calculations, a grid of 100 x 50 was used, with fixed boundary conditions of zero at the surface and the background geothermal gradient temperatures along the sides and at the bottom. Explicit finite difference schemes are only stable when relatively small time steps are used; in this case, time steps must be less than 7,922 years to ensure mathematical stability. The model used a time step of 5,000 years to ensure this stability. The background geothermal gradient was established by using an exponential decay of radioactive elements with depth in the crust, given by:

$$T = T_s + \frac{q_m z}{k} + \frac{AL}{k}(1 - e^{-z/L}). \tag{5}$$

MODEL RESULTS

Initial tests of the model involved intrusions of a single magma body at t=0 and allowing for simple conduction to cool the magma over time. However, regardless of deep or shallow intrusion or the volume of the intrusion, very high temperatures could not be reached at any distance from the intrusion, except along the contact. This required a reassessment of the scenarios for magma intrusion and it was eventually decided that a multiple injection model was better suited for testing. This corroborates well with evidence of multiple stages of deformation of the Marcy anorthosite massif, suggesting the massif was intruded in multiple stages.

Using values of T_s=0, K=2.25, q_m=0.03, A=2×10^{-6}, and L=10 km, to establish the geotherm and of 1mm^2/s for thermal diffusivity, which are typical of continental geotherms today, the model was run with multiple intrusions, each intrusion displacing the previous. This is geologically unreasonable but provided an end member case to test. Intrusions every million years at both deep and shallow depths produced higher temperature gradients than a single intrusion but temperatures where not very high for any great distance from the intrusion.

Further evaluation of the model led to the realization of the absence of an important heat source that had previously been neglected, latent heat. Using a method, described by Jaeger (1964), which adds the equivalent temperature of latent heat to the initial intrusion temperature, thus conserving energy, the latent heat was accounted for. It is important to note however, that this method overestimates the temperature along the contact and thus, for practical purposes, these values were generally ignored and gradients were calculated beginning 1-2 km from the contact. At this distance, the problem of temperature overestimation has disappeared and the temperatures are valid.

Using typical values of latent heat of 100 cal/g and a heat capacity of 0.25cal/gK, the model was run with multiple intrusions. The addition of the latent heat term was the equivalent of adding 400 degrees C to the intrusion temperature and this proved to create a leveling of the

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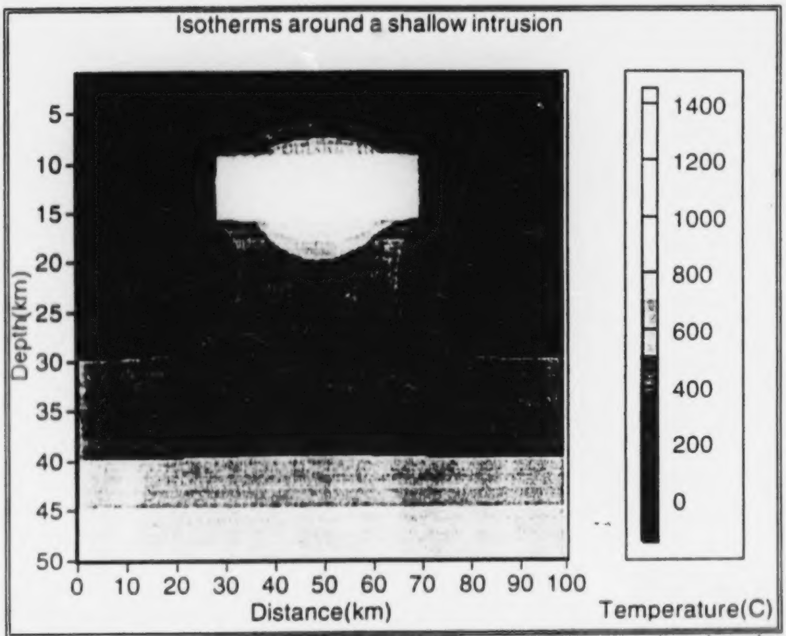

Figure 1: Isotherms around a shallow intrusion. Note the steep temperature gradient above the intrusion and that temperatures in excess of 800 degrees C are only reached less than 2 km from the contact.

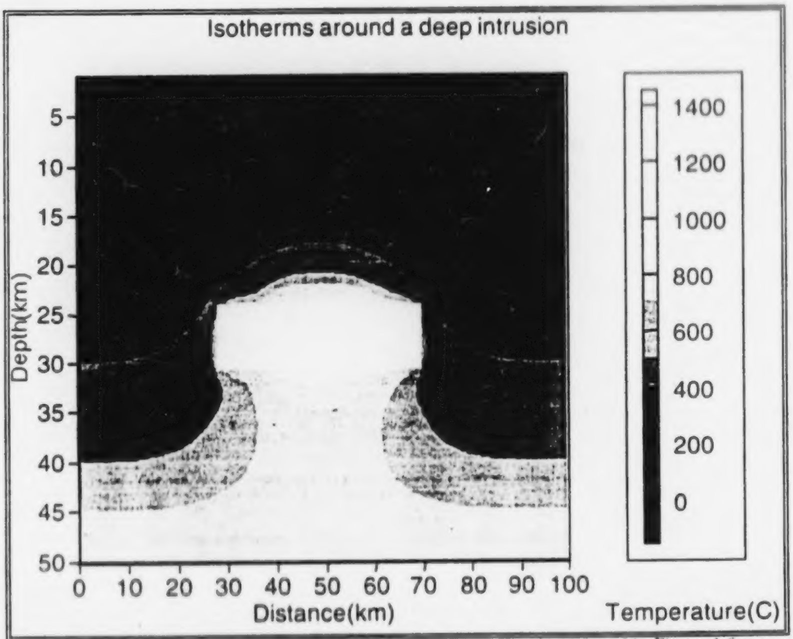

Figure 2: Isotherms around a deep intrusion. Compare these to those found in Figure 1 for a shallow intrusion and note they are further apart and that temperatures greater than 800 degrees C are reached more than 5 km from the contact.

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gradient, on the orders of 100 deg. C/km for shallow intrusions and 50-75 deg. C/km for deep intrusions. Further refinement of the model allowed for user input of the timing and placement of intrusions, so that more accurate geological scenarios could be tested.

The final test of the model yielded the results shown in Figures 1 and 2. For this model, multiple intrusions, spaced at half a million years, were intruded beside each other. In addition, values of q_m=0.04, k=2.0, A=3x10^{-6}, and L=15 km were used to simulate two possible scenarios, a hotter crust in the Proterozoic or a regime that had been crustally thickened. The results of this model run created gradients around 100 deg. C/km for shallow intrusions and around 50 deg. C/km for deep intrusions. However, what is important for this scenario is the extent to which high temperatures are reached, especially around deep intrusions. Temperatures in excess of 800 deg. C occur almost 5 km above the intrusion and the gradient is near horizontal below the intrusion.

A WORD OF CAUTION TO THE READER

Though the results of this study point to deep intrusions, in the proper thermal regime, of creating high-temperature metamorphism at distance greater than 5 km from the contact, there are several assumptions in the model. First, the pluton geometry was approximated as a rectangle. Secondly, the intrusion is assumed to be emplaced instantaneously. In addition, although the latent heat term is correct in that it satisfies conservation of energy, it overestimates the temperature along the contact and it does not release the latent heat in a nonlinear fashion, as Neksavil (1988) suggested is the case. However, the overestimation of temperature along the contact is not important for implications of this study, which focuses on more regional effects of intrusions, rather than contact metamorphism. One final note is that several heat sources were left out, because they are complex to implement. The heat sinks are advective heat transfer, lost through hydrothermal fluids, often set in motion by intrusions, and metamorphic reactions, which are endothermic and consume heat. Magma convection was neglected; this provides fresh hot magma from the base of the magma chamber to the top and thus acts as a heat source.

CONCLUSIONS

Generally, all attempts to generate shallow temperature gradients around shallow intrusions failed. However, given a particular thermal regime, such as a hotter Proterozoic crust or a crust that has been doubly thickened, intrusions at depths > 20 km can produce high temperature metamorphism at distances on the orders of 5 km from the contact. In light of the Grenvillian models for the history of the Adirondacks, this study would suggest that deep emplacement of the anorthosite s favored but that drawing this conclusion indefinitely is premature, given the cautions outlined above. However, thermal modeling provides a powerful tool for testing different geological scenarios and the potential of this model, with the additions of the terms neglected above and using a more accurate geometry, is great.

REFERENCES

Alcock, J. A., and Muller, P. D., 1997, Nearly synchronous penetrative deformation, very high-temperature, moderate-pressure metamorphism and anorthosite emplacement in the northeastern Adirondack Highlands, New York. Canadian Journal of Earth Science, in review.

Bohlen, S. R., Valley, J. W. and Essene, E. J., 1985, Metamorphism in the Adirondacks. I. Petrology, pressure and temperature. Journal of Petrology, 26: 971-992.

Florence, F. P., Darling, R. S., and Orrell, S. E., 1995, Moderate pressure metamorphism and anatexis due to anorthosite intrusion, western Adirondack Highlands, New York. Contributions to Mineralogy and Petrology, 121: 424-436.

Furlong, K. P, Hanson, R. B., and Bowers, J. R., 1991, Modeling Thermal Regimes. *In* Contact Metamorphism, vol. 26, Reviews in Mineralogy. *Edited by* Kerrick, D. M., Mineralogical Society of America, pp. 437-505.

Jaeger, J. C., 1964, Cooling and Solidification of igneous rocks. In: Basalts, the Poldervaart Treatise on Rocks of Basaltic Composition. Edited by Hess, H. H., and Poldervaart, A. 2: 503-536.

McLelland, J. M. and Chiarenzelli, J., 1990, Isotopic constraints on emplacement age of anorthositic rocks of the Marcy Massif, Adirondacks Mts., New York. Journal of Geology, 98: 19-41.

Neksavil, H., 1988, Calculation of equilibrium crystallization paths of compositionally simple hydrous felsic melts, American Mineralogist 73, 956-965.

Peacock, S. M., 1989, Thermal modeling of metamorphic pressure-temperature-time paths: A forward approach. *In*: Metamorphic Pressure-Temperature-Time Paths, Short Course in Geology, vol. 7, International Geological Congress. American Geophysical Union, pp. 57-102.

Valley, J. W. and O'Neil, J.R., 1982, Oxygen isotope analysis evidence for shallow emplacement of Adirondack anorthosite. Nature, 300: 497-500.

Valley, J. W., 1985, Polymetamorphism in the Adirondacks: Wollastonite at contacts of shallowly intruded anorthosite. *In* The Deep Proterozoic Crust in the North Atlantic Provinces. *Edited by* A. C. Tobi and J. L. R. Touret, D. Reidle Publishing Company, Dordrecht, Holland, pp. 217-236.

1385

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ULTRA SENSITIVE DIODE LASER BASED MONITORS FOR TOXIC ENVIRONMENTAL GAS NO_2

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INTRODUCTION

The photodissociation of nitrogen dioxide (NO_2) plays an important role in the photochemical production of ozone in the global troposphere as well as being a large contributer to the production of acid rain.[1] High levels of this nitrogen oxide in the atmosphere will affect human health both directly and indirectly. The direct effects include the impact on the human respiratory system. The indirect effects of nitrogen oxides are due to their direct effect on animal and plant life and how these effects impact human life. The production of acid rain and the increased levels of ozone in the atmosphere result in the depletion of aquatic life in rivers and streams, as well as leaching out nutrients in soil. This affects humans by reducing wildlife, as well as subjecting these animals to contamination from additional pollutants that result directly from the original NO_x contamination. Human beings may also be impacted by the fact that many of these contaminated animals (i.e., fish) are consumed by humans. Monitoring the different sources of NO_2 and its dispersion into the atmosphere will be helpful to develop strategies to control the concentration of tropospheric ozone through a control of NO_2 concentration.

The most significant anthropogenic source of nitrogen oxides is the combustion process. The two largest components of this are automobile pollution, and pollution from power generation plants. In the upper troposphere, nitrogen dioxide levels are high in the area where air traffic is most prevalent.

There are a number of techniques presently in use for monitoring environmental NO_x pollutants.[2] The most popular is chemiluminescence. This technique is rather expensive and can monitor only one pollutant at a time. An alternative method which is often used is to employ passive diffusion tubes which measure the integrated amount of a pollutant absorbed over a period of about a week. This technique also requires chemical analysis. Another technique, based on lasers, is differential optical absorption spectroscopy (DOAS). In this method one uses a high pressure xenon lamp source and measures the molecular absorption spectrum as a function of wavelength. Using this technique, one can obtain a sensitivity of about 1 ppb for a variety of pollutants including VOC molecules. The main drawback of this method is that it is quite expensive and requires elaborate optical alignment.[3]

The new diode laser-based techniques are attractive. They only need small samples, can monitor samples in real-time, and can be automated easily using computers.

SAMPLE PREPARATION

A quartz tube gas cell of approximately 1 meter in length was used for the absorption measurements. The glass cell was fitted with optical windows and evacuated. The evacuation system consisted of a mechanical pump, diffusion pump and a liquid nitrogen trap. The cell was connected to a high purity nitrogen dioxide cylinder using appropriate stop cocks. The cell was evacuated a couple of times and was pumped for several days so that surface absorbed molecules were removed. The cell was then filled with nitrogen dioxide gas at a pressure of 800 mbar and was used for the measurements.

LASER ABSORPTION MEASUREMENTS [3,4]

In order to choose an optimal optical absorption line, we studied the absorption spectrum of nitrogen dioxide over an extended laser wavelength range. This procedure would enable us to select an appropriate transition matching with the diode laser output. A high resolution Ti-sapphire laser, which was pumped by a 6 W argon ion laser, was used for the laser absorption measurements of NO_2 as a function of laser wavelength in the region 640 - 840nm. The Ti-sapphire laser gives a continuously tunable output in the region 600 - 1000 nm, and the linewidths are less than 1 GHz. The experimental arrangement consists of a multiple pass optical cell. The following observations were taken with 4 passes. More passes were impossible because the beam spread was large and needed secondary focusing. A schematic of the experimental arrangement is shown in Figure 1. The transmitted laser intensity was measured with the help of a diode detector and lock-in detection to improve the signal to noise ratio. The cw laser output was chopped with a mechanical chopper at a frequency of 500 Hz to enable lock-in detection. Table 1 shows some of the prominent peaks observed in this research as comnared with data available in the literature.

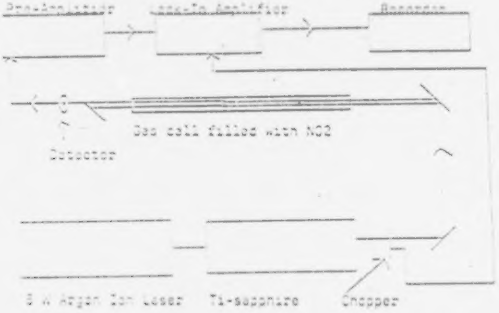

Figure 1. Initial Experimental Set-up

Table 1. Observed absorption lines compared with reported values

Presently studied absorption lines (nm)	Corresponding absorption line reported in the literature [5]
735.4	735.8
739.2	
740.2	740.2
742.49	
744	
744.8	744.8
745.2	
745.75	
745.9	
746	
746.3	
746.5	746.51
747.72	748.92
750	751.69
759.93	758.46
760.2	760
761	
790.45	790
791.4	791.32
832.18	829.25
835.22	
836	836

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Absorption peaks observed in this research are shown in Figure 2.

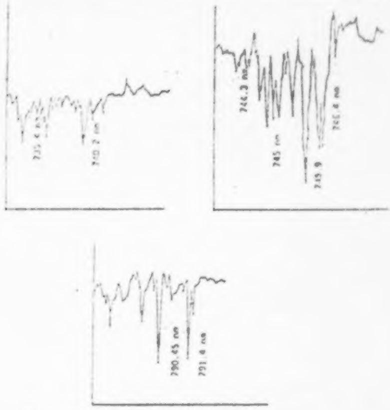

Figure 2: Absorption Peaks

FREQUENCY MODULATED SPECTROSCOPY USING DIODE LASERS LOCKED TO AN EXTERNAL CAVITY [6,7]

Semiconductor lasers offer a number of attractive features for monitoring pollutant gases in the atmosphere. Diode lasers are efficient, compact in size and provide tunable output with excellent intensity stability. The power requirements of diode lasers are quite low and they can be conveniently operated by batteries. Diode lasers can be easily electronically modulated even at high frequencies. Diode laser tuning can be accomplished in a number of ways: (1) temperature tuning (2) injection current tuning and (3) external cavity tuning. Though lead salt diodes are traditionally used for monitoring environmental pollutants, they are not convenient for field monitoring because they have to be operated at liquid nitrogen temperatures

FREQUENCY-MODULATION SPECTROSCOPY FOR TRACE POLLUTANT DETECTION

During this decade, a variety of frequency-modulation methods have been reported for high-sensitivity detection of pollutant gases in the atmosphere. Frequency-modulation detection techniques enhance the sensitivity for trace gas detection. These techniques provides real-time quantitative measurement of a wide variety of species with high sensitivity and fast response. Though these methods are known as wavelength-modulation spectroscopy (WMS), frequency modulation spectroscopy (FMS) and two-tone frequency-modulation spectroscopy (TTFMS), they are basically similar in methodology except for the range of modulation frequencies and their number. The choice among these three techniques is driven by the laser tuning characteristics, the absorption linewidth, and the detection bandwidth. The detection can be at single, double or higher order harmonics; the choice again depends on the particular experimental conditions.

By modulating the diode laser's frequency at rates above the diode's shot noise level, the effective signal to noise ratio is improved. In addition to this, by detecting at a second harmonic of the modulation frequency, the signal to noise ratio is further improved.

DIODE LASER LOCKED TO AN EXTERNAL CAVITY OR A REFERENCE NO_x CELL

Fine wavelength tuning and stability can be accomplished by locking the laser to an external cavity. In this arrangement the diode laser emits light radiation at the frequency selected by the external cavity, thus minimizing the problems associated with instabilities, mode hops, and tuning gaps of a free running diode laser. The high

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Q of the external cavity results in a narrower linewidth of the laser output. The external cavity arrangement also provides continuous tuning over a wider range than a free-running diode laser. The desired frequency is chosen by rotating the gold mirror, which has good reflectivity in the near infrared region such that the appropriate portion of the first order maximum from the diffraction grating is reflected back to the grating and then back into the laser. This rotation also changes the cavity length such that a standing wave is maintained for the selected wavelength. The rotation of the mirror is controlled by means of a Piezo drive. A virtual instrument (software program) developed using the LabView programming environment enables one to vary and control the amplitude, frequency, and waveform of the ramp signal across the Piezo drive.

Employing WMS, we first studied the detection of rubidium in a rubidium optical cell. The rubidium optical cell was prepared by introducing rubidium in an evacuated optical cell and then sealing it off. The experimental setup used is shown in Figure 3.

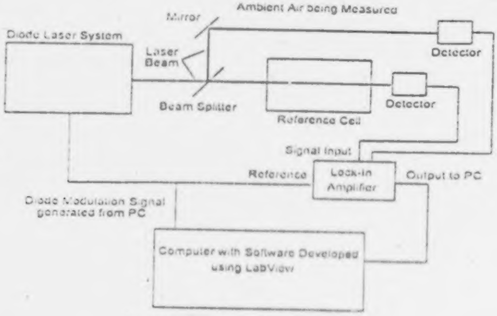
Ambient Air being Measured
Mirror
Diode Laser System
Laser Beam
Detector
Beam Splitter
Reference Cell
Detector
Signal Input
Reference
Lock-in Amplifier
Output to PC
Diode Modulation Signal generated from PC
Computer with Software Developed using LabView

Figure 3: WMS experimental set-up

We were able to observe a signal corresponding to the second derivative. The observed signal is shown in Figure 4. The present studies continue to observe the WMS signals corresponding to NO_2. The next stage will be to optimize the detection sensitivity.

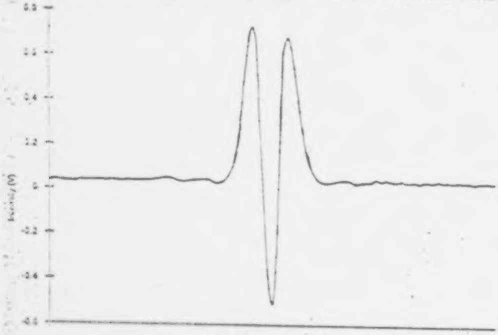

Figure 4: 2nd Derivative Spectrum of Rb

CONCLUSION

Laser absorption measurements of NO_2 are reported covering the 640- 840 nm region. A number of new absorption lines are reported in comparison to existing literature. A Ti-sapphire laser and multi-pass NO_2 cell are used for the measurements.

REFERENCES

1 Logan, J.A, *et al.*, Tropospheric ozone: seasonal behavior, trends, and anthropogenic influence, J. of Geophys. Res., 1985,90, 10463.

2 Wilken, J., Driver, G. S., and Stevenson, J. K., Evaluation of ambient monitoring techniques for low levels of nitrogen dioxide, preprint.
3 Allen, M. G., et al., Ultrasensitive dual-beam absorption and gain spectroscopy: applications for near-infrared and visible diode laser sensors, Applied Optics, 34, 3240(1995).
4 Cooper, D. E., and Martinelli, R. U., Near-Infrared diode lasers monitor molecular species, Laser Focus World, November 1992, p133.
5 Georges, R., et al., Jet cooled NO_2 intra cavity laser absorption spectroscopy (ICLAS) between 11200 and 16150 cm-1, Chemical Physics, 190,207(1995).
6 Silver, J.A., Frequency-modulation spectroscopy for trace species detection: theory and comparison among experimental methods, Applied Optics, 31 707(1992).
7 Supplee, J. et al., Theoretical description of frequency modulation and wavelength modulation spectroscopy, Applied Optics, 33, 6294(1994).

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SAMPLE HEATING AND ITS EFFECTS ON DIFFUSION DEPTH

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ABSTRACT

The diffusion of dopants into semiconductors requires inserting the sample to be diffused and the diffusion source into a furnace. The sample and the source heat in a finite time from room temperature to the final diffusion temperature. During the time the sample temperature is increasing, the diffusion coefficient increases rapidly. However, there is negligible diffusion depth during the early stages of diffusion. The calculation and data presented show that (a) the sample's temperature rise is exponential and (b) diffusion is insignificant until the sample temperature is within about 5% of the final temperature. This temperature is reached approximately 3 time constants after insertion into the furnace.

INTRODUCTION

High packing density in integrated circuit fabrication requires precise shallow placement of diffused dopants. Shallow diffusions demand short diffusion times. As the time of diffusion shortens, the time required to raise the temperature of the ampoule becomes a significant portion of the total time required for diffusion. Observations indicate that during the temperature rise of the ampoule, there is negligible diffusion for some period of time. This "incubation" period lasts until the ampoule has reached a temperature close to the final temperature.

In this paper a model for the rise in temperature of the diffusion ampoule and its effects on the calculation of diffusion depth will be presented. The rise in temperature of the ampoule can be modeled using Newton's law of heating and cooling. Once the temperature schedule of the ampoule is known, the diffusion depth can be accurately determined.

THE HEATING SCHEDULE OF THE DIFFUSION AMPOULE

In order to accurately predict diffusion depth for short times, the rise in temperature of the sample must be taken into account. The sample does not rise to the final diffusion temperature instantaneously, and can be modeled with Newton's equation for heating and cooling:

$$\frac{dT}{dt} = -k(T_2 - T_1)\,, \tag{1}$$

where k is a constant to be determined and T is the temperature. Beginning at $t = 0$, $T(0) = T_i$, the initial temperature rises to a final temperature $T(\infty) = T_f$, and equation (1) yields:

$$T(t) = T_i + (T_f - T_i)\left[1 - \exp\left(\frac{-t}{\tau}\right)\right]. \tag{2}$$

where τ is the time constant of the furnace. This equation was examined for two cases. [1] The heating schedule of the diffusion ampoule was established for a sample inserted at an initial temperature T_i into a furnace at final temperature T_f (curve 1 in Figure 1). [2] For this case, the furnace temperature was initially increased above the final diffusion temperature (curve 2 in Figure 1). The sample was then inserted, and the furnace temperature was decreased to the final diffusion temperature. This was done in order to shorten the rise time of the ampoule, and caused a slight overshoot in sample temperature (curve 3 in Figure 1).

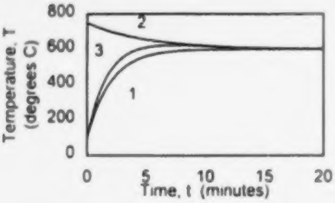

Figure 1: The ampoule rise(1), the furnace cooling(2), and the ampoule overshoot(3).

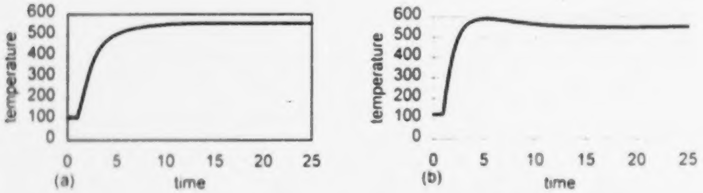

Figure 2: The heating schedule of the diffusion ampoule inserted in: a furnace at constant temperature T_f = 550°C (a), and a furnace at initial temperature T = 700°C decreased the final temperature T_f = 550°C upon insertion of the ampoule (b).

In Figure 2, the temperature rise data is shown for the diffusion ampoule. The data is separated into the two cases described above.

DIFFUSION DEPTH

Two solutions of the diffusion equation will be described below. The first solution assumes that the diffusion coefficient is independent of temperature, and the second solution assumes that the diffusion coefficient varies with temperature.

$$\frac{\partial^2 C}{\partial x^2} = \frac{1}{D}\left(\frac{\partial C}{\partial t}\right) = \frac{\partial C}{\partial (D t)} \quad \text{for constant D} \tag{3}$$

If the surface concentration is constant, the solution is given by:

$$C(x,t) = C_{surf}\, erfc\left(\frac{x}{\sqrt{4Dt}}\right). \tag{4}$$

The diffusion depth is usually defined as the point:

$$x = x_j = \sqrt{4Dt}. \tag{5}$$

The diffusion coefficient D is assumed to have the form:

$$D = D_0 \exp\left(\frac{-E_a}{kT}\right). \tag{6}$$

Taking these equations the junction depth can solved for each of the two cases. In both cases, it is assumed that D_0 is approximately constant, because its temperature dependence is much less than that of the exponential. For the first case, the diffusion coefficient will be treated as independent of temperature, by taking the temperature to be constant with respect to time. Although the diffusion mechanism in GaAs is not strictly Fickean, experimental data is found to fit equations of the same form as (4) and (5), viz.:

$$x_j = 2\sqrt{D_0 t}\exp\left(\frac{-E_A}{2kT}\right) = A\sqrt{t}\exp\left(\frac{-B}{T}\right). \qquad (7)$$

where $A = 2\sqrt{D_0}$, and $B = E_A/2k$. With this experimental fit in mind, consider the effects of the finite rise in temperature of the diffusion ampoule.

This solution implies a linear relationship between x_j and $\sqrt{t}$. For equation (7), diffusion begins as soon as the ampoule is inserted into the furnace, and the diffusion is ideal. However, the ampoule does not rise to temperature instantaneously. It has a finite temperature rise time, which will be approximated with a linear ramp, as shown in Figure 3. Beginning with equation (3), incorporate the temperature dependence of the diffusion coefficient. The temperature dependence is a function of time, so defining a temperature dependent function:

$$T(t) = \int_0 D(t)dt, \qquad (8)$$

equation (3) becomes:

$$\frac{\partial^2 C}{\partial x^2} = \frac{\partial C}{\partial T(t)}, \qquad (9)$$

which has the same form as equation (3), so equation (4) is now:

$$C(x,t) = C_{surf}\,erfc\left(\frac{x}{2\sqrt{\int_0 D(t)dt}}\right). \qquad (10)$$

The linear temperature ramp has the form:

$$T(t) = T_0 + rt, \qquad (11)$$

where r is the rate of rise, and T_0 is the initial temperature. Since we will show that diffusion is delayed until $T = T_f$ we will set $T_0 = 0$ in order to simplify the equations:

$$x_j^2 = 4D_0\int_0^{T_f/r}\exp\left(\frac{-E_A}{krt'}\right)dt'. \qquad (12)$$

Making the substitution:

$$u = \frac{E_A}{krt'} \qquad du = \frac{-E_A kr}{(krt')^2}dt' \qquad (13)$$

yields

$$x_j^2 = \frac{4D_0E_A}{kr}\int_{E_A/kT_f}^{\infty}\frac{e^{-u}}{u^2}du. \qquad (14)$$

This equation can be solved two different ways. The first method follows Killoran (1962), and solves the equation by integrating by parts. The integral can also be evaluated numerically. To continue with the first method:

$$x_j^2 = \left(\frac{4D_0E_A}{kr}\right)K(y). \tag{15}$$

Define

$$K(y) = \int_y^\infty \frac{e^{-u}}{u^2}\,du. \tag{16}$$

Integrate by parts to get a power series in y:

$$K(y) = \frac{e^{-y}}{y^2}\left(1 - \frac{2!}{y} + \frac{3!}{y^2} - \frac{4!}{y^3} + \ldots\right) \approx \frac{e^{-y}}{y^2} \quad \text{for large values of } y. \tag{17}$$

which gives the junction depth as:

$$x_j^2 = \frac{4D_0E_A}{kr}\left\{\frac{\exp\left(-E_A/kT_f\right)}{\left(E_A/kT_f\right)^2}\right\} = \frac{4DkT_f^2}{E_Ar}. \tag{18}$$

Substituting the diffusion coefficient, D, into the equation for junction depth yields,

$$\Delta t \cong \frac{kT_f^2}{E_Ar} = \frac{T_f^2}{2Br}, \tag{19}$$

keeping only the first term. The time interval Δt is the additional time of diffusion needed to calculate the correct diffusion depth, as shown in Fig. 3(b), and B is defined in equation (7).

EXPERIMENTAL DATA

In order to test this model the ampoule is assumed to follow a linear temperature ramp, and compared to two cases in which the ampoule came to temperature instantaneously. This translated into two instantaneous diffusions bounding a case in which the diffusion process was delayed by the heating of the ampoule. Diffusion begins with a high initial rate, and then levels off to the rate for the ideal case. By extrapolating backwards to find the intercept, we find the effective additional time, Δt, of diffusion. The effective time represents the time at which diffusion would have begun if treated as an ideal case.

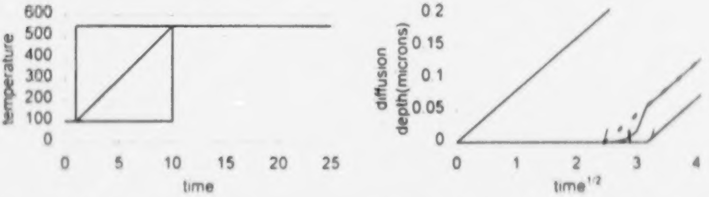

Figure 3: Two ideal temperature rises bounding a linear rise (left); two ideal diffusions bounding a varying one. 't' is the additional diffusion time (Δt) (right).

Experiments were performed diffusing zinc into GaAs using a Zn_3As_2 source. Zn_3As_2 decomposes into Zn and As. The Zn is the diffusion source, and the As provides an overpressure which prevents the decomposition of GaAs. The time of diffusion was measured beginning with the insertion of the diffusion ampoule into the furnace. Diffusions from 10 min to 1000 min. were considered. After staining the samples, the diffusion depths were measured on an SEM. The experimental data is plotted in Figure 4, and the lines are fitted using equation (7) with:

$$\begin{aligned} A &= 2.1 \bullet 10^{4} \mu / \sqrt{\min} \\ B &= 12825K \end{aligned} \tag{20}$$

For the numerical solution to the exponential integral, we used MathCad to the calculation. The linear portion of the plot was projected back across the axis to calculate the effective diffusion time. This solution shows the increase in diffusion depth upon insertion of the ampoule and is plotted in Figure 3(b).

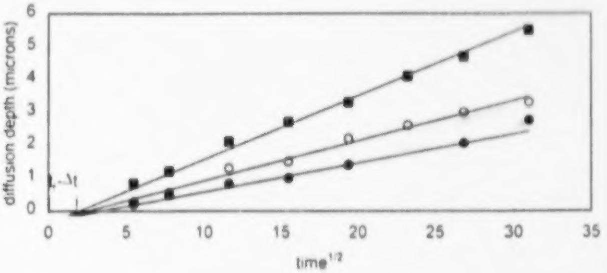

Figure 4: A plot of diffusion depth in microns vs. the square root of time in minutes: the solid lines show the fitted model, the points show the experimental data.

In conclusion, for shallow diffusions in which the diffusion time is not large compared to the heating of the diffusion ampoule, the diffusion depth can be modeled in two stages. Newton's law of heating and cooling describes the behavior of the diffusion ampoule upon insertion into the furnace. Then taking into account the temperature rise of the ampoule, the diffusion can be modeled by solving the diffusion equation with a temperature dependent diffusion coefficient. The result of this model is that the diffusion process does not begin immediately. There is an incubation period until the ampoule has been heated for a time within Δt of the final temperature. The incubation period (t_i-Δt), (see Figure 4) can be estimated and then used to determine the diffusion depth.

REFERENCES

D.R. Killoran, "The Effective Duration of a Linear Slow-Cool", *Journal of the Electrochemical Society*, Vol. 109, No. 2, pp. 170 - 171, 1962.

A. Luque, J. Martin, G.L. Araujo, "Zn Diffusion in GaAs under Constant As Pressure", *Journal of the Electrochemical Society*, Vol. 123, No. 2, pp. 249 - 254, 1976.

K.N. Tu, J.W. Mayer, L.C. Feldman, *Electronic Thin Film Science: For Electrical Engineers and Materials Scientists*, New York: Macmillan, 1992.

S.S. Lau, J.W. Mayer, *Electronics Material Science: For Integrated Circuits in Si and GaAs*, New York: Macmillan, 1990.

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The Hyperpolarizabilities of Phthalocyanines

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The hyperpolarizabilities of molecules is studied in a search for optimum compounds to be used in non-linear optical devices. The phthalocyanine molecule has been investigated. The molecule was studied theoretically using the MOPAC and HYPER programs. The hyperpolarizabilities were calculated using semiempirical Hamiltonians (AM1 and PM3). The hyperpolarizabilities of the entire molecule and of the different segments of the molecule (e.g., inner ring structure, isoindoles structure) were studied to find the greatest contributing segment. The hyperpolarizabilities of similar molecules (e.g., porphyrins) were also compared with the molecule and its different segments. Finally, the effect that a metal (Zn) has on the hyperpolarizabilities was also investigated.

BACKGROUND

Non-linear optical materials have a variety of potential uses in the future due to their ability to allow the control of light by light [1]. Materials with large second- and third- order polarizabilities are the key for future photonics applications. They have the potential for applications in optical computers as switches or high density optical recordings [1]. In the field of non-linear optics, the need for organic molecules with high non-linear hyperolarizabilities is great. The hyperpolarizability (second-order polarizability) of a molecule is the measurement of the efficiency with which the molecule can generate second harmonics [2-4]. The hyperpolarizabilities are greatest in highly polarizable molecules. It has been shown in previous research that conjugated and aromatic organic molecules demonstrate the largest non-linear optical properties [5]. The phthalocyanine molecule (see figure 1) was studied and calculations resulted in a hyperpolarizability of $1.73 * 10^{-49}\ \mathrm{Cm^3V^{-2}}$ [5]. This is unusually high due to the fact that the molecule is primarily symmetrical which would make it nonpolar. However, there is one point of asymmetry in the molecule which occurs in the d ring of the structure (see figure 1e) which could be the segment that causes its high hyperpolarizability. In this research, a comparative study was performed on the phthalocyanine molecule in order to determine the greatest contributing unit to the high molecular non-linearity. Thus, the molecule was broken into different segments (see figure 1) and H atoms were added to make the molecules neutral and non-radical. The hyperpolarizabilities of the different pieces were found and compared, when possible, with other molecules of similar structure.

CALCULATIONS

The approach followed in this work is to obtain an initial geometry of the molecule from semiempirical calculations using the AM1 and PM3 Hamiltonians, then optimize this structure to minimize energy. This lowest energy optimized geometry is then subjected to a variety of static fields using semiempirical techniques. This method provides information on the polarization versus static field strength, which can then be analyzed to find the second order polarizability or hyperpolarizability β using the finite field formulation, according to equation 1:

$$P(F) = \mu + \alpha F + \beta F^2 + \gamma F^3 \qquad [1]$$

where μ is the permanent dipole moment, α is the linear polarizability, and γ is the third order polarizability. The calculations were done using the semiemperical MOPAC program [6] and the HYPER [7,8] program, in which the calculations of molecular hyperpolarizabilities have been implemented.

The molecules studied were derivatives of the phthalocyanine molecule (see figure 1:a-j) which were selected by removing different segments of the molecule and then adding hydrogen molecules to make the molecules neutral and non radical. As shown in figure 1, the half of the molecules contain a zinc atom within the porphyrin cage. The effect of this zinc atom on the hyperpolarizability was calculated. The phthalocyanine cage was also studied with and without the zinc atom. Due to the similarity of the phthalocyanine cage and the porphyrin ring, the hyperpolarizability of the porphyrin was also calculated and compared with the phthalocyanine cage.

RESULTS

In these calculations, the determination of the hyperpolarizability of the phthalocyanine was much lower than expected, and had a large uncertainty (see table 2). This large uncertainty is due to an unsatisfactory optimization of the geometry. The geometry of the molecule is modified by changing the atom coordinates until optimum energy can be reached, but the optimization is very dependent on the initial geometry. The molecule 1j, however, expressed an extremely high hyperpolarizability in comparison with the other phthalocyanine molecules. This molecule is symmetrical except for the position where ring d would be placed. Thus when the isoindoles structure of the molecule is removed, the polarity of the molecule is greatly increased.

As known from previous results, there is an element in the porphyrin ring that produces a high hyperpolarizability when zinc is placed within the cage. Zinc also causes an increase in hyperpolarizability for the phthalocyanine ring, although not as dramatic as for the porphyrin. In figure 2 we see that when compared, the porphyrin ring with a zinc atom has a hyperpolarizability approximately 1000 times higher than the porphyrin ring without the zinc atom, the phthalocyanine cage with the zinc atom and the phthalocyanine cage without the zinc atom.

CONCLUSION

It was found that the phthalocyanine ring with two segments on the top and bottom of the ring (see figure 1j) produced the greatest hyperpolarizability with the smallest uncertainty for all of the molecules. This fact leads us to believe that this could possibly be the greatest contributing unit. Future research will include a study on the hyperpolarizabilities associated with addition of substituents onto the phthalocyanine ring in the top and bottom (t&b, see table 1) positions. Research is already in progress to synthesize this unsymmetrical molecule.

ACKNOWLEDGMENTS

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REFERENCES

1. Bosshard, C. Knopfle, G. Pretre, P. Follonier, S. Serbutoviet, C., and Gunter, P.Optical Engineering, Molecular Crystals and Polymers for Nonlinear Optics. 34 1951 (1995).

2. Prasad, P.N. and Williams, J.D.1990, Introductions to Nonlinear Optical Effects in Molecules and Polymers. Wiley, New York.

3. Marder, S.R., Sohn, J.E., and Stucky, G.D., Eds. "Materials for Nonlinear Optics: Chemical Perspectives." American Chemical Society Symposium 455, Washington; 1991.

4. Chelma, D.S. and Zyss, J. Eds 1987 Nonlinear Optical Properties of Organic Molecules and Crystals. Academic,. vol. 1.

5. Cardelino, B.H. and Moore, C.E. Proceedings of the International Society for Optical Engineering. Aromaticity and Conjugation Effects on the Nonlinear Optical Properties of Multi-dimensional Molecules. 2852 153 (1996).

6. MOPAC, *Quantum Chemistry Program Exchange*; No. 455, Version 6.1, 1990.

7. Cardelino, B.H., Moore, C. E., and Frazier, D.O. J. Phys. Chem. *Calculation of Static Third Order Polarizabilities of Large Organic Molecules*. March (1997).

8. Cardelino, B.H., Moore, C.E., and Stickel, R.E. J. Phys. Chem, *Static Second- Order Polarizabilities Calculations for Large Molecular Systems* 95 8645 (1991).

Table 1: Molecules Studied

#	Name
a	Porphyrin Ring + Zn Metal
b	Porphyrin Ring
c	Phthalocyanine Ring
d	Phthalocyanine Ring + Zn
e	Phthalocyanine
f	Phthalocyanine + Zn

g	Phthalocyanine Ring + 2 pieces (L&R)
h	Phthalocyanine Ring + 2 pieces (L&R) + Zn
i	Phthalocyanine Ring + 2 pieces (T&B)
j	Phthalocyanine Ring +2 pieces (T&B) + Zn

Table 2: Static second order (β) and third order (γ) polarizabilities for the phthalocyanine structures and the porphyrin structures. The permanent dipole moment (μ), the angle between the dipole moment and the second order polarizability (θ) are also shown.

Molecule	μ	α	Ave β	+/-	γ	+/-	θ
a	10.10	34.37	109	3	-22	7	9
b	2.79	20.71	9.256	0.004	3.004	0.009	41
c	4.15	21.68	3.7652	0.0005	3.645	0.005	15
d	3.53	23.57	7.588	0.002	2.967	0.007	20
e	6.13	84.13	230	191	112	75	51
f	5.92	65.29	85	45	24	46	21
g	6.66	46.57	150	170	17	80	79
h	3.60	49.80	70.05	0.04	26	2	77
i	5.26	90.63	1684	1318	211	960	83
j	11.68	72.31	2205	1696	2207	1212	0

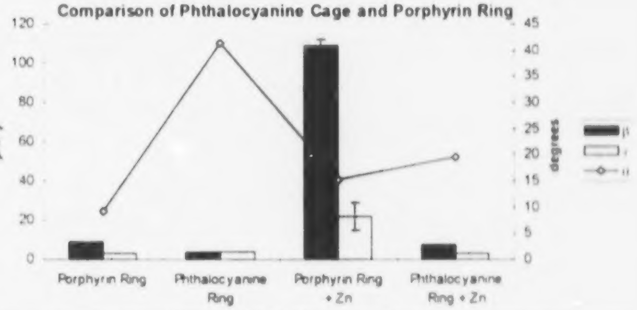

Figure 2- Comparison between porphyrin ring
and phthalocyanine cage [Units: β in 10^{-51} Cm^3V^{-2}; γ in 10^{-61} Cm^4V^{-3}; θ = angle between μ and β]

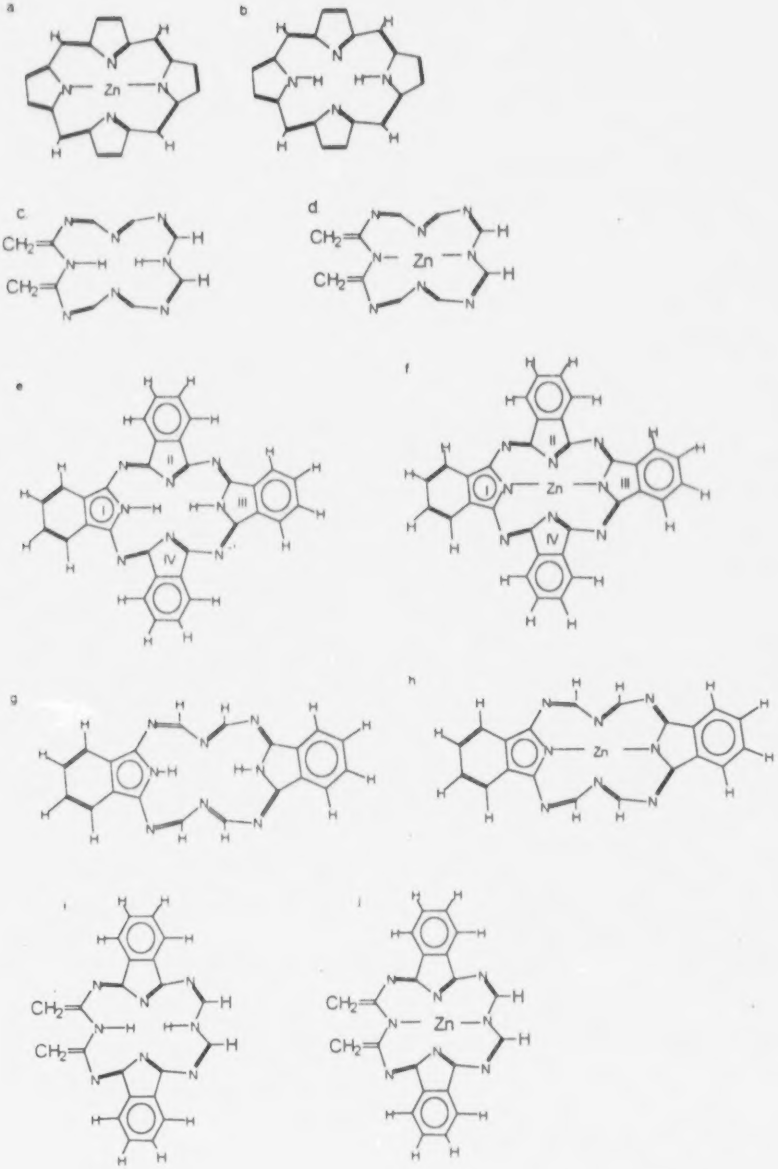
a
b
c
d
e
f
g
h
i
j
Zn
I
II
III
IV
CH₂

Figure 1: Phthalocyanine and porphyrin molecules studied

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Simulated Super Resolved Imaging of Compact Radio Sources

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Many celestial radio sources have structure on the order of light years, corresponding to an angular resolution below the standard beam size of 1 milliarcsecond. Because the structure is below the conventional resolution limits, it is important to test the standard mapping and modeling programs for systematic errors when such data is used. From studying the programs DIFMAP and MODELFIT, we have found that there do exist some systematic errors and have tested several solutions to reduce these errors.

INTRODUCTION

For many hundreds of years, people used only optical telescopes in observing astronomical phenomena due to the fact that they are naturally equipped with devices to observe electromagnetic waves from the visible part of the spectrum. Then in 1932, Karl Jansky identified the first celestial radio source at which point radio astronomy was born. Radio astronomy opened up a whole new window through which scientists could study celestial bodies. Not only could scientists learn more about sources that had been studied previously using only visible wavelengths, but some sources with structures too faint to be seen optically could now be studied in greater detail. Due to the many improvements over the years, today radio telescopes can achieve better resolution than most optical telescopes, and so radio astronomy has become very important in gaining a better understanding of a wide variety of astronomical objects.

Early problems with radio astronomy dealt with resolution. Since the radio waves studied (from celestial sources) have wavelengths on the order of centimeters, a telescope with a diameter too large to be practical in a single telescope was needed to achieve any kind of resolution comparable to that achieved by optical astronomy. This can be seen from the formula for angular resolution,

$$\theta \sim \lambda/D \qquad (1)$$

(with θ in radians) where λ is the wavelength of radiation and D is the diameter of the telescope. The technique developed to study compact radio sources is known as VLBI or Very Long Baseline Interferometry. The radio telescopes in an array spread out over a large distance are linked together electronically. The rotation of the earth causes the waves arriving at a pair of telescopes to be successively in phase and out of phase; so, the telescope array "sees" the sky as a series of bands of constructive and destructive interference. A computer can then take the amplitude and phase patterns collected from many pairs of telescopes and convert them into an image of the celestial radio source. Higher resolution can be achieved using VLBI because the distance between the farthest pair of telescopes becomes the diameter of the radio telescope.

PROJECT OUTLINE

When studying real radio sources, each telescope in the given array records the radio emissions from the source. Then a special purpose computer known as the correlator combines these signals using principles of interferometry. The correlator output is written to a tape which can be read into a computer where the data can be processed and used to create an image of the source. From measurements made on the image, numerical values can be obtained for relative location, size, and intensity of each component. For our purposes, we required data for which we already knew the relative locations, sizes and intensities. Using the FAKE program (from the Caltech VLBI Software package), it was possible to simulate the observation of a celestial radio source by having the computer create an artificial data file based on a model. This data file is then used in other programs as if it were a true source.

The main array of telescopes used for this project was the VLBA or Very Long Baseline Array, which consists of ten stations ranging across the US from St. Croix in the Virgin Islands to Mauna Kea in Hawaii and north to Brewster in Washington. Each telescope has a diameter of 25 meters, a 70% efficiency, and a system temperature (system power) of 60 K. The wavelength of radiation we used, a mid-range value, was λ=3.6 cm (equivalent to a frequency of 8.4 GHz) which gives, using the VLBA diameter, a resolution of $\theta \sim 1$ mas (1 milliarcsecond = 1 thousandth of an arc second).

When studying radio sources, the conventional beam size is approximately 1 mas. Many remote radio sources (including quasars and the nuclei of galaxies) turn out to be extremely compact, which means they are only a few light years in diameter. This corresponds to an angular resolution below the conventional beam size. Therefore, it is important to test the accuracy of imaging and modeling programs on sources below this limit (This corresponds to going beyond the familiar Rayleigh or Sparrow criterion). In addition to viewing structure at compact sizes, it is also important to be able to detect subtle variations in structure corresponding to the relative movement of the components. With these ideas in mind, we set out to investigate the potential and limitations of super-resolved imaging of compact radio sources using the Caltech programs DIFMAP and MODELFIT (Pearson 1991).

Most of the models we worked with were simple two component sources. The important parameters were flux, component separation, position angle, component size, and declination. The declination refers to the position of the source in the sky. Because the VLBA has a larger east/west than north/south spread, the shape of the beam (and therefore the resolving ability) will vary with declination. Here we used models at a high declination of 60°, corresponding to a circular beam, and a low declination of 15°, corresponding to an elliptical beam. Also, because the resolution was different depending on direction, we varied the position angles in increments of 45° from 0° to 135° (Position angle gives the position of a component relative to the central component. The angle is measured counterclockwise with 0° being directly north of the central component). The total model flux was usually about 100 mJy (where 1 Jansky=10^{-26} W/m^2/Hz). To determine whether the flux of each component affected other parameters we used low flux ratios such as 2:1 and 6:1, a mid-range ratio of 8:1, and high flux ratios of 10:1 and 15:1, with the first component having the highest flux. Component separations ranged from above the beam size at 2.0 to below the beam size at 0.2 mas. To study both compact and extended sources, we used component sizes or diameters of 0.1 and 0.3 mas.

DIFMAP RESULTS

Using the DIFMAP program (Shepard, Pearson, & Taylor 1994), the computer performs a Fourier transform on the amplitude and phase interference data received from the source to create an image of the source which is known as the "dirty map." The computer initially treats the object as a point source and then iteratively builds up a more complicated, accurate model by imaging the difference data after removing the effects of structure from previous iterations. During each iteration, the response of the array to a point source (called the "dirty beam") must be removed in a technique called "cleaning." In cleaning, a box is drawn around the brightest component of the source and a specified amount of flux is subtracted to reveal less luminous components. The result, after several iterations, is a "clean map" which is the "true" image of the radio source. Between each "clean" step and remapping, the *selfcal* command is used to determine telescope phase and gain corrections by "self calibration", i.e. comparing the observed data with an approximate model of the source structure. When the selfcal values converge or decrease to below 1 sigma the cleaning process is finished. The *mappl cln* command produces a "clean map" of the source using the standard beam for the given telescope array and declination. For our model sources where the component separation was less than the standard beam size (at dec=60° the beam is .993 x .962 mas at 41.1° and at dec=15° the beam is 1.56 x .85 mas at -4.19°), the second component could not be seen on this clean map. To see the two components separately we changed the beam size to be 0.25 mas circular which is roughly 1/4 the standard VLBA beam size at dec=60°. Reducing the beam size, in most cases, enabled us to see each component separately. We could then print a hard copy of the clean map and measure the component separations and position angles to compare with the true model values.

For all flux ratios, we noticed a positive separation discrepancy which increased as the true separation decreased. This discrepancy remained constant as the absolute flux level of the components was increased. At high declination, the discrepancy was independent of position angle; however, at low declination the separation discrepancy appeared to depend on position angle, with PA=0° showing the most severe discrepancy.

There originally seemed to be a trend for a positive discrepancy in position angle at low declination and a negative discrepancy at high declination, but this was not true for all position angles. This trend was definitely apparent for PA=45° at all flux ratios with the discrepancy increasing as the true separation decreased (except for a true separation of 0.2 mas). At PA=90°, tests were done at the low flux ratio which confirmed the results of the PA=45° tests at the low declination, but gave correct position angle values at the high declination. So there may be a trend toward positive PA discrepancies for PA=45° and 90°, i.e. those angles more nearly perpendicular to the major axis of the beam.

Once we had established the position angle and separation discrepancy trends, we tried invoking several different tasks in DIFMAP in an attempt to reduce these discrepancies. First we tried changing the weighting scheme which could be done using the command *uvweight*. The uniform weighting scheme we had been using weighted each data point by the inverse of the number of points in a box of fixed size in the aperture (uv) plane. We tried using natural weighting, instead, which gives equal weight to each visibility. We noticed the same discrepancy trends for separation and position angle as in the uniform weighting tests; however the discrepancies using natural weighting were somewhat higher than those found using uniform weighting (which makes sense since natural weighting gave more weight to the shorter baselines than uniform weighting did). Since we wanted to place more emphasis on the longer baselines (the baselines with the better resolution), we also did a few tests deleting some data from the short baselines by changing the *uvrange*, but this lowered the discrepancy only very slightly.

In another test of the weighting, we used the *selftaper* command to place more weight on the longer baselines than on the shorter baselines. From a uv plot we found that most points were between 0 and 50 mega-wavelengths so we successively decreased the weight of these points by a factor of 10 each time (from 0.1 to 0.0001). The most extreme case was 0.0001 at 100 mega-wavelengths. These tests revealed the smallest separation discrepancies for the case of a 0.4 mas true separation so far. The separation values from each successive test fluctuated from 0.55 to 0.59mas, still a large discrepancy.

In addition to changing the weighting scheme, we also tried to eliminate the position discrepancies by refining the cleaning technique. Mapping is an interactive process where the user selects a region of the image and draws a box around it on the computer screen. Standard technique is to box the brightest region of the image, clean a specified amount of flux, self-calibrate, and then draw a box around each successive bright region that appears. We "re-difmapped" some of the previous models using only one box around the first and second components. Using only one box eliminated the separation discrepancy for the 0.8 mas true separation and significantly decreased the discrepancy for 0.6 and 0.4 mas true separation. We did several tests at RA=0.4 varying the position angle from 0° to 135° at dec=15 for flux ratios of 2:1, 8:1, and 15:1. The separation discrepancy was independent of flux ratio, but did appear to depend on position angle. The separation discrepancy was smallest for PA=90° since for the elliptical beam the east/west direction has the best resolution. The separation discrepancy increased as the position angle moved away from 90°. The worst separation discrepancy was at 0° since the north/south direction has the poorest resolution. The position angle discrepancy was positive at angles below 90° and negative at angles above 90°, and seems to show a mild positive correlation with flux ratio. Combining the one box test with the most severe selftaper resulted in the same values found with one box and no selftaper.

MODELFIT RESULTS

The MODELFIT program fits Gaussian profile components to the interferometric data. The result is a table of numerical values for the intensity, size and location of each component of the source. The tests of the MODELFIT program involved varying flux, separation, position angle, and axis (component size).

For the low flux ratio cases (2:1 and 6:1) the program overestimated the size of the separation by a few hundredths of a milliarcsecond (mas). For the high flux ratios (8:1, 10:1, and 15:1) the program underestimated the separation by a few hundredths of a mas. This trend appears to be independent of the declination, position angle and component size.

We only noted a significant discrepancy in the flux ratio for the low flux ratio cases (2:1 and 6:1). From tests done, this discrepancy is always positive, and appears to depend only on the separation. For large separations (0.8 mas and above), the flux ratio only varied slightly from the original model. For smaller separations, the discrepancy increased with decreasing true separation, increasing to as much as 4:1 in the case of a 2:1 true ratio (for the true 6:1 case, the discrepancy increased to approximately 7:1). At true separations of 0.4 mas and under, the discrepancy in the flux ratio remained constant.

For cases where MODELFIT was run on the models with components of unequal size, a diameter discrepancy was noted. In the low flux ratio (2:1) case only, the small diameter was overestimated and the large diameter underestimated, even going to zero on occasion. This effect increased with decreasing true separation, but leveled off and in some cases even reversing at very small separations (0.4 to 0.2 mas) where the flux ratio had leveled off. This effect was the same at both declinations and at each position angle.

Because of the apparent interdependence of the discrepancies in separation, flux ratio, and component size, we ran several tests holding one of the three parameters (flux, separation, and diameter) constant each time. For a separation from 1.0 to 0.6 mas the program found the right answer (for each variable parameter) regardless of which parameter was held constant. For separations of 0.4 and 0.2 mas, the right answers were found holding the flux ratio constant, but holding another parameter constant led to errors in the two parameters that were varied (i.e. holding separation constant led to incorrect values for flux and diameter and holding diameter constant led to incorrect values for flux and separation). These tests led us to conclude that the flux parameter has the greatest influence over all other parameters.

BLIND TESTS

After finishing the models we performed several blind tests to see if we could use the discrepancy trends found in the DIFMAP and MODELFIT tests to get the correct values for source parameters. Several tests were set up with models that covered the range of model parameters which we had been using in our previous tests. In order to employ the one box scheme, it was necessary for the user to first draw a box around the core. Then when the second component could be seen, the user could start from scratch and draw one box to encompass both components. We also found that it was necessary to input 2 to 3 times the peak flux (shown on the DIFMAP plot) of the extended component as a starting value for MODELFIT in order to get the correct results. After adding extra flux to the second component, the true values of the parameters fit within the error bars.

CONCLUSION

The results presented here details of the super-resolution tests that have been summarized in Barth, Hough, and Davis (1996). These results indicate that the DIFMAP and MODELFIT programs do have some problems when the structure of the source requires super resolution, but as yet, only some of the details of these problems are known. A deep understanding of the systematic effects will only come with a much larger study covering a wide range of sources and telescopes. Although it is too early to advertise a "correction table" for automatically adjusting results from real data, it is not too soon to begin warning observers to beware of errors and search for them in their data.

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REFERENCES

E.L. Barth, D.H. Hough, & M.A. Davis, 1996, *Bulletin of the American Physical Society*, **41**,1847: "Simulated Super-Resolved Imaging of Weak, Compact Radio Sources"

Pearson, T.J., 1991, *Bulletin of the American Astronomical Society*, **23**,991: "Caltech VLBI Analysis Programs"

Shepard, M.C., T.J. Pearson, & G.B. Taylor, 1994, *Bulletin of the American Astronomical Society*, **26**,987: "DIFMAP - An Interactive Program for Synthesis Imaging"

A Study of the Lobe-Dominated Superluminal Quasar 3C263

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ABSTRACT

We report the first milliarcsecond-resolution, simultaneous-multi-frequency VLBA radio images of the nucleus in the lobe-dominated quasar 3C263. We confirm apparent accelerated superluminal motion in the parsec-scale jet, and identify a flat-spectrum "core" and a steep-spectrum "jet". We discuss physical conditions in the nucleus and implications for unification of active galaxies.

INTRODUCTION

Billions of light-years away, at the very edge of our expanding universe, lie some very fascinating quasi-stellar objects that we refer to as quasars. These distant objects are the subjects of many extensive studies that have sought to pin down their exact characteristics. In seeking to explain these phenomena, observers and theorists alike have devised potential unification models that would bring together different types of active galactic nuclei, of which quasars are an extreme example. In our studies of the radio-loud, lobe-dominated, superluminal quasar 3C263, we have found evidence that supports these models.

Under current models, quasars have certain things in common. They all have a supermassive black hole in their center with an accretion disk circling around it made up of very hot gas and other material; many eject some of this matter in a bipolar fashion from the central "core" in "jets" that fill huge "lobes". Previous studies of these active galactic nuclei have provided us with evidence of relativistic outflows that move at apparently superluminal (faster-than-light) speeds. These jets have been explained using simple relativistic beaming models in the past which have attempted to account for the wide variety of core-dominated and lobe-dominated quasars, as well as radio galaxies. Unfortunately, these models are doubtlessly oversimplified, and more intensive observations are needed to constrain more complicated beaming models.

To probe the innermost recesses of these active galactic nuclei, a technique known as Very Long Baseline Interferometry (VLBI) has been developed. Using a large array of radio telescopes in different parts of the world such as the Very Long Baseline Array (VLBA), the VLBI technique can be used to combine the interference of the various telescopes. This provides multiple baselines that, in effect, simulate both small and large apertures. The resulting "synthesized aperture" allows us to probe sub-milliarcsecond structure with very reliable results.

Our observations of the superluminal, lobe-dominated quasar 3C263, in conjunction with multiple previous observations (see Zensus, et al. 1987 and Hough, et al. 1996), provide stronger evidence for both acceleration and nonradial motion of its jet components. These results have led us to question the standard beaming model used to explain various quasar characteristics. Using six other epochs of both 10.7 GHz and 8.4 GHz data, we report further superluminal motion as well as strong evidence for acceleration. In addition to high-resolution observations, the VLBA now allows us to perform simultaneous, multi-frequency observations. With spectra thus obtained we were able to make further calculations that revealed other physical properties of the quasar 3C263.

These results were presented briefly in Beyer, et al. (1996). Here we provide comprehensive details and discuss their implications for the current standard models.

OBSERVATIONS AND DATA REDUCTION METHODS

The quasar 3C263 was observed on November 15, 1995 for 12 hours at three simultaneous frequencies. The ten VLBA antennae around the United States observed 3C263 at 4.971 GHz, 8.405 GHz, and 15.349 GHz. This wide range of frequencies allows us to analyze spectral information that has not previously been available in the radio wavelength range. In addition, the multiple epoch observations of 3C263 in the past allow us to make detailed investigations of the physics of this lobe-dominated quasar.

To reduce this data, we used two software packages common to the astrophysical community. With the latest version of the NRAO AIPS software on Sun workstations we performed the initial editing and phase calibration of the data. Once these preliminary steps were completed, the data was ported to the CalTech VLBI Software environment where other specific data editing and amplitude calibration took place, with utilization of the DIFMAP program (see Shepherd et. al. 1994) for the actual Fourier imaging.

RESULTS

Structure

The structure of the nucleus of 3C263 at the epoch 1995.87 is best represented by four Gaussian components in the 5 GHz and 8 GHz observations, but only three components in the 15 GHz data. This discrepancy is probably due to the optically thin nature of the fourth and weakest component, making it especially dim at higher frequencies. In each of the attached figures, the core component (C) has been modeled as elliptical, but the three jet components (J0, J1, J2) have all been fitted as circular. There is also another discrepancy between the different frequency observations. When the clean maps are super-resolved and all set to the same beam size, the overlaid maps, which are also attached, show that the components are not at exactly the same locations at the different frequencies. We refer you to Figures 1, 2, and 3. While the separations of the various jet components do stay more or less constant, the core component seems to be shifted to the northwest, especially at 15 GHz, when all the maps are lined up on the J1 and J2 components. This is most probably due to the optically thick nature of the core component. As we increase the frequency of our observations, we are able to probe deeper into the structure of the quasar nucleus, and therefore, we can see more of the core.

J1 Motion

A straightforward, weighted least-squares fit to the data for J1 for the first three epochs starting from 1982.75 yields a proper motion of 0.058 ± 0.007 mas yr^{-1} while a fit to the remaining epochs starting from 1984.94 yields a proper motion of 0.12 ± 0.01 mas yr^{-1} and a fit to the entire range of epochs yields a value of 0.105 ± 0.008 mas yr^{-1}. Due to the inconsistency of the linear fits and the absence of an overall agreement, we decided to perform a number of polynomial fits. Of these, the quadratic fit gave the most reasonable values for J1's proper motion and resulted in a very smooth acceleration that seems to agree with the relative errors. The quadratic fit implies instantaneous proper motion relative to C ranging from 0.066 mas yr^{-1} at epoch 1982.75, to 0.150 mas yr^{-1} at the epoch 1991.17, to 0.197 mas yr^{-1} at epoch 1995.87. Thus, J1 shows significant evidence for apparent acceleration.

J0 and J2 Motion

Since they have also been observed at other epochs, we may also analyze the other two jet components' proper motion. Between the epochs 1989.27 and 1991.15, J2 showed a proper motion of 0.03 ± 0.03 mas yr^{-1}, but between 1991.17 and 1995.87, J2 showed a visible increase in proper motion with a value of 0.16 ± 0.02 mas yr^{-1}. Since the proper motion over the entire range of epochs is 0.14 ± 0.03 mas yr^{-1}, it appears that J2 has accelerated in a similar fashion. Similarly, J0 has showed an increase in proper motion over time. A linear fit to the data between the epochs 1991.17 and 1995.87 gives a proper motion of 0.206 ± 0.07 mas yr^{-1}, but over the entire range, the proper motion only reaches a value of 0.17 ± 0.05 mas yr^{-1}. Although the case is not as strong, we conclude that J0 may also show apparent acceleration.

Position Angle

We have also seen evidence for nonradial motion in the jet components of 3C263. The position angles of the jets seem to change with time, but they appear to be dependent on the component's separation relative to the core. Although they are difficult to distinguish, when the components are less than about half a milliarcsecond from the core, they are at a position angle of roughly 113 degrees. Once past this distance from the core, they seem to all be oriented at a rough angle of 111 degrees.

Due to the wide range of epochs we spent observing 3C263, it has become necessary to determine whether there has been any significant field rotation due to precession. Using a standard program to model various component positions in a quasar location identical to 3C263, we were able to determine that the position angles of the components differed from the originals by only two tenths of a degree. Since this is well below our calculated errors, it has no real effect on our data.

Spectral Analysis

With the VLBA, it is now possible to do multi-frequency observations simultaneously. This provides us with a chance to do a spectral analysis of the quasar assuming that its radio emission is due to the synchrotron process. We can calculate the spectral index between the observed frequencies. If we assume that S goes as ν^{α} (where S is the flux density, ν is frequency, and α is the spectral index), then for the C component we find $\alpha = -0.58 \pm 0.03$ from 5 GHz to 8 GHz, and $\alpha = 0.00 \pm 0.02$ from 8 GHz to 15 GHz, and $\alpha = -0.27 \pm 0.03$ from 5 GHz to 15 GHz. This indicates that in the self-absorbed spectrum of the core, its turnover frequency is most probably somewhere between 8 GHz and 15 GHz above which it becomes optically thin. The other components have spectral indices consistent with an interpretation that they are optically thin.

DISCUSSION

Superluminal Motion

Depending on the cosmology one favors, we get different values for the apparent velocity of these jets. Throughout this discussion we assume a Friedmann cosmology with $H_o = 100h$ km s^{-1} Mpc^{-1} and $q_o = 0.5$ so as to give something of a lower limit for a given component's speed, where H_o is the Hubble constant and q_o is the deceleration parameter. While both J0 and J2 exhibit superluminal speeds, the wealth of data on J1 allows us to calculate much more than its apparent velocity. Using the quadratic fit to J1's proper motion, we found J1's apparent transverse velocity to be $>3c$ in the later epochs. Since it is definitely superluminal, we proceeded then to calculate possible line of sight angles, actual speeds, and Lorentz factors which could lead to this apparent velocity. In addition to these calculations, we also calculated Doppler factors and boosting factors for each of these scenarios. Combining the results of these two important calculations forces us to reexamine the beaming model we have adopted. Under the current model, there is an angle and Lorentz factor associated with an actual velocity which yields an apparent transverse velocity greater than the speed of light. While this is mostly accepted as an explanation for superluminal motion, another important aspect of beaming models is their attempt to explain the rise in flux as the line of sight angle decreases. It is here where we run into a problem. Our calculated values for the Lorentz factors and angles can perhaps be manipulated to show a constant speed with varying angles or a constant angle with acceleration. However, when relativistic beaming is used, the corresponding Doppler factors need to be consistent with observed flux densities. Using a test angle of about 20 degrees, our calculations show an acceptable Lorentz factor increase from roughly 1.8 in 1982.75 to 4.8 in 1995.87, and the Doppler factor stays more or less in the same range moving from 2.6 in 1982.75 to 2.5 in 1995.87. Even when these Doppler factors are applied to boosting factor formulae, their respective differences are of order unity. However, if a constant Lorentz factor is taken around 5, the angle shows a very unacceptable decrease of 50 degrees from 70 degrees in 1982.75 to 20 degrees in 1995.87. The Doppler boosting factor also changes by more than a factor of 100. These drastic changes do not correspond to the observed flux values, and since the minimum value of the Lorentz factor for J1 in 1995.87 is about 4.5, we are unable to use a smaller number in the constant Lorentz factor case. Our only plausible explanation, then, is that the jet remains at a relatively constant angle and has been experiencing a true acceleration. As to the cause of this Lorentz factor change, we might speculate that the jet has been recollimated and, much as in a simple fluid model obeying Bernoulli's Principle, has thus been accelerated.

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Position Angle

We presented evidence earlier that the position angle of the jet component J2 has changed depending on it distance from the core. This raises the question that there could possibly be some different position angle for each component within the inner half milliarcsecond. Although the evidence is not particularly strong, this change in position angle with distance could indicate something more about the innermost regions of the jet, such as nonradial component ejection or a curved path along which all components move.

Synchrotron Theory

After determining certain observable characteristics of 3C263, we can now proceed to derive physical conditions in the source, assuming that the non-thermal radiation we detect is synchrotron radiation. One of these involves the inverse Compton catastrophe. According to this theory, the brightness temperature of a component may not exceed 10^{12} Kelvin, or else inverse Compton scattering will cause it to dissipate its energy. By our calculations, none of the component temperatures came within that value by more than a factor of 100.

Another major concern is with the distribution of the magnetic field in the quasar. Since the majority of this radiation is synchrotron related, the magnetic field plays an important part in our calculations. Since we had spectral results, we were able to calculate the magnetic field in two ways. Using the self-absorbed spectrum of the core we were able to determine that the turnover frequency lies somewhere between 8 GHz and 15 GHz, so we calculated the magnetic field accordingly. It turned out higher than expected, ranging from 1 G to 75 G, but these are still within the range observed at other quasars. Using the equipartition of energy assumption, we obtained much smaller values which ranged from 0.05 G to 0.3 G. Thus, if the self-absorption calculation is reliable, the equipartition condition is not satisfied, and the magnetic field energy dominates. These applications of synchrotron theory to 3C263 help us to confirm some aspects of our models and learn about physical conditions close to the "central engine".

Unification Models

Current theories hold that both the lobe-dominated and the core-dominated quasars are the same astronomical object simply oriented differently in the sky. According to our observations and calculations, 3C263 holds true to this unified model. We have found 3C263's exhibited superluminal motion to be consistent with that of other lobe-dominated quasars and significantly less than other core-dominated ones, which is predicted by the model. The acceleration of the jet components in 3C263 is mild when compared to those of well studied core-dominated quasars, and its flux variations over time are similarly weaker than its core-dominated counterparts. The bend angles are also less than those commonly observed in core-dominated quasars, and the self-absorbed core with optically thin jet components stays consistent with previous observations. All of these characteristics support the unification models that have been proposed. There are also indications that our observations support some of the "grander" unification models which include radio galaxies. Since we have established that 3C263 is most probably oriented at about 20 degrees to our line of sight, it is possible to say that radio galaxies may be only oriented in the 50 to 90 degree range. These models are still being developed, and, with better observations, we might someday be able to come to a final unification conclusion.

ACKNOWLEDGMENT

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REFERENCES

Beyer, P.J., Hough, D.H., Zensus, J.A., and Porcas, R.W. 1996, "Accelerated Superluminal Motion and Physical Conditions in the Nucleus of the Lobe-Dominated Radio Quasar 3C263", Bulletin of the American Physical Society, 41, 1855.

Hough, D.H., Zensus, J.A., and Porcas, R.W. 1996, "Evidence for Acceleration and Nonradial Motion of Parsec-Scale Jet Components in the Lobe-dominated Superluminal Quasar 3C263", Astrophysical Journal, 464, 715.

Shepherd, M.C., Pearson, T.J., and Taylor, G.B. 1994, "DIFMAP - An Interactive Program for Synthesis Imaging", Bulletin of the American Astronomical Society, 26, 987.

Zensus, J.A., Hough, D.H., and Porcas, R.W. 1987, "Superluminal Motion in the Double-lobed Quasar 3C263", Nature, 325, 36.

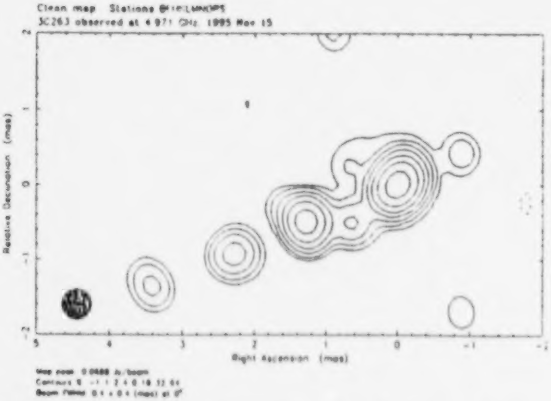

Figure 1: A clean map at a frequency of 5 GHz shows the common structure of 3C263.

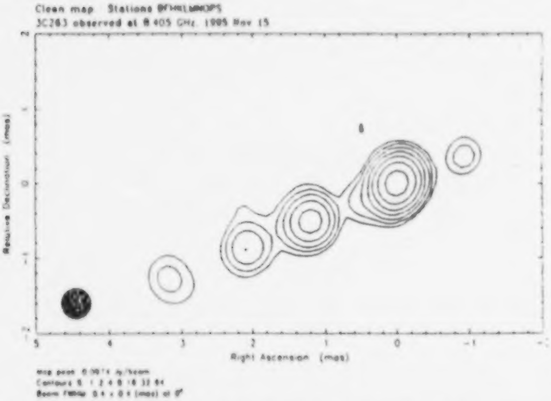

Figure 2: The clean map at 8 GHz, after being resolved to the same scale and beam size, also exhibits three jet components.

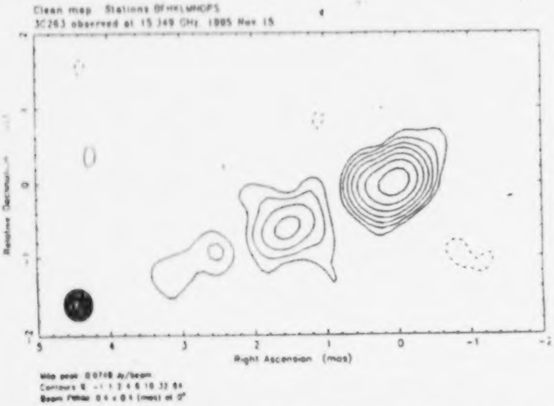

Figure 3: The same clean map at 15 GHz, however, displays a slightly different structure due to the optically thick nature of the core component.

GLOBAL IMAGING OF THE CUSP REGION OF THE EARTH'S MAGNETOSPHERE

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ABSTRACT

The earth's magnetosphere is the region around the earth in which the solar wind interacts with the earth's magnetic field. Understanding the large scale dynamics of the magnetosphere is a difficult task. Current satellites are able to make in situ measurements which give us data only on a local scale. We are then forced to extrapolate or even guess at the relationship between various measurements. The IMAGE (Imager for Magnetopause-to-Aurora Global Exploration) satellite, to be launched in February, 2000, is the first attempt at global imaging of the magnetosphere. IMAGE will utilize several different methods for imaging the magnetosphere including energetic neutral atom (ENA), ultraviolet radiation, and radio sounding. My research deals with work to aid in designing the ENA instruments to be used on IMAGE and preparing to analyze the data that will be collected with these instruments. Using computer models of the cusp region of the magnetosphere we are simulating the ENA data that will be collected by the satellite. The satellite will see a two dimensional image which must be changed back to a three dimensional image by means of deconvoluting an integral along the line of sight of the ENA instrument. From this we can attain and analyze a large scale three dimensional picture of the magnetosphere which will give more insight into the behavior of the magnetosphere than was previously possible.

BACKGROUND

The earth's atmosphere is so named because the region is dominated by atoms, as the ionosphere is dominated by ions. So it follows that the region around the earth that is dominated by the earth's magnetic field is known as the magnetosphere. The atmosphere extends above the earth's surface about 100 kilometers. The next level is the ionosphere which extends to about 1000 kilometers. Above the ionosphere lies the magnetosphere. The earth's magnetic field is very similar to the magnetic field created by a simple bar magnet as shown in Figure 1. In fact, the source of the earth's magnetic field produces a field that is almost identical to that of a magnetic dipole including having two poles, what we call the north and south poles. However, this field is severely deformed by the solar wind from the sun.

The solar wind is composed of charged particles that are being blown off the surface of the sun along with the sun's magnetic field which extend into interplanetary space and forms the IMF (Interplanetary Magnetic Field). These charged particles are a plasma, which simply means that they are a group of charged particles which exhibit collective behavior. When these fast moving charged particles hit the earth they warp the earth's magnetic field and leave us with a magnetosphere that is shaped something like figure 2. This region extends above the surface of the earth toward the sun about 10 Earth Radii(R_e), or about 60,000 kilometers, and away from the sun several hundred R_e, well past the moon which lies at about 125 R_e.

There are several regions of the magnetosphere, but the studied here is known as the cusp region. The cusp is a funnel shaped region near the poles of the earth. This funnel shape allows charged particles from the solar wind to be 'funneled' into the aurora region near the surface of the earth. However, these solar wind particles are not the only charged particles in this region. Ions from the ionosphere move up the magnetic field

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lines, away from the earth, into the magnetosphere. This region, near the earth, where these ions are rising out of the ionosphere is the region of interest in this study.

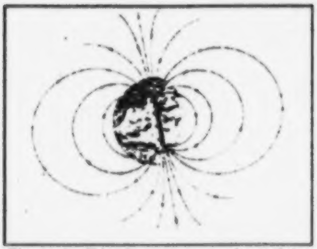

Figure1: Dipole representation of the earth's magnetic field.

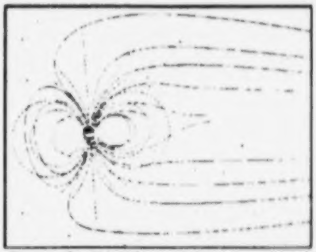

Figure 2: Warping of the magnetosphere by the solar wind (A dipole field is superimposed for comparison).

Current satellites are only capable of making in situ measurements. This means that these satellites can only detect what is touching the satellite. If some object or structure exists a few kilometers away the satellite can not see it. A good example of this problem comes from data that was taken by the satellite Dynamics Explorer 2 in the 1980's. When looking at this data one sees that in a typical pass over the polar regions, the satellite initially sees very few charged particles coming up the magnetic field lines. As the satellite moves through its orbit suddenly the satellite detects a large number of such charged particles. Then, as the satellite continues through its orbit these charged particles disappear. From this type of data it is not possible to be certain whether the satellite flew through some spatial structure in the magnetosphere or if the entire region became active for this period of time.

THE IMAGE MISSION

The IMAGE (Imager for Magnetopause-to-Aurora Global Exploration) mission is the first attempt at global imaging of the magnetosphere. There are four methods by which IMAGE will obtain these global images. The first method involves radio sounding. This method uses the same principle as a submarine's sonar. A radio pulse is sent from the satellite into different regions of the magnetosphere. When these waves hit a region with a high density of charged particles it will bounce back to the satellite allowing us to generate a picture of that region.

The next two methods use ultraviolet imaging. The first of these two images far ultraviolet light. This will provide images of activity in the auroral zones that will allow us to relate the data to previous studies. The second type of ultraviolet imaging uses extreme ultraviolet light. Extreme ultraviolet light is more energetic than far ultraviolet light. This allows the determination of the shape of the plasmasphere, which is a sphere of charged particles that is co-rotating with the earth.

The last type of imaging is energetic neutral atom (ENA) imaging. ENA imaging is the focus of this study. ENA imaging will allow the study of the ion upwelling from the ionosphere.

ENA IMAGING

It is very difficult to obtain an image from a charged particle in the magnetosphere. When a charged particle is in a region where a magnetic field exists, it will not travel in a straight line. This is demonstrated in Figure 3, which shows the behavior of a charged particle which is 'stuck' to a field line. When the particle is moving through a region where there is a magnetic field it will tend to follow the field lines. Since the particle does not travel in a straight line we cannot tell where the particle originated if we detect it with our satellite.

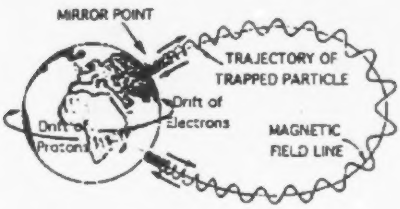

Figure 3: A charged particle moving through a magnetic field.

In order to obtain images from this region we will make use of the existence of the geocorona, a cloud of neutral atoms whose density exponentially decays with distance away from the earth. As the energetic ions rise out of the ionosphere along the magnetic field lines they will interact with these neutral atoms. When one of these ions flies close enough to one of the neutral atoms it will pick up an electron from the neutral atom. This produces an ion that is moving relatively slowly and a neutral particle moving with a high velocity in a straight line that can be detected by our satellite.

Our satellite's instrument is an array of pixels, each of which looks in a straight line from the satellite. Each pixel will detect any neutral particles that are coming towards the satellite along the line of sight of that pixel. By summing all of the particles that are coming toward the satellite along the line of sight for each pixel we can generate an image of the region toward which the satellite is looking. Using a model of the cusp region developed by Dr. Gordon Wilson at The University of Alabama in Huntsville and Marshall Space Flight Center these images can be simulated. A sample simulation is shown in Figure 4. In this image the satellite is located on the night side of the earth, away from the sun, looking down on the north pole from about 3 R_e above the surface.

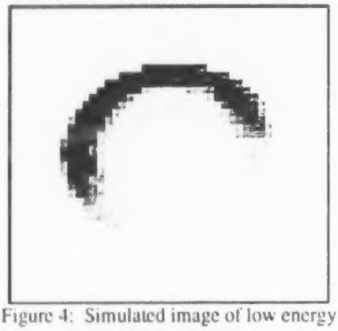

Figure 4: Simulated image of low energy neutral oxygen atoms.

In this image the ion upwelling in the auroral region around the north pole. These images show that sufficient counts can be obtained with our instrument to generate useful images.

CONCLUSION

The IMAGE mission is the first attempt at global imaging of the magnetosphere. It will give insight into the dynamics of this region which will aid in the understanding of the mechanisms that drive this system. IMAGE will go beyond any previous mission by yielding global images on an almost instantaneous time scale. This will allow understanding of how regions of the magnetosphere work as well as how different regions are related. We are working to simulate the images that will be obtained by the ENA instruments in order to help design the instruments as well as develop new techniques for analyzing the data that will be received from the satellite.

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3D CIRCUIT NETWORKS SIMULATE BIOMATERIALS

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The advance of Magnetic Resonance Imaging (MRI) depends strongly on the behavior of radio frequency (RF) fields inside the human body Complete information of RF penetration is hard to obtain experimentally since it requires accessing a solid object in many points This would become a destructive technique and cannot be used for human subjects To circumvent this problem, we have designed a 3D cubic circuit such that between two nodes there is an impedance Z (resistor and capacitor) The impedances are adjusted in such a way as to correspond to the known permittivity and conductivity of the biomaterial that we wish to simulate We will show field profiles at the nodes of the network when suitable voltages are applied at the faces of the cube

INTRODUCTION

MRI is a technique used to obtain pictures of the inside of the human body It is particularly useful in imaging soft tissue In fact, what is imaged is not the tissue itself but the nuclei of a given chemical species contained in that tissue This chemical species could be hydrogen, sodium, potassium[1], phosphorus[2], fluorine[3], and others Due to the high content of water inside the human body, hydrogen is the most common element imaged Under the application of a strong external static uniform magnetic field (~ 1 T= 10,000 Gauss) along the z-axis, the spins of these nuclei will be aligned along z The spin orientation can be manipulated (rotated) and, in particular be taken away from the z-axis by means of radio-frequency (RF) electromagnetic fields in the x-y plane The maximum efficiency of this rotation happens when the frequency of the RF field and the magnitude of the static field are related through $\omega = g B$ where g is the gyromagnetic ratio of the proton (26000 1/Gauss) This is called the resonance condition Off resonance rotation can also exist but it is far less efficient A slice of human body to be imaged is obtained in the following way a "linear gradient" static magnetic field is superimposed on top of the uniform field This produces a static magnetic field which is different in different slices of the body, thus the resonance condition is met only at one slice (actually a small slab) The rest of the image appears black A gradient also exists inside the slice, in order to encode the various parts of the region[4,5] The angle by which those spins are rotated depends on the strength of the RF magnetic field and on the time it remains turned on Knowledge of these angles is crucial in obtaining the images (the closer the angle to 90°, the stronger the radiated signal from that point) The fact is, that the mere presence of the object being imaged (the human body in our case) modifies the RF field In other words, the RF field depends not only on the field-generating antenna that we have but also on the electromagnetic properties of the material into which these fields are penetrating Strictly speaking, then, it is not possible to build a "universal" antenna to create the wanted RF fields, since the fields inside the patient will depend on the patient herself (himself) Even though the RF fields may be spatially uniform under certain conditions, they may be distorted when a given patient is being imaged (this statement is more important as the RF frequency is increased) Many different systems have been studied and published in the literature[6,7,8,9,10,11,12] Among them, the most popular ones are spherical, cylindrical and planar models

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The first one is well suited for studies of MRI of the head, the second for whole body imaging and the third in flat regions of the body, its strengths being in simplicity and possibility of accounting for multiple-layer systems. Also, many different coil geometries have been considered, from simple loops to more complicated shapes trying to mahe the RF fields inside the imaged bodies uniform.

This work is motivated by the need to understand electromagnetic radiofrequency (RF) field profiles inside biomaterials. RF fields are used in MRI but their exact behavior is difficult to obtain in situ, that is, inside the human body. There are complications, both experimentally and theoretically: experimentally because cutting the body is only done in extreme situations, and theoretically because the Maxwell Equations are cumbersome and the boundary conditions not well defined due to the fact that organ size depends on the patient. So we built a 3D impedance network that mimics the conductivity and resistivity of various organs[13]. In addition, this system has the advantage of being easily accessible.

For wavelengths long compared to the size of the system, Maxwell's equations may be approximated by the simpler electric circuit theory[14]. Quasi-static field theory also applies. An important feature of the field behavior in this range is that the electric and magnetic fields are only weakly coupled. In our study we developed a computer simulation of our model using the circuit simulation program Spice3f4 (electric circuit analysis and simulation program). We will present some results of the simulation.

BIOMEMBRANE MODEL

The objective of our model (see Figure 1) is to represent a body organ (electrically characterized by a conductivity σ_1 and permitivittty ε_1) surrounded by body tissue with different electrical properties, (σ_2, ε_2) an electrical circuit. The tissue elements are represented by an impedances (Z), specifically by the parallel combination of a resistor (R) and a capacitor (C). The values of the impedances are adjusted so that they correspond to the values of σ and ε for human tissues.

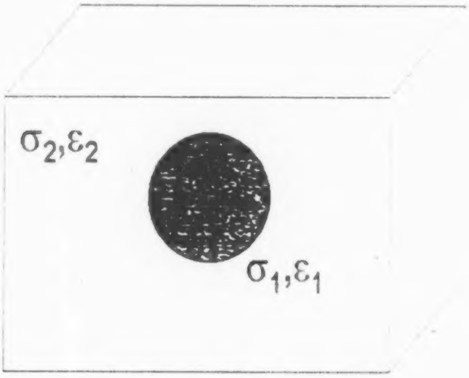

Figure 1. Model of human body organ electrically characterized by σ_1, ε_1 surrounded by body tissue characterized by σ_2, ε_2

Using the basic definitions of resistance and capacitance we can obtain the values of R and C. The different body parts are then represented by three dimensional networks of impedances, as shown in Figure 2.

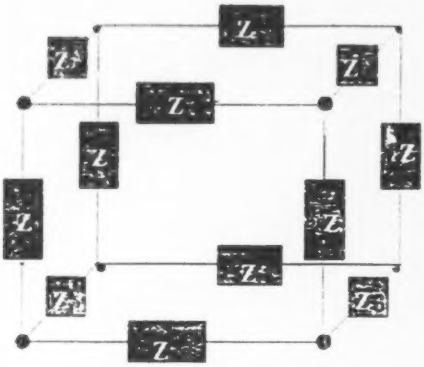

Figure 2 Element of 3D Impedance Network

For our simulation we used values corresponding to muscle and fat The values of Z have been calculated previously as 49 7 - j23 8Ω for muscle and as 510 - j544Ω for fat at a frequency of 1 92 MHZ [15]

To obtain the values of the resistance and capacitance we used the definition for the impedance of an RC parallel circuit

$$Z = \frac{R - jR\omega C}{1 + \omega^2 C^2} . \qquad (1)$$

where ω = 2pf and f is the frequency of the source

The power source used was a sinusoidal ac source and the simulations were performed at frequencies of 64 MHZ, 128 MHZ and 192 MHZ The power was applied between two faces of the cube that were parallel to each other The simulations were performed using the circuit analysis program Spice3f4 in a PC Computer

RESULTS

Using equation 1, we obtained the values of the resistances and capacitances as R=61 kΩ C= 39 nF for muscle and R= 1 09 kΩ and C=0 96 pF for fat For the first simulations we built a 6x6x8 network of impedances representing only one type of tissue (muscle or fat) at a time

We recorded the voltages at the nodes of the network and plotted the equipotential surfaces across it The equipotential lines obtained were parallel to the faces of the cube where the voltage source was applied

Then we repeated the simulation but using a 2x2x2 cube made of a different tissue in the center of the cube A 2D plot of the equipotential lines for a cube of muscle tissue surrounded by fat performed at 192 MHZ are shown in Figure 3 The map shows the presence and shape of the muscle tissue cube No significant changes were found when performing the simulation at 64 MHZ and 128 MHZ

Our results are limited because of the reduced number of nodes With a higher number of nodes we will be able to model organs with different shapes

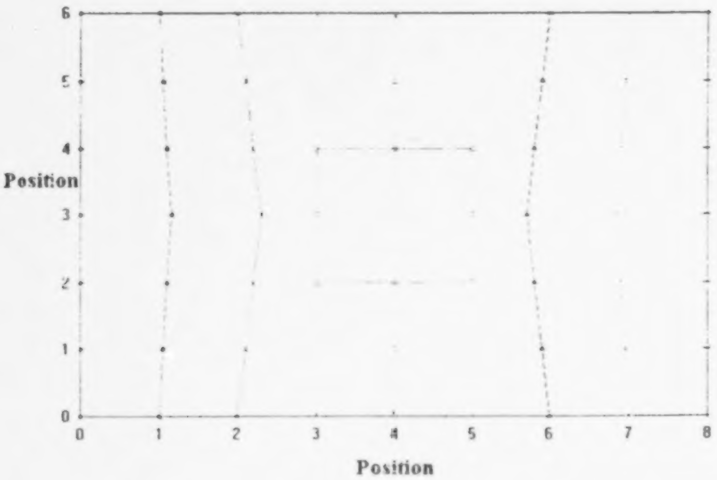

Figure 3 Electric Field Profile for Muscle Tissue Inside Fat Tissue at a Frequency of 192 MHZ

CONCLUSIONS AND FUTURE DIRECTION OF THE PROJECT

We modeled a section of the human body using a 3D cubic circuit where the values of the impedances are adjusted to those corresponding to the impedances of human tissues The interaction with an electromagnetic field was simulated using the program Spice3f4 Our results show that mapping the field profiles at the nodes of the network we obtain information about the object (organ) of study

We plan to extend our model to include a higher number of nodes to represent more tissues and organs with different shapes

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REFERENCES

1 G N Holland, P A Bottomley, W S Hinshaw, J Magn Reson , 28, 133 (1977)
2 P C Lauterbur, Nature 242, 190 (1973)
3 P Mansfield, P K Granell, J Phys C6, L422 (1973)
4 A Abragamn, "Principles of Nuclear Magnetism", Oxford University Press, Oxford, 1961
5 E R Andrew, "Nuclear Magnetic Resonance", Cambridge University Press, Cambridge, 1969
6 P A Bottomley, E R Andrew, "RF Magnetic Field Penetration, Phase Shift and Power Dissipation in Biological Tissue Implications for NMR Imaging", Phys Med Biol 23, 630 (1978)
7 F R Zypman, R W Brown, E M Haacke, Proceedings, Sixth Annual Meeting of the Society of Magnetic Resonance in Medicine, New York, August 17-21, 1987, p 839

8 F R Zypman, E M Haacke, R W Brown, J L Patrick? "Radiofrequency Penetration at High Frequencies in the Human Body", Proceedings, 73rd Scientific Assembly and Annual Meeting of The Radiological Society of North America, Chicago, November 29-December 4, 1987 p 130

9 F R Zypman, PhD Thesis, "High Frequency Electromagnetic Resonance Imaging," Case Western Reserve University, 1988

10 A Jasinski, T Jakubowski, M Rydzy, P Morris, I C P Smith, P Kozlowski, J K Saunders, "Shielded Gradient Coils and Radiofrequency Probes for High-Resolution Imaging of Rat Brains", Mag Res Med 24, 29 (1992)

11 C J Schneider, N Engelberts, J D P Van Dijk, "Characteristics of a Passive RF Field
Probe with Fibre-Optics Link for Measurements in Liquid Hyperthermia Phantoms", Phys Med Biol 36, 461 (1991)

12 T K F Foo, C E Hayes, Y Kang, "Reduction of RF Penetration Effects in High Field Imaging", Mag Res Med 23, 287 (1992)

13 N Orcutt, P Gandhi, "A 3D Impedance Method to Calculate Power Deposition in Biological Bodies Subjected to Time Varying Magnetic Fields, IEEE Trans Biom Eng., 35-8 (1988), p 577

14 T F Budinger, "Emerging Nuclear Magnetic Resonance Technologies", Biological Effects and Safety Aspects of NMRI and Spectroscopy, Vol 649 (1992), p 1

15 P Gandhi, J Y Chen, "Absorption and Distribution Patterns of RF Fields", Biological Effects and Safety Aspects of NMRI and Spectroscopy, Vol 649 (1992), p 131

A Two-year Climatology of Radiation Budget and Cloud Properties for the ARM SGP Site

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The Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) data set has been analyzed for the period from April, 1994, through April, 1996, to obtain a two-year climatology of surface radiation and cloud properties. Monthly means of both observed and clear-sky solar radiation for the two-year period were calculated, as well as the difference between the two values: the observed cloud forcing. A climatology of cloud base using a combination of micropulse-lidar and ceiliometer data was then created. Using this climatology, the relationship between cloud liquid water path (LWP) as measured with a microwave radiometer and cloud forcing was examined. A significant relationship exists, although a large amount of scatter is present in the data.

INTRODUCTION

Amid a sea of wheat crops in north-central Oklahoma rises a collection of tall antennas and instrument towers. This is the site of the Southern Great Plains (SGP) Cloud and Radiation Test Bed (CART). As part of the Atmospheric Radiation Measurement Program (ARM) of the Department of Energy, the ARM SGP site collects data on numerous atmospheric properties including downwelling and upwelling radiation, cloud base altitude, liquid water path (the amount of liquid water in a column through a cloud), and a host of other local conditions. The program's goals are to improve the understanding of atmospheric processes that affect atmospheric radiation and the description of the same processes in climate models (Stokes and Schwartz, 1994).

Clouds have a tremendous impact on the Earth's radiation budget. Many scientists believe that an increase in cloud cover will be a response of the climate system to increasing greenhouse gases. An increase in certain cloud types could potentially offset some warming that may take place while other cloud types will actually serve to increase warming. As a result, understanding this cloud-radiation interaction becomes important.

One of many projects involved with the ARM program, this research focused on the creation of a two-year cloud and radiation climatology. The period analyzed extended from April, 1994 through April, 1996. Such a climatology allows for various cloud-radiation relationships to be analyzed and parameterizations of the reduction of radiation from cloud properties to be created. These parameterizations can then be implemented in climate models to represent atmospheric processes.

A RADIATION CLIMATOLOGY

An empirical curve fitting technique was developed by Long (1996). This technique involves finding periods of clear sky each day, then fitting a cosine curve to those values. With as few as 110 minutes of clear sky each day, accurate functions describing clear-sky radiation can be generated which have the form

$$\text{Clear Sky Radiation} = a\,(\cos Z)^b \qquad (1)$$

where a and b are coefficients determined by the fitting technique and Z is the solar zenith angle. Coefficients can be interpolated to days that have fewer than 110 minutes of clear sky. Interestingly, the technique determines whether clear sky is present without examining data from cloud measuring instruments.

Liquid water efficiently scatters and absorbs radiation. The sharp reduction in visible light on cloudy days testifies to that fact. Fortunately, the radiation instruments located at the SGP site measure both direct and diffuse radiation. Even on cloudy days, some amount of radiation passes through the cloud cover without being scattered or absorbed; this is direct radiation. Similarly, some of the radiation reflected by clouds is directed towards the ground; this is diffuse radiation. When no clouds are present, the amount of diffuse radiation is minimal. So, by simply examining the magnitude of the diffuse radiation, the presence of cloud cover can effectively be determined. With the implementation of the Long technique over the entire two-year period, the desired radiation climatology became a reality.

Merely examining the raw radiation data, in the form of one minute averages, would not reveal much useful information, so averages needed to be found. By summing the radiation values, then dividing by 1440, the number of minutes in one day, daily averages of radiation were created. This method allowed for day-to-day variations to be examined. For comparisons of seasonal variations, monthly means were created. The monthly means of cloud forcing needed to be normalized in some way as the available solar energy varies by season. The best way to do this is to represent the mean cloud forcing as a fraction of the clear-sky radiation value. Figure 1 shows the mean fractional cloud forcing for each month during the two-year period. Average values of fractional cloud forcing are greatest in spring and winter. The average fractional cloud forcing for spring (March, April, and May) is 0.293 compared to an average fractional cloud forcing of 0.301 in winter (December, January, and February).

The frequency of cloud forcing values was calculated for each season. Figure 2 presents these values. Summer tends to favor low values of cloud forcing, as might be expected, while winter tends to experience the greatest percentage of high fractional cloud forcing events; the frequency of fractional cloud forcing values between 0.6 and 0.85 is twice as high in winter as in summer. A distinct bimodial distribution is also present in winter with the first peak occurring near a fractional cloud forcing value of zero and the other near 0.75. The low sun angle in the winter probably accounts for this distribution. At lower sun angles, a greater amount of shortwave radiation will be reflected by clouds than at a high sun angle, so a given cloud type will produce a greater fractional forcing in winter than in summer. Low stratus cloud events, which often produce large cloud forcing values, also occur more frequently in winter than in summer.

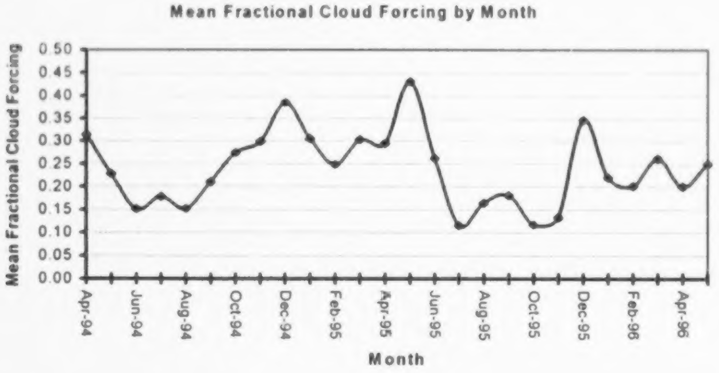

Figure 1. Plot of mean fractional cloud forcing by month for the April 1994 to May 1996 period. Fractional cloud forcing being the cloud forcing value divided by the clear-sky value.

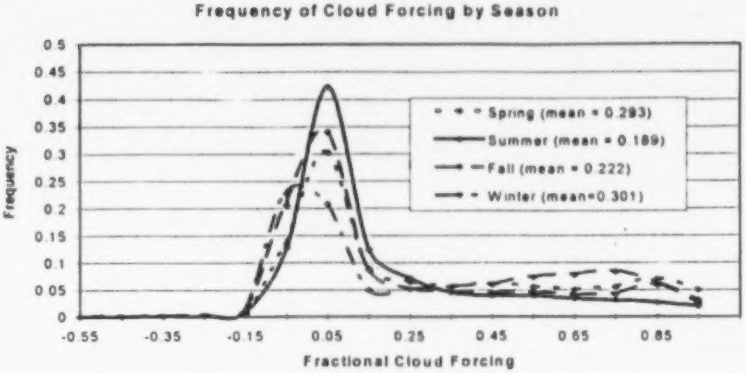

Figure 2. Frequency of cloud forcing by season. The number of occurrences of fractional cloud forcing were tabulated for bins of width 0.10, then normalized by season. Each value on the x-axis denotes a bin center.

A CLOUD CLIMATOLOGY FOR THE SGP SITE

Radiation data by itself can produce useful information relating to cloud forcing, but the type and structure of cloud present for any given cloud forcing event can not be determined. This resulted in the need to create a cloud climatology for the same period as the radiation climatology -- April, 1994 to April, 1996. Then comparisons between clouds and associated radiative forcing could be made.

One cloud characteristic desired was cloud base height. Instruments such as the micropulse-lidar and the ceiliometer measure cloud base quite accurately. The primary drawback is that the instruments have a very small field of view. The conditions present overhead may not be representative of what is occurring in the majority of the sky. Satellite data gives a better spatial representation of cloud cover, but cloud base can not be determined and the exact conditions over the observation site are often difficult to assess.

The primary cloud type of interest in the study were low stratus. The data obtained from the lidar and ceiliometer were used to determine periods with low cloud bases, in this case, less than 2000 meters. Cloud tops could not be determined, so while many stratus cloud cases were probably found, many cases could have been thunderstorm events, or multi-layered cloud deck events.

CLOUD LIQUID WATER PATH

For a given cloud base, almost any cloud forcing can occur because cloud geometry and optical depth vary widely. Cloud characteristics other than cloud base are needed to obtain a better relationship to cloud forcing. One such characteristic is cloud liquid water path (LWP). This is the integrated amount of liquid water in a vertical column through a cloud. Presumably, a cloud with a higher liquid water path will be denser and thicker than one with a low liquid water path. So, high liquid water paths would be expected to correspond to high values of cloud forcing. For the entire two year period examined, 15 minute averages were taken of cloud forcing and liquid water path during periods of continuous cloud cover. Periods with 45 minutes of continuous cloud base measurements as determined from micro-pulse lidar and ceiliometer data were considered to be continuous cloud events. Figure 3 shows the resulting distribution when these two values are plotted against each other. While a good deal of scatter is present, a definite logarithmic relationship exists. Much of the scatter can be attributed to the presence of mixed phased clouds. Ice water will contribute to cloud forcing, yet will not be represented by liquid water measurements. Nonetheless, high fractional cloud forcing values coinciding with high liquid water path values as expected. For very small values of liquid water path though, a very large range of cloud forcing exists. Part of this large range of forcing values may be attributed to errors in cloud coverage measurements. Cloud cover often is not contiguous across the sky, and variations in density and thickness can be present. A cumulonimbus cloud, for example, can reduce the amount of radiation reaching the instruments even though the cloud may not be in the field of view of the instruments.

Figure 4 presents the same data in the form of averages and standard deviations. The logarithmic relationship between cloud forcing and liquid water path is much more apparent. As shown by the standard deviation lines on the plot, the range of fractional cloud forcing values is much less for liquid water paths greater than 0.01 cm than for values less than 0.01 cm.

Above a liquid water path of 0.01 cm, fractional cloud forcing can be estimated quite accurately from liquid water path. Once liquid water path values exceed 0.04 cm, little additional gain in cloud forcing is observed. Changes in solar zenith angle can contribute more to the cloud forcing than an increase in liquid water content of the cloud.

The solar zenith angle, the angle with respect to vertical at which the sun is located in the sky, will influence cloud forcing. More shortwave radiation will be reflected by a given cloud when the sun is low in the sky than when it is directly overhead. This can also contribute to the wide variation in cloud forcing for very low liquid water path values. For the majority of the day though, cloud forcing will not vary significantly as a result of solar zenith angle.

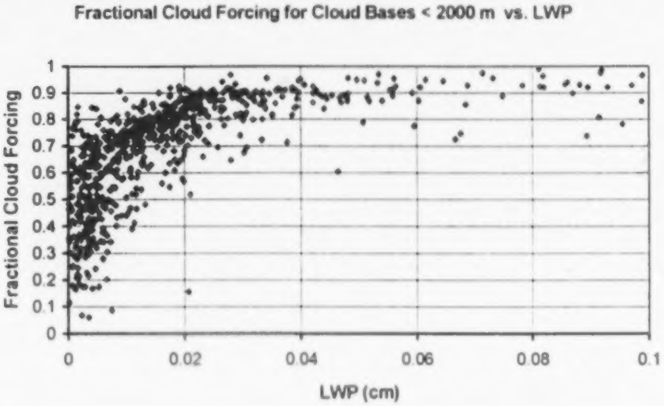

Figure 3. Plot of fractional cloud forcing against liquid water path (LWP). Only cases in which the cloud base, determined from ceiliometer data, was less than 2000 meters were accepted.

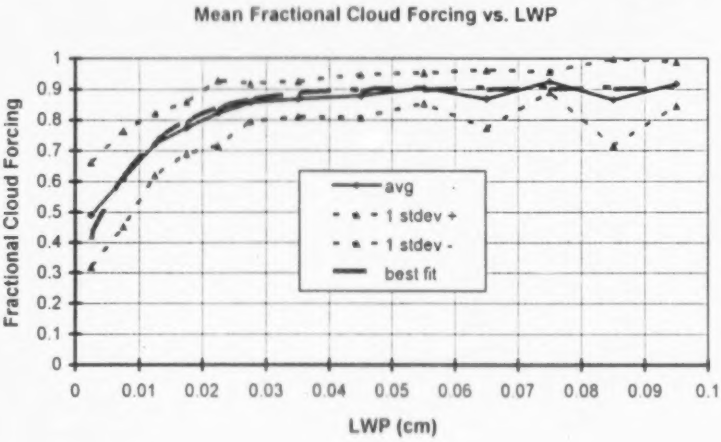

Figure 4. Plot of mean fractional cloud forcing against LWP for cloud bases less than 2000 meters. The dashed curve represents the best fit to the data and has the form: $FCF = 0.9 [1 - e^{(-100 (LWP) - 0.35)}]$ where FCF is the fractional cloud forcing and LWP is the liquid water path in centimeters.

CONCLUSIONS

From the comparison of monthly and seasonal cloud forcing, a definite trend for increased values of cloud forcing during the winter and spring can be observed. Values of fractional cloud forcing greater than 0.35 most frequently occur in the winter and spring seasons and December and May have the greatest mean values of fractional cloud forcing.

The comparison of liquid water path to cloud forcing revealed a significant relationship, however only when liquid water path values exceed 0.01 cm. When examining low-based clouds, liquid water path does provide a reasonable estimation of cloud forcing. The relationship is less useful for mid and high level clouds. Ice reflects and absorbs radiation differently than liquid water and ice crystals are more likely to be present in mid and high level clouds.

In the near future, a cloud radar will be installed at the SGP site. This radar will allow for both cloud base and cloud top to be detected. By comparing the cloud base and top to an atmospheric temperature sounding, the phase of the cloud can be deduced. The result will be more accurate parameterizations of cloud forcing since mixed phase cloud events can be eliminated.

Some evidence has shown that cloud properties can change as climate changes (Lindzen, 1990). If models are to accurately depict cloud-radiation interactions, and resulting surface temperature changes, then the relationships between various cloud properties and cloud forcing need to be understood.

ACKNOWLEDGMENTS

Dr. Thomas P. Ackerman is greatly appreciated for all of his guidance throughout the study. Thanks is also extended to Drs. Gerald Mace, Eugene Clothiaux, and Charles N. Long for all of their helpful conversations and providing needed insight.

REFERENCES

Cess, R.D., et al., 1995. Absorption of Solar Radiation by Clouds: Observations versus Models. *Science*, Vol 267, 496-499.

Lindzen, R.S., 1990. Some coolness concerning global warming. *Bull. Amer. Meteor. Soc.*, Vol 71, 288-299.

Long, C. N.,1996. Surface Radiative Energy Budget and Cloud Forcing: Results from TOGA COARE and Techniques for Identifying and Calculating Clear Sky Irradiance, Doctoral Thesis, Penn State Univ., 193pp.

Long, C.N., and T.P. Ackerman, 1995. Surface Measurements of Solar Irradiance: A Study of the Spatial Correlation between Simultaneous Measurements at Separated Sites. *J. Appl. Meteor.*, Vol 34, 1039-1046.

Rieland, M., and R. Stuhlmann, 1993. Toward the Influence of Clouds on the Shortwave Radiation Budget of the Earth-Atmosphere System Estimated from Satellite Data. *J. Appl. Meteor.*, Vol 32, 825-843.

Slingo, A., 1990. Sensitivity to the Earth's radiation budget to changes in low clouds. *Nature*, Vol 343, 49-50.

Stokes, G.M., and S.E. Schwartz, 1994. The Atmospheric Radiation Measurement (ARM) Program: Programmatic Background and Design of the Cloud and Radiation Test Bed. *Bull. Amer. Meteor. Soc.*, Vol 75, 1201-1221.

Uttal, T. E.E. Clothiaux, T.P. Ackerman, J.M. Intrieri, and W.L. Eberhard, 1995. Cloud Boundary Statistics during FIRE II. *J. Atmos. Sci.*, Vol 52, 4276-4284.

Welch, R.M. S.K. Cox, and J.M. Davis, 1980. Solar Radiation and Clouds. *Meteor. Monographs*, 96pp.

NONLINEAR OPTICAL PROPERTIES OF HALOGENATED PORPHYRIN

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This computational investigation explores the effects that halogenated phenyl groups and halogenated methyl groups have on the nonlinear optical properties of the highly conjugated and two-dimensional molecule, porphyrin. Theoretical results are compared with experimental values. Second and third-order polarizabilities are calculated for a series of halogenated porphyrins, tetramethylporphyrins and tetraphenylporphyrins. These computations utilize a modified finite field formalism which include calculations of polarization values versus static electric fields. All calculations are performed on optimized molecular geometry based on semiempirical quantum chemical results using the AM1 Hamiltonian.

INTRODUCTION

Porphyrins are an important class of cyclic conjugated tetrapyrrole molecules which are essential constituents of a number of biological systems. The porphyrin nucleus can combine with metal ions, such as magnesium (e.g., in chlorophyll) and iron (e.g., in hemoglobin). Water-soluble porphyrins have functioned favorably in a variety of novel chemical and medicinal procedures and, most recently as photochemical sensitizers and magnetic imaging contrast agents. Because of their electronic properties, polymers with porphyrin derivatives are promising compounds for possible application as nonlinear optical materials.

As light travels through a material, a variety of nonlinear effects may occur, such as second or third order harmonic generation. The interaction of light with matter can cause the original optical beam to have its frequency, phase, polarization or path changed significantly. These materials provide the means to tailor the nature of light to make suitable applications in optical signal processing, laser technology, optical computing and telecommunications.[1-2] In order to control light, materials scientists must design and synthesize an ideal medium in which a combination of photons can take place and the generated beam can have an appropriate magnitude and response time. These materials are called nonlinear optical (NLO) materials.

In recent years much attention has been given to organic compounds, in view of their unusual large nonlinear response. This characteristic feature is attributed to the large polarization of the delocalized electron cloud. Because of its conjugation and abundance in nature, porphyrin is an ideal candidate.

An understanding of the relation between molecular structure and polarizabilities is emerging which may lead to the discovery of materials with yet improved nonlinear optical characteristics. The polarizability of a molecule can be approximated with the following equation:

$$P = \mu + \alpha F + \beta F^2 + \gamma F^3 \ldots \qquad (1)$$

where μ is the dipole moment, α is the linear polarizability, β is the second order polarizability, and γ is the third order polarizability. Both β and γ are nonlinear polarizabilities.

The efficiency of a molecule to generate second and third harmonics is related to the magnitude of β and γ, respectively. A common procedure for measuring these properties is the DC-induced second harmonics generator (EFISH). The measurement depends on the projection of the β vector on the dipole moment of the molecule. Consequently, the larger the angle ($\mu\beta$) between these vectors, the smaller the measurement. Theoretical computations can be used to estimate the dipole moment, linear polarizability, second and third order polarizability. These computations have the potential to assist greatly in facilitating the design of new NLO molecules.

Method

This computational investigation explored the effect that halogenated methyl groups and halogenated phenyl groups have on the nonlinear optical properties of porphyrin, and focused on the second and third order polarizabilities of these porphyrin compounds, as well as their potential use in polymer matrices. For comparison purposes both halogenated and nonhalogenated compounds were analyzed.

Theoretical calculations have been performed as follows: [3-4]

1. Optimized structures were calculated using the AM1 [5] Hamiltonian implemented within the MOPAC [6] program.
2. Data on polarization versus static electric fields were obtained by including values of fields into the AM1 Hamiltonian.
3. The data was analyzed using the HYPER program within the finite-field approach.
4. Values of dipole moment, linear polarizability, second and third order polarizability were obtained with their associated uncertainties.

Results

Please refer to figure 1 for the designation of the molecules studied. The results are summarized in table 1. The headings of this table are as follows: μ corresponds to the permanent dipole moment, in Debye units; α is the linear polarizability, in $Å^3$; Ave β and +/- are the magnitude of the second order polarizability vector with its uncertainty, in 10^{-51} C m^3 V^{-2}; angle μβ corresponds to the angle (in degrees) between μ and β; γ and +/- are the value of the scalar third order polarizability and its uncertainty, in 10^{-61} C m^4 V^{-3}.

The results are depicted in figures 2 and 3. The vertical columns in figure 2 display the values of β for the molecules studies, and the squares indicate the values of the angles between μ and β. Figure 3 shows the values of γ and the corresponding uncertainties.

The values of β and γ for non-halogenated porphyrin are 23.6 x $10^{-51}Cm^3V^{-2}$ and 20 x $10^{-61}Cm^4V^3$ respectively. When halogens were placed in positions 2, 3, 5, 6, 8, 9, 11, 12 (on the pyrrole) the γ value was increased by only 10% and the β value was reduced by 54% . However when the halogens were placed on the pyrroll bridge (positions 1, 4, 7, 10), the β and γ values were increased by 260% and 175 % respectively.

Both the β and γ values for non-halogenated tetramethylporphyrin were significantly decreased when compared to non-halogenated porphyrin. Even though placing halogens on the pyrrole increased the second and third order polarizabilities, the best β and γ values occurred when halogens were placed on the pyrrole bridge, in positions B and D. The β value dramatically increased 17-fold (when compared to the non-halogenated tetramethylporphyrin). The γ value for this molecule (VIII) was also increased by 60%.

The β value for non-halogenated tetraphenylporphyrin was 34% lower than non-halogenated porphyrin. However, the γ value was increased by 170%. Even though the γ values for all the tetraphenylporphyrin molecules were fairly high (>41 x $10^{-61}Cm^4V^3$), only one tetraphenylporhyrin compound (molecule XIX) showed a promising β value of 65.3 x $10^{-51}Cm^3V^{-2}$.

Conclusion

Although halogens have the capability of greatly enhancing the second and third order polarizabilities, their positions is crucial. For the porphyrin and tetramethylporhyrin molecules, the best β and γ values occur when the halogens are located on the pyrrole bridge. Please refer to figure 1, for the molecule designations. Molecules II and VIII have the best β and γ values among the molecules studied. Molecule II is a F substituted porphyrin and molecule VIII is a F substituted tetramethylporphyrin molecule.

Both of these molecules may be capable of generating large second and third harmonics. However, VIII may be problematic due to its large angle for the projection of β onto μ. On the other hand, XV through XXXI result in very good γ values. The γ value of these tetraphenylporphyrin molecules were barely affected by the halogen location.

Acknowledgment. This work was partially supported by the NASA Alliance for Nonlinear Optics (Grant MAGW-4078), NASA Cooperative Agreement NCC8-71, and NSF Center for theoretical studies of Physical Systems (Grant HRD 9450386).

References

[1] J. Zyss, ed; Molecular nonlinear Optics: materials, physics, devices; Academic Press; Boston, 1994

[2] P. N. Prasad, J. D. Williams; Introduction to nonlinear optical effects in molecules and polymers; John Wiley & sons, Inc.; New York, 1990

[3] B. H. Cardelino, C. E. Moore, D. O. Frazier; J Phys Chem A, 101, 2207 (1997)

[4] B. H. Cardelino, C. E. Moore, R. E. Stickel; J Phys Chem 95, 8645 (1991)

[5] M. J. S. Dewar, E. G. Zoebisch, E. F. Healy, J. J. P. Stewart; JACS 107, 3902 (1985)

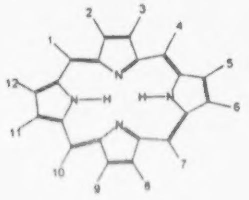
[6]QCPE Program 455, review 6.1 (1990)

Table 1 - Results of Molecules with corresponding values of μ, α, β and γ

Molecule	μ	α	Ave β	+/-	angle uβ	γ	+/-
I	1.06	41.50	23.6	0.0	0.3	20	0
II	2.55	43.92	86.2	0.1	0.2	31	0
III	1.07	43.05	22.4	0.0	0.1	22	0
IV	0.43	43.78	13.8	0.0	0.0	22	0
V	0.40	45.37	10.8	0.0	0.0	24	0
VI	1.35	47.48	30.6	0.0	18.3	28	0
VII	0.30	48.47	8.7	0.0	4.9	22	0
VIII	1.14	59.60	168.4	11.1	49.6	55	6
IX	2.81	47.91	48.2	0.1	11.4	22	0
X	2.07	51.07	28.2	0.0	19.2	24	0
XI	1.26	50.71	13.5	0.0	9.5	27	0
XII	6.86	48.15	30.4	0.0	76.2	22	0
XIII	5.09	47.31	44.7	0.0	49.5	21	0
XIV	2.26	48.13	41.7	0.0	17.2	22	0
XV	0.31	84.37	15.6	0.8	6.8	54	5
XVI	3.52	85.89	34.1	0.1	70.1	49	2
XVII	5.21	87.89	28.2	0.0	75.3	49	2
XVIII	4.62	89.71	19.2	0.6	18.6	48	1
XIX	2.49	87.86	65.3	0.0	76.2	42	0
XX	1.71	84.43	10.1	0.2	71.0	50	2
XXI	2.01	84.49	15.9	0.1	15.0	48	2
XXII	0.14	84.83	5.2	0.2	87.0	50	2
XXIII	1.57	84.73	11.3	0.1	77.0	47	1
XXIV	0.84	83.95	19.7	0.2	32.0	49	1
XXV	3.54	85.03	10.7	0.8	86.0	52	2
XXVI	4.67	85.50	14.2	0.1	38.0	49	2
XXVII	0.21	85.54	9.0	0.5	17.0	51	2
XXVIII	0.80	86.43	22.9	0.3	33.0	53	3
XXIX	1.28	85.32	15.2	0.2	88.0	52	2
XXX	1.39	86.06	17.5	0.1	56.0	50	1
XXXI	0.81	94.46	19.1	0.5	44.0	64	5

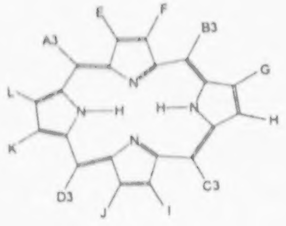
Units μ = Debye α = A^3 β = 10^-51 Cm^3V^-2 γ = 10^-61 Cm^3 V^-2

Molecule	Fluorine substitution
I	NONE
II	1, 4, 7, 10
III	5, 6, 11, 12
IV	2, 3, 8, 9
V	2, 3, 5, 6, 8, 9, 11, 12
VI	1 thru 12


1
2
3
4
5
6
7
8
9
10
11
12
N
N—H
H—N
N

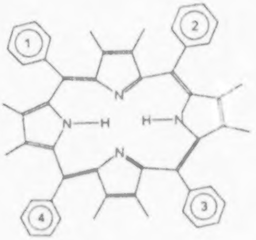
Tetramethylporphyrin

Molecule	Fluorine substitution
VII	NONE
VIII	B, D
IX	A, B, C, D
X	A thru L
XI	E, F, G, H, I, J, K, L
XII	C, D
XIII	A, D
XIV	A, C


E
F
A3
B3
G
L
N
N—H
H—N
H
K
N
D3
C3
J
I

Tetraphenylporphyrin

Molecule	Fluorine substitution
XV	NONE
XVI	2
XVII	1, 2
XVIII	1, 2, 4
XIX	1, 2, 3, 4


1
2
N
N—H
H—N
N
4
3

Molecule	Fluorine substitution
XX	A
XXI	A, B
XXII	A, C
XXIII	A, B, C
XXIV	A, B, C, D
XXV	A, E
XXVI	A, B, E, F
XXVII	A, C, E, G
XXVIII	A, B, C, D, E, F, G, H
Molecule	**Chlorine substitution**
XXIX	A
XXX	A, B
XXXI	A, B, C, D, E, F, G, H

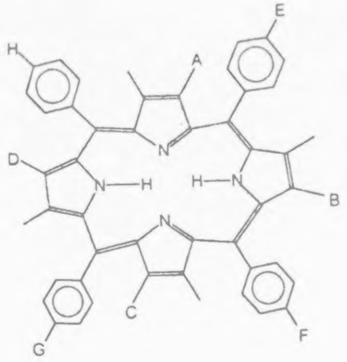

E
H
A
N
D
N—H
H—N
B
N
C
G
F

Figure 1 - Molecules Studied

Porphyrin Molecules with Halogens located at the corresponding positions;

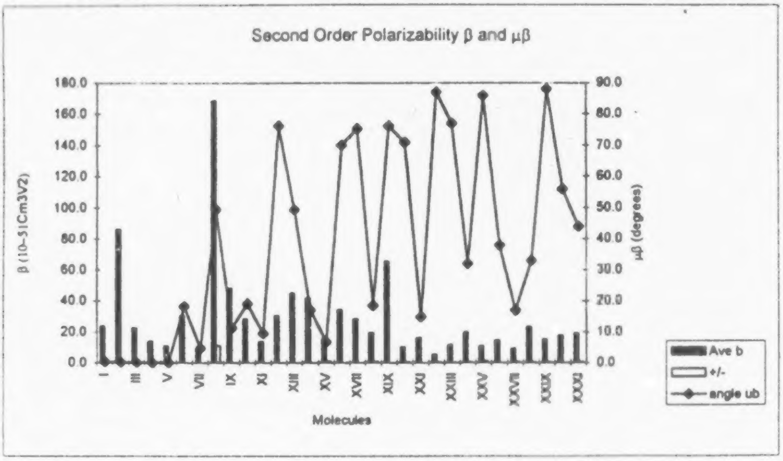


Figure 2 - The second order hyperpolarizabilities and the angles between the permanent dipole moment and the second order hyperpolarizability.

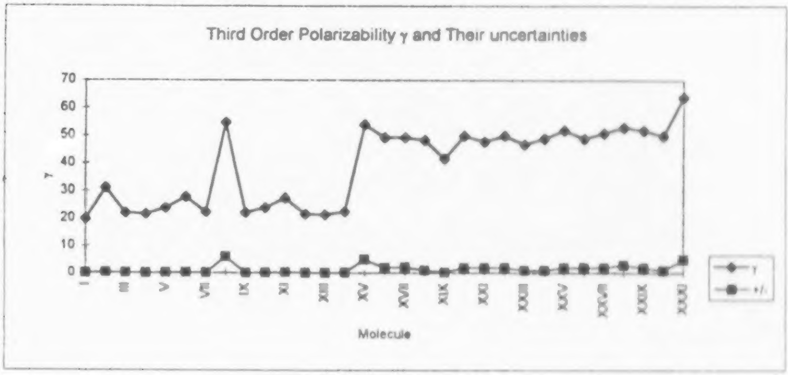


Figure 3 - Third order polarizabilities and Their uncertainty.

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A Novel Method for Investigating Phase Disturbances

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We report on a new, simple method for examining phase disturbances. In our method, we use the finite time response of two beam coupling in a photorefractor to obtain images of rapidly varying phase disturbances. We show both theoretically and experimentally that, when using our technique, there is a simple relationship between the intensity distribution of the image and the phase disturbance. We use this relationship to interpret images of phase phenomena, and we demonstrate the usefulness of this technique by analyzing the flow of butane from a small nozzle.

INTRODUCTION

There are many methods available to analyze phase disturbances such as fluid flow, gas flow, and other atmospheric disturbances.[1] We have developed a new, optical method for examining such phase disturbances. Our method has several advantages over other phase-contrast methods, such as Schlieren photography, in that our method is robust, can be used to analyze large phase changes, and provides for simple analytic interpretation of the image. In our method, we use the finite time response of two beam coupling in a photorefractor to obtain images of rapidly changing phase disturbances.[2] So that we may analyze these phase disturbances, we derive a relationship between recorded intensity and the phase disturbance. We show both theoretically and experimentally that, when using our method, there is a simple relationship between the recorded intensity and the phase disturbance. We also demonstrate the usefulness of this method by analyzing gas flow through the small nozzle of a butane lighter.

Our apparatus for investigating phase disturbances is a variation of that previously used by others in visualizing phase disturbances.[3] It produces images that clearly depict phase changes as intensity variations. As illustrated in Figure 1, we direct the beam from an Ar^+ laser ($\lambda = 514.5$ nm) through a spatial filter and collimate the beam with a diameter of approximately two inches. After propagating through a sample region, the beam is then focused through a photorefractor (a SBN:Ce crystal) where the process of two beam coupling depletes the sample beam. The sample region is then imaged on to a CCD array.

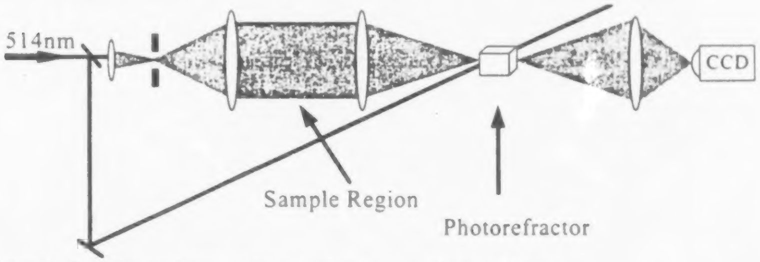

Figure 1. Experimental setup used to capture images of phase changes.

Using this arrangement, we can capture real-time images of phase changes in the sample region. An example is shown in Figure 2, which is the image of gas flow from an ordinary

Figure 2. The image of gas flow from a butane lighter.

hand-held butane lighter viewed through the experimental arrangement shown in Figure 1. This method has been previously reported,[4] however the interpretation of images such as that shown in Figure 2 has to our knowledge never before been possible.

THEORY

To interpret such images as that shown in Figure 2, we must develop a relationship between the recorded intensity distribution and the phase change occurring inside the sample region. The process of two beam coupling in photorefractors is well understood. It begins with the interference between the two beams within the crystal.[2] The intensity distribution inside the photorefractor causes electric charges inside the crystal to move from regions of higher intensity to regions of lower intensity. Because the regions of charge are separated within the photorefractor, an electric field is formed. This spatially varying electric field produces an index grating within the photorefractor via the Pockels effect. As a result of this index grating, light is scattered from the signal beam into the pump beam. In Figure 3 we graphically depict how the intensity affects the electric charges, electric field, and the index of refraction inside the photorefractor. Note that the electric field and the index of refraction are out of phase with the intensity and the charge distribution by a quarter of a wavelength. This phase difference is responsible for the process of two beam coupling.

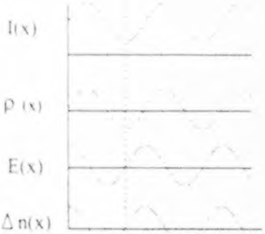

Figure 3. Plot of the intensity (I), charge distribution (ρ), electric field (E), and index variation (Δn). (after reference 2)

It is important to note that photorefractive two beam coupling is a dynamic process, and that the index grating is continuously changing and adapting to changes in the two beams. Whenever the phase of intensity of either beam is altered, the photorefractor changes as well. However, at the intensity typically used in the laboratory, the photorefractor requires a few seconds to respond to any changes. When a phase change in the signal beam occurs faster than the crystal can adapt, we can consider the grating inside the photorefractor to be static. Since we are interested in analyzing rapidly varying phase changes, from this point forward, we will consider the index grating in the photorefractor to be static.

It can be shown that the following equations apply to a static, thick grating:[4]

$$\frac{\partial A_p}{\partial z} = i\kappa A_s \exp(i\varphi) \qquad (1a)$$

and

$$\frac{\partial A_s}{\partial z} = i\kappa A_p \exp(-i\varphi), \qquad (1b)$$

where A_p is the amplitude of the pump beam, A_s is the amplitude of the signal beam, κ is a constant dependent upon the specific photorefractor and the geometry, and φ is the grating phase shift in the photorefractor (i.e. the phase shift between the intensity modulation and the phase grating). Assuming that the phase of the pump beam and the index grating is zero at $x = y = 0$, the boundary conditions are given by:

$$A_p(0) = |A_p(0)| \qquad (2a)$$

and

$$A_s(0) = |A_s(0)| \exp[i(\varphi + \Delta\varphi)], \qquad (2b)$$

where $\Delta\varphi$ is the unknown phase change imposed on the signal beam within the sample region. Using equations (1) and (2), it can be shown that the intensities of the beams upon exiting the crystal are given by:

$$\frac{I_s(L)}{I_p(0)} = \left(\frac{1+\beta}{2}\right) - \left(\frac{1-\beta}{2}\right)\cos(2\kappa L) - \sqrt{\beta}\,\sin(2\kappa L)\sin(\varphi + \Delta\varphi) \qquad (3a)$$

and

$$\frac{I_p(L)}{I_p(0)} = \left(\frac{1+\beta}{2}\right) + \left(\frac{1-\beta}{2}\right)\cos(2\kappa L) + \sqrt{\beta}\,\sin(2\kappa L)\sin(\varphi + \Delta\varphi) \qquad (3b)$$

where

$$\beta = \frac{I_s(0)}{I_p(0)}, \qquad (4)$$

and L is the length of the grating inside the photorefractor.

When only changes in phase occur within the sample region (i.e., β is a constant) then, except for the argument of the sine function, all of the terms in equations (3) are constants. Also, by setting $\varphi = \pi / 2$, as is commonly the case for most photorefractors, the sine function becomes a cosine function. Assuming maximum two beam coupling, we then have the following equation, relating the observed intensity to the phase change in the sample region:

$$\frac{I_s(L)}{I_p(0)} = \left(\frac{2\beta}{1+\beta}\right)[1 - \cos\Delta\varphi]. \qquad (5)$$

Equation (5) explicitly describes the relationship between the change in phase or amplitude of the signal beam and the recorded intensity for the case of optimal two-beam coupling. For non-optimal coupling equation (3a) must be used, however, the functional form remains cosinusoidal in $\Delta\varphi$.

Equations (3) also indicate a nonlinear dependence on a change in the intensity of the input beam. That is, if β is not constant, but Δφ is, a change in intensity will be recorded at the output of the apparatus. This relationship between $I_s(L)$ and β cannot be reduced to a simple formula, as can be done with Δφ.

EXPERIMENT

We have experimentally verified equation (4) using a modified version of the experimental arrangement shown in Figure 1. As shown in Figure 4, we modified the configuration from that shown in Figure 1 by placing a Pockels cell into our sample region, and replacing the CCD with a photo-diode.

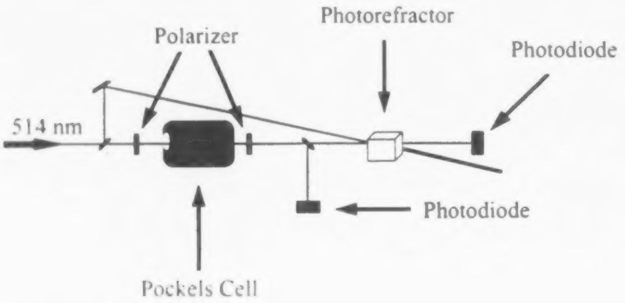

Figure 4. Experimental Setup

To investigate the relationship between Δφ and $I_s(L)$ we do not use the Pockels cell in the traditional manner. Rather, we orient the crystalline axes of the cell parallel to the polarization of the light, thus allowing the introduction of a pure, known shift in phase into the signal beam. To investigate the dependence of $I_s(L)$ on β, we orient the Pockels cell in the usual manner, allowing the introduction of a pure, known intensity variation of the signal beam.

RESULTS AND DISCUSSION

Results of experiments demonstrating the relationship between the intensity and Δφ are shown in Figure 5, where we plot the intensity of the signal transmitted through the photorefractor as a function of the applied phase shift. Also plotted in Figure 5 is the fit to equation (5). Note the excellent agreement between theory and data.

The dependence of $I_s(L)$ on β is shown in Figure 6 using the experimental setup shown in Figure 4 (with the Pockels cell oriented in the traditional manner). The line is a fit to the data we obtained in the experiment using equation (3a). Again, note the excellent agreement between theory and data.

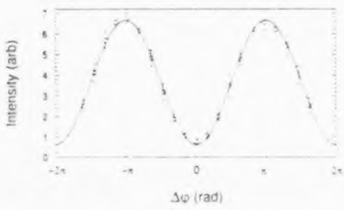

Figure 5. Sample beam intensity of the photorefractor plotted against Phase shift.

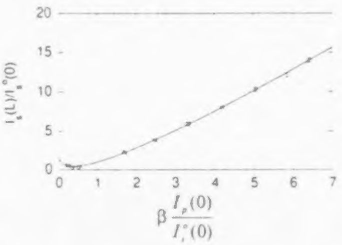

Figure 6. Intensity of the transmitted beam plotted against the intensity of the incident beam.

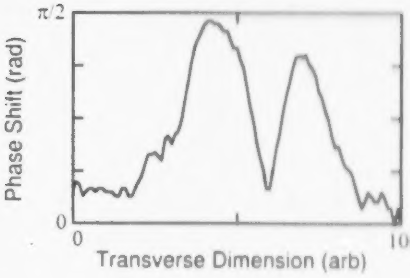

Figure 7. Phase shift versus the transverse dimensions using intensity data derived from Figure 2.

Using equation (3a) and the fit obtained from the data shown in Figure 5, we can deconvolve the intensity data from the picture in Figure 2 to a graph that depicts the phase shift versus the transverse dimensions of the beam. This is shown in Figure 7. Thus, we have determined the phase aberration induced by the flowing gas *in situ*, without affecting the flow in any way.

CONCLUSION

In conclusion, we have developed a new, simplified method for analyzing phase disturbances. We have shown that when using our technique, the observed intensity and the phase change have a cosinusoidal relationship. Unlike most phase-contrast methods, our method requires no expansion of the phase change to relate the recorded intensity to the actual phase change in the sample region. Therefore, our method can be used to analyze large phase changes. Finally, we have demonstrated the utility of this new technique by measuring the phase delay due to a gas jet.

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[1] see for example: G.O. Reynolds, J.B. DeVelis, G.B. Parrent, and B.J. Thompson, *Physical Optics Notebook: Tutorials in Fourier Optics*, Bellingham: SPIE, 1989.

[2] Boyde, Robert. *Nonlinear Optics*. Academic Press: New York, 1992.

[3] D.Z. Anderson and J. Feinberg, "Optical Novelty Filters," *J. Quant. Elec.* 25, 635 (1989).

[4] T.R. Moore, B.L. Shoop, J. Campbell, and K.A. Ingold, "Flow studies using photorefractive optical time-differentiation," Annual Meeting of the Optical Society of America, 1996 (Optical Society of America, Washington, D.C., 1996), paper WG6.

[5] Moore, T.R. "Theory for interpreting the images from photorefractive novelty filters," *Opt. Lett.*, submitted.

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An X-ray and Optical Study of Galaxies in Pairs

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We have obtained X-ray (L_x) and blue luminositities (L_b) for a sample of 57 pairs of galaxies of mixed morphology, including spiral galaxy pairs, elliptical galaxy pairs, and pairs consisting of one elliptical and one spiral galaxy (mixed pairs). We find a strong relationship between L_x and L_b for the spiral and elliptical pairs, with L_x dependent on L_b. We also find clear evidence for increased levels of star formation for galaxies in pairs compared to isolated galaxies. Furthermore, data from the elliptical pairs as well as some of the mixed pairs suggest that elliptical galaxies are the products of mergers within small groups of galaxies.

INTRODUCTION

Galaxies are enormous, gravitationally bound ensembles of gas, dust, and stars. They are the residence of almost all stellar objects, including black holes and dark matter, and are spread throughout the universe in various shapes and sizes. Galaxies rarely travel solo and are often members of small groups of galaxies or larger structures called clusters. These local groups are said to be "virialized", or existing in an equilibrium state with respect to gravitational potential. The combined mass of the group, including both the visible and non-visible matter, exerts control over the intergalactic medium in the galaxies; thus, the dust and gas in a galaxy is bound to the group as much as it is to the individual galaxy.

Two distinctly different classes of galaxies exist, namely elliptical and spiral galaxies. Elliptical galaxies are spherically shaped objects dominated by old stars and are essentially devoid of interstellar medium. The interstellar medium, i.e., the gas and dust found in galaxies is the fuel for stellar birth, without which a galaxy cannot produce new stars. Therefore, elliptical galaxies are not thought to be very active in their star formation roles. Quite in contrast to the ellipticals, spiral galaxies are highly structured, disked-shaped galaxies with central bulges and outward spiraling arms. Spirals are identified with high concentrations of interstellar medium and are consequently the breeding grounds of new stars. Stellar birth serves to heat the nearby interstellar medium, resulting in large portions of hot gas throughout the galaxy.

Although elliptical and spiral galaxies have identifying properties of composition and stellar activity, these properties are subject to alteration due to galactic environment and history. We investigate these two parameters, i.e., stellar activity and abundance of hot, interstellar gas, to evaluate the effect of pairing on galaxies of various morphology class. Since young, new stars emit blue light, stellar activity is measurable through a galaxy's luminosity in the blue part of the electromagnetic spectrum (L_b). The heated, interstellar component gas in galaxies is a major contributor to the X-ray luminosity (L_x), along with X-ray binaries and supernovea remnants, all indicators of star formation.

We have surveyed and analyzed these parameters for over 50 pairs of galaxies using previously collected optical data and sensitive X-ray observations of the galaxies. Albeit that X-ray satellites have focused their attention on a few pairs of galaxies, there are not nearly enough targeted pairs to constitute a statistical sample. Our sample was achieved by hunting through the X-ray image field of the ROSAT PSPC satellite for chance observations of galaxy pairs. With a gold mine of findings, this study presents the first X-ray analysis of galaxies in pairs.

DATA ANALYSIS

X-ray Luminosity

Our sample of 57 galaxy pairs were located in X-ray images taken by the PSPC detector on board the ROSAT satellite. The PSPC spent approximately four years in orbit capturing X-ray pictures of the universe through a one degree viewing lens. The satellite was programmed to target large, visible objects in the nearby universe, as well as an all-sky snapshot survey. Images collected from the detector during its lifetime have been placed in NASA data archives and made available to the public. It was from these archives that we obtained our data.

Data analysis began by locating the galaxy pairs in the ROSAT image fields. This location was our source region and we captured it with a circle of radius > 100 Kpc (300, 000 light years), chosen to include the X-ray emission from both galaxies. Four sourceless regions were similarly captured and defined as background regions. X-ray counts were found for each of the regions and the error taken as the square root of the counts (Eq. 1). The net counts for the source region was found by subtracting the area-normalized average background counts from the total counts in the source region (Eq. 2). The error for the net counts was calculated via Equation 3

$$\sigma_t=(C_t)^{1/2},\ \sigma_b=(C_b)^{1/2},\ \text{where } C_s = \text{total counts},\ C_b = \text{background counts} \qquad (1)$$

$$\text{net counts} = (C_t) - (C_b)\,(A_1/A_2) \qquad (2)$$

$$\sigma^2_{net} = \sigma^2_{total} + \sigma^2_{back} \qquad (3)$$

Positive net counts resulted in a source detection, while negative counts were converted to upper limits. Upper limits were calculated as 3σ + total source counts. This ensures with 99% confidence that the source is below this level.

Positive net counts were used to derive a best-fit spectrum for the source which included as parameters the temperature, absorption coefficient, and abundance of elements. X-ray fluxes were calculated from this spectrum and converted to luminosity using the distances to the galaxies (Eq. 4). Distances are given inversely as Hubble's constant (H_0), a constant which measures the expansion of the universe and is currently known within a factor of two. For this study, we assumed the value H_0=50 Km s^{-1} Mpc^{-1}. Any comparisons made to other studies also utilize this value.

$$L_x=4\pi D^2 \times \mathit{flux},\ D\sim(1/H_0) \qquad (4)$$

X-ray analysis included accounting for several complications due to the lack of a "flat field" in the image screen. To correct for these problems, NASA has available an exposure map image which displays the X-ray collection pattern for each image. Corrections for locations of the regions on the image field were made using this file.

Optical Luminosities

Optical luminosity in the blue part of the electromagnetic spectrum were calculated using the apparent magnitudes and redshifted velocities of the galaxies listed in the Catalog of Isolated Galaxy Pairs in the Northern Hemisphere (Karachentsev,1972) in conjunction with Solar luminosity and magnitude (Eq. 5-7).

$$D = V/H_0,\ H_0 = 50 \text{ Km s}^{-1} \text{ Mpc}^{-1} \qquad (5)$$

$$M_g = 5 - 5\text{Log}[D] + m_a \qquad (6)$$

$$M_g - M_s = 2.5\text{Log}[L_s/L_b],\ M_s = 4.5,\ L_s = 3e39 \text{ (ergs/sec)} \qquad (7)$$

RESULTS AND DISCUSSION

Our final sample of data included X-ray and blue luminosities for 24 pairs of spiral galaxies, 15 pairs of elliptical galaxies, and 18 mixed pairs of galaxies. The data was analyzed using Survival Analysis (ASURV), a statistical package adopted from the insurance agency for use in astronomical research. The variables in each subset of pairs were tested for correlations, and linear regression models were run to obtain mathematical fits to the data. Moreover, comparisons were made between each subset and a corresponding set of isolated galaxies.

Spiral/Spiral Pairs

Correlation test between L_x and L_b for the spiral galaxy pairs show a 99% probability that the variables are linearly related, with L_x dependent on L_b. This indicates that the amount of hot gas in a galaxy is indeed dependent on the rate of star birth. This conclusion is further confirmed for isolated spirals, where L_x and L_b are again found to be linearly related (Fabbiano et. al, 1987). It is found, however, that the range of values of blue luminosities for spirals in pairs is smaller than that of isolated spirals, and resides at the upper end of the spread. The small relative number of dim spirals in pairs suggests that, whereas some isolated spirals may not be very active in stellar formation, spirals in pairs are generally swarming with stellar birth. Following a similar trend, X-ray luminosities are found to be higher in pairs than in isolated spirals. The relationship between X-ray and blue luminosity for the pairs is similar to that of isolated spirals, indicating that the increase seen in X-ray luminosity is due to high levels of stellar activity which heats the surrounding medium, causing it to shine in the X-ray. Gravitational interactions in the pairs are the likely source of this stellar phenomenon.

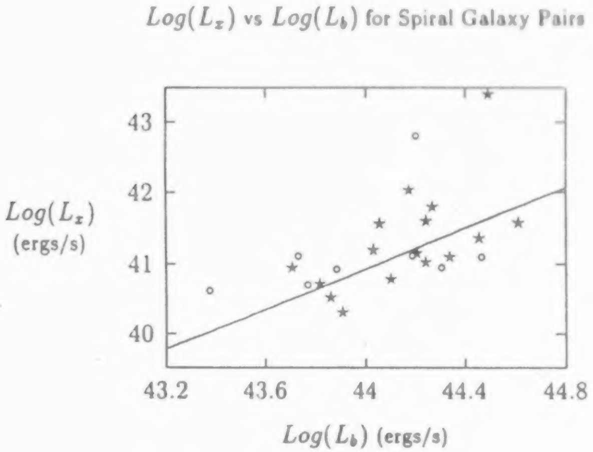

Fig. 1. X-ray vs. blue luminosity for spiral galaxy pairs. Stars represent detections, and open circles represent upper limits.

Elliptical/Elliptical Pairs

Similar to the spiral pairs, L_x and L_b for elliptical pairs of galaxies are shown to be linearly related with a correlation probability of 99%. X-ray and optical luminosities for isolated ellipticals are well correlated (Eskridge et al, 1994), again verifying that the amount of hot gas is determined by the level of star formation. Blue luminosities are shown to be higher for ellipticals in pairs than isolated ellipticals, once more suggesting higher levels of star formation for galaxies in pairs than isolated galaxies. X-ray luminosities were found to be several orders of magnitude higher for pairs than for isolated galaxies. Moreover, the relationship between blue luminosity and X-ray luminosity for the pairs was not consistent with that of the isolated set of galaxies. The fit to the data for L_x vs L_b for the pairs follows a much steeper slope than that of isolated galaxies, showing that X-ray luminosities for pairs increases much more quickly with increasing blue luminosity than isolated ellipticals. Thus, there is an extra component of X-ray, seen most prominently in optically luminous pairs, which suggests that many of the elliptical pairs are the product of mergers of small groups of galaxies. Mergers would trigger new star formation, accounting for the high levels of blue luminosity. The intergalactic medium, separated from the halo of early-type galaxies would remain after merger, producing X-ray emission around the newly formed pair characteristic of a group of galaxies. It has been shown that the velocity dispersion of a group is related to its corresponding level of X-ray luminosity (Ponman et.al, 1997). However, correlation tests between X-ray luminosity and velocity dispersion for pairs of ellipticals do not show a relationship between the two parameters. We deduce that the mergered galaxies have not had sufficient time to achieve an equilibrium state.

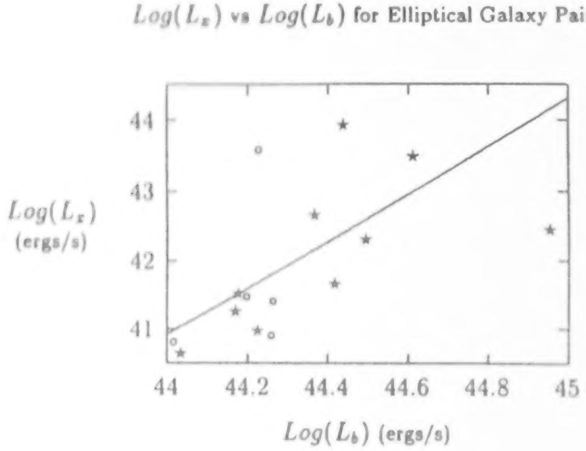

Fig. 2. X-ray vs. blue luminosity for elliptical galaxy pairs. Stars represent detections, and open circles represent upper limits.

Elliptical/Spiral Pairs

Mixed pairs of galaxies comprise the only set of pairs that do not show a clear correlation between X-ray and blue luminosity. The correlation breaks down due to a few pairs of galaxies with high X-ray luminosities but low relative blue luminosities. These appear very much like the elliptical set of pairs, but with low blue luminosities. The remainder of the sample corresponds well with the spiral set of pairs. The possibility exists that the mixed pairs with low L_b and high L_x are systems which have had a merger some time in the past, so that star formation has faded but group X-ray emission remains.

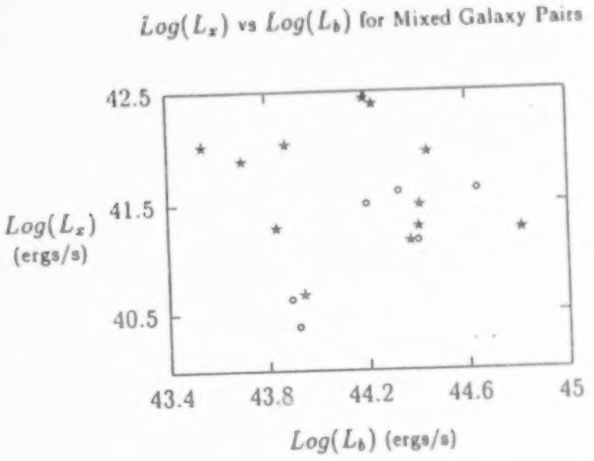

Fig. 3. X-ray vs. blue luminosity for mixed galaxy pairs. Stars represent detections, and open circles represent upper limits.

CONCLUSIONS

A survey of X-ray and blue luminosities of 57 pairs of galaxies has resulted in the first complete set of X-ray data on galaxies in pairs. Comparisons to isolated galaxies, along with statistical analysis of the data, have enabled us to single out unusual behavior among pairs of galaxies and gain insight into the history and current on going of the pairs. It is found, in general, that the amount of diffuse, hot gas in a galaxy is predicted by the level of star formation. Galaxies in pairs are shown to have higher rates of star formation than isolated galaxies, and correspondingly high levels of hot gas. These results are predicted by the increase seen in L_b and L_x for the galaxies in pairs compared with isolated galaxies. Gravitational interactions account for the increase in star formation observed in the spiral pairs. The elliptical pairs, however, exhibit an additional component of X-ray which makes gravitational interactions alone an unlikely candidate for their unusually high levels of X-ray luminosity. We theorize, instead, that the ellipticals pairs, as well as some of the mixed pairs, are the descendants of three or more galaxies which have merged together to leave only a pair. We further conclude that the there has not been an adequate amount of time since the mergers for the pairs to reach virial equilibrium.

References

Eskridge, P. B., and Fabbiano, G. 1994, preprint
Fabbiano, G., Gioia, I.M., and Trinchieri, G. 1987, *Ap. J* 324, 749-766
Karachentsev,1972, in *Catolog of Isolated Galaxy Pairs in the Northern Hemisphere*

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Optically Driven Pendulum

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A physical pendulum with adjustable period has been studied in free decay, and also when excited at very low levels with a laser. Using a novel capacitive sensor to measure displacement, it was found that the motion of the pendulum depends significantly on the material properties of strategically placed samples, that are load bearing members of the pendulum structure. Placed in pairs, on opposite sides and near the center of mass; the samples, under compression, are exposed sequentially to the laser. Differential thermal expansion causes periodic lateral shifts in the center of mass, which is the driving mechanism. The frequency of the laser drive is adjustable, by means of an electronic timer connected to shutters. For samples of single crystalline lithium fluoride, the motion involves complicated hysteresis. Moreover, the damping constant can be negative, meaning that the pendulum oscillates as a result of stimulated processes involving defect structures of the LiF.

BACKGROUND

The pendulum is probably the most studied and among the best understood mechanical systems. For centuries it has been the basis for a variety of physical phenomena investigations. Most of the early work with pendula involved observations using a simple timepiece. Since about 1990, new measurement technology has permitted the study of physical pendula with very low amplitudes and long periods of oscillation. These new sensors enable the physical pendulum to be an instrument for the study of internal friction involving defect structures.

This paper seeks to demonstrate the relevance of physical pendula to the study of internal structures and how internal friction can affect the behavior of a pendulum. It will be shown that the popular equation of motion, that of the simple harmonic oscillator in free decay with damping, does not apply to all physical pendula. Although the classical equation for a simple harmonic oscillator with damping predicts that the log decrement of the amplitude of oscillation (L.D.) of a physical pendulum is proportional to the period (T) to the first power, we have found, for the pendulum studied, that the L.D. is more nearly proportional to T squared. Additionally, we have found that activity internal to samples placed in the pendulum structure is responsible for much of the unexpected behavior of the system.

THEORY

Traditionally, the solution to the equation of motion of a damped pendulum is

$$\theta(t) = \theta_o e^{-\beta t} \cos(\omega t + \phi), \qquad (1)$$

where $\theta(t)$ is the displacement at time t, θ_o is the maximum amplitude, β is the viscous damping term, $\omega = (\omega_0{}^2 - \beta^2)^{1/2}$, and $\omega_0 = (mgd / I)^{1/2}$, in which d is the distance from the axis to the center of mass, m is the mass, g is the gravitational constant and I is the moment of inertia about the axis. Using θ at two different turning points, one period apart, we obtain

$$\theta(t = 0) = \theta_o e^{-\beta(0)} = \theta_o \qquad (2)$$

$$\theta(t = T) = \theta_o e^{-\beta T} \qquad (3)$$

from which the log decrement is found to be proportional to T:

$$L.D. = \ln(\frac{\theta_o}{\theta_T}) = \beta T. \qquad (4)$$

Contrary to the above prediction, our experimental results show that the traditional viscous damping term is not adequate. So, we resort to a phenomenological treatment in which (1) is rewritten as:

$$\ddot{\theta} + \gamma\dot{\theta} + \omega_o^2\theta = 0, \qquad (5)$$

Were γ is not a constant, but rather $\gamma = c / \omega_0$. Although sometimes nearly constant, c can vary with changes in molecular structure of the pendulum samples. With c constant, L.D. is proportional to T^2, rather than the commonly accepted T. Some of our data, as well as that of others, are nearly consistent with a quadratic dependence on T of L.D. [1]. However, as contrasted with earlier studies, our research is concerned with low level oscillations which are sometimes discontinuous.

The damping most important to our investigation is due to anelasticity. When a crystalline material is cycled in stress and strain, some molecular bonds can break and internal grains can rearrange, a type of molecular "musical chairs." These irreversible processes generate heat internal to the system. Because the strain in the material normally lags in phase behind the stress, there is a mechanism for damping. It is also possible, under some circumstances, to have the strain lead in phase. This negative damping case results in "self-oscillation," meaning that the pendulum will oscillate without an external driving force. Understanding the damping mechanism from first principles for anelastic damping is not as simple as with viscous damping. It is dependent on many variables, not the least of which is the geometry of the structure being used and how the material was prepared. Therefore, each case is unique.

Another consideration of our study was the relative significance of driving frequency versus natural frequency for the pendulum when driven. Classically, when an oscillator is driven, the equation of motion becomes non homogeneous:

$$\ddot{\theta} + \gamma\dot{\theta} + \omega_o^2\theta = \alpha(t) \qquad (6)$$

and its steady state response as a function of the periodic drive is:

$$\theta \propto \frac{1}{\sqrt{(\omega_D{}^2 - \omega_o^2)^2 + (\gamma\omega_D)^2}} \cos(\omega_D t + \phi) \qquad (7)$$

where ω_D is the drive frequency and ω_0 is the natural frequency of the undamped oscillator. As the drive frequency approaches the natural frequency, ω_0, the amplitude approaches a maximum. Additionally, an oscillator driven at a frequency other than its natural frequency will experience "beating" as it tries to oscillate at both frequencies. Classically, this transient beating will eventually die out and the drive frequency will dominate.

EXPERIMENTAL SYSTEM

The research presented in this paper focuses on pendulum motion at very low levels and lower frequencies than are usually studied. These pendulum motions are larger than atomic scale motions and smaller than macro-scale motions; they are sometimes said to be in the meso-realm and are invisible to the human eye. Because the motions are on such a small scale, the sensors used to measure them are very important.

In conducting this research, the authors used a new measuring device, the symmetric differential capacitance (SDC) transducer [2]. A small metallic plate is fixed to the pendulum arm, and as the pendulum swings, the metal plate travels back and forth between static electrodes. As the plate moves, a signal proportional to the pendulum displacement is sent through an analog-to-digital converter to an IBM computer, which can display and store the wave forms. The SDC sensor can resolve motions of the pendulum on the order of 1 μ radian. This is sufficient to observe interesting phenomena in the meso-realm. Additionally, the computer can store permanent records of the pendulum motion, which is essential for data analysis.

The period of the pendulum is adjustable from 1s to 10s. Figure 1 shows the pendulum design. Although the illustration shows LiF samples placed between the masses, other materials were also studied, including aluminum, rubber, and brass. The position of the top mass along the support tube is variable, which allows one to change the natural period of the pendulum. The pendulum and sensors were placed under a bell jar to reduce the effect of air currents on the system. The pendulum rests on a standard pneumatic optical bench to isolate the system from seismic events. Finally, a Faraday shield, consisting of a grounded mesh wire surrounds the bell jar and pendulum, to stabilize the electronics. This minimizes false readings caused by stray capacitance changes and electromagnetic disturbances external to the system.

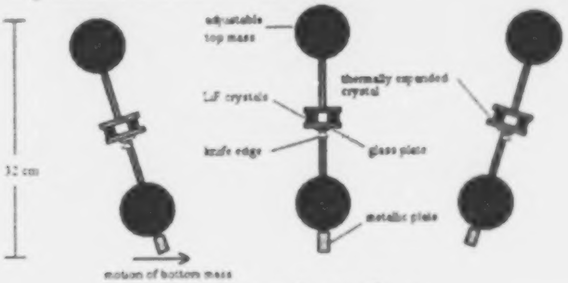


Figure 1: Pendulum Design

A 10 Watt Argon ion laser, operating at a wavelength of 514 nm, provided the drive. The laser and optical elements were fixed to a separate optical bench so as not to disturb the pendulum. A timing circuit controlled two shutters and allowed the laser to heat the lithium fluoride, alternating from one crystal to the other, at an adjustable frequency.

RESULTS

Expecting the damping of this system to be of particular interest, we began our studies by measuring free decay log decrements with LiF samples. Using the laser, we built up oscillations to about 200 μ radians peak to peak. We then measured amplitudes as a function of time. We found that the log decrement at a given pendulum frequency varied by 30% or more in some cases. Some examples are shown in Figure 2.

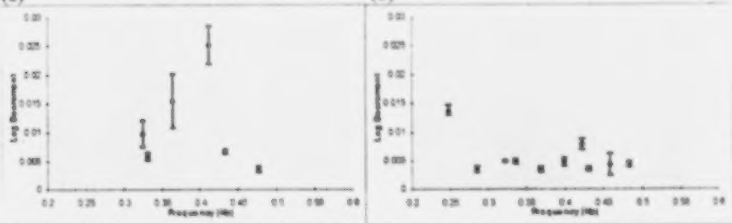


Figure 2: Log Decrement plot for the pendulum with LiF samples (a) and irradiated LiF samples (b)

Figure 2 shows log decrement plots for the pendulum with two different sets of LiF crystals. One set of crystals had been irradiated with 10^8 rad (water) of gamma radiation, while the other had not. As can be seen from each of the two cases, the log decrement of the pendulum using LiF samples shows a peak around 0.40 Hz to 0.45 Hz. However, the peak is better defined in the case of non-irradiated crystals. This observation is consistent with Frankl and Read [3]. Similar data taken with samples of brass, aluminum, and rubber exhibit less variability than that of LiF. Figure 3 provides a

1441

comparison with Al. In all of these measurements (LiF, Al, brass, and rubber) the log decrement was found to be more closely proportional to T^2 than to T.

Several long records of the pendulum motion were taken in which free decay was preceded by laser driving of the LiF. For those records, the pendulum was driven to an amplitude of approximately 200 μ radian peak to peak, then allowed to decay. Although the mean position of the pendulum sometimes shifted during a record, the peak to peak features of free decay appeared normal for several minutes after the driving had ceased. However, some records showed negative damping, beginning five to fifteen minutes after the drive had stopped.

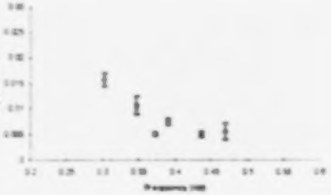


Figure 3 Damping of Pendulum with Al Samples

Figure 4 shows an example of negative damping. For most cases in which negative damping developed, the increase in amplitude began to first appear after the amplitude of oscillation had decayed to the order of 10 μ radian, which is just above the noise level for the measuring device. Analysis of the power spectrum confirms that this oscillation is at the natural frequency of the pendulum, and is not simply random motion or electronic malfunction.

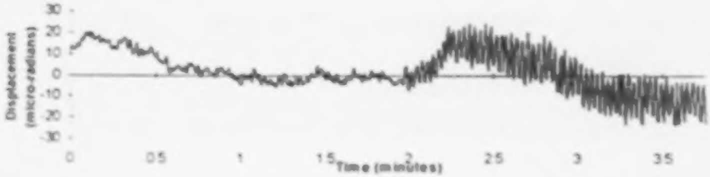


Figure 4: Free decay record of the pendulum showing a smooth rise in amplitude, signifying a negative damping process.

Other records show discrete jumps in the pendulum motion. Again, these were cases in which the free decay was preceded by laser drive. The jumps usually occur with a sudden anti symmetric shift in the mean position, as illustrated in Figure 5, where three such jumps are readily seen.

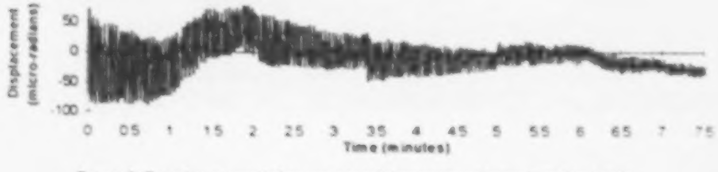
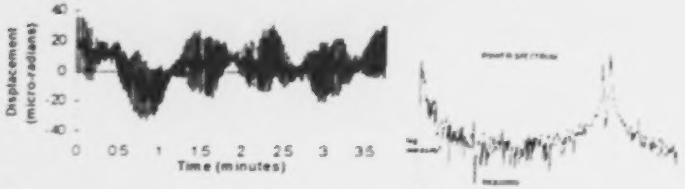


Figure 5: Free decay record showing several discontinuous "jumps" in amplitude

Measurements while the laser drive was still active also led to unusual cases. By comparing these to the classically expected steady-state response of a driven pendulum, we attempted to discover effects of the samples on the response of the pendulum. Classical theory predicts that beating will occur when the drive frequency does not equal the pendulum's natural frequency. The beat amplitude should decrease exponentially with time, and eventually disappear. In this final steady-state, the pendulum should oscillate at the frequency of the drive mechanism, as opposed to its natural frequency. We found this not to be the case in all situations.

Several interesting cases emerged from our data involving the driven pendulum with LiF samples. In one case, we drove the pendulum at a frequency of 0.565 Hz, where the pendulum had a natural frequency of 0.535 Hz. Figure 6 shows a $7\frac{1}{2}$ minute record of the oscillation of the pendulum and the corresponding power spectrum. This record was taken after the laser had been driving the pendulum for 30 minutes. One can easily see the beating as predicted by classical theory. The surprise, however, is that the beating remains long after it should have died out.

Using a log decrement of 0.004, one can readily estimate the time required classically for the beat amplitude to decay to $^1/_{10}$ of its initial amplitude. For a period of 1.87 seconds this should happen after 18 minutes of driving. In the case shown, the beating after over 30 minutes is nearly the same as it was initially.



(a) (b)

Figure 6: Record of a driven pendulum (a) and its accompanying power spectrum (b)

In an effort to explain the unusual oscillations of our pendulum, we theorized that the LiF crystals must somehow store and then release energy. As a starting point, we attempted to detect any fast photomechanical effects in the crystal at the time of laser turn-on. Because thermal expansion alone cannot explain the anomalous behavior, it is possible that an immediate restructuring of the crystal might take place when bombarded by photons from the laser.

To detect the postulated photomechanical effect, we built a Michelson interferometer using a Helium Neon laser and placed a LiF crystal in the beam path. We monitored the output of the interferometer with a fast photo diode. The diode was connected to an oscilloscope with sufficient bandwidth to observe any fast transients. Since none were seen, some other mechanism must be responsible for the erratic and unpredicted behavior that we have observed.

CONCLUSIONS

One explanation for the pendulum's anomalous behavior is that the defect structures involving pinned dislocations of the LiF crystals store energy, and then release that energy in response to stress that the pendulum imposes on the crystals. This seems to explain the cases where negative damping occurred several minutes after the drive was turned off. This explanation does not seem unlikely since gamma irradiated LiF is known to exhibit thermoluminescence. Samples of LiF bombarded with radiation can be placed in an oven and heated until they give off photons [4]. In the present case, it is postulated that the pendulum provides periodic low-level stress that eventually triggers the release of energy stored in the defect structures of the LiF crystals. The specific mechanisms whereby triggering occurs is not presently known. An attempt will be made in future experiments to understand the postulated defect dynamics.

REFERENCES

[1] E. Skudrzyk, Simple and Complex Vibratory Systems, Penn. State Univ. Press, Univ. Park, 106 (1968).

[2] R. Peters, "Symmetric Differential Capacitance Transducer. . ." U. S. Patent # 5,461,319 (1995).

[3] D. R. Frankl and T. A. read, *Phys. Rev.* 89 663 (1953).

[4] N. Tsoulfanidis, Measurement and Detection of Radiation, Hemisphere, Washington D.C., 531 (1983).

Surface Morphology of CdZnTe Crystals Grown by Physical Vapor Transport

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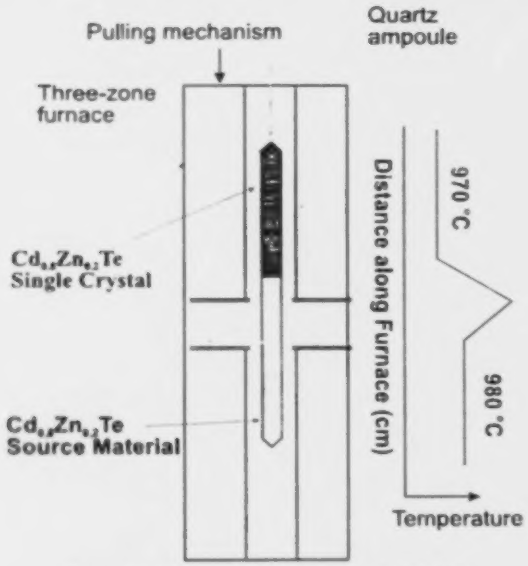
Cadmium zinc telluride single crystals were grown by physical vapor transport method with a 970 °C growth temperature and a 8 mm/day growth rate. Atomic force microscopy was employed to reveal the surface morphology of crystal along growth direction. The crystal revealed smooth surfaces, in sub-nano-meter range, and lack of structural defect and second phase features along growth direction indicating that its overall high quality in terms of defect and chemical homogeneity. Some precipitates have been observed at the beginning of crystal growth, and they might induced from the initial unstable growth conditions by higher Cd vapor pressure.

INTRODUCTION

Cadmium zinc telluride (CdZnTe) was first developed as a substrate material for epitaxial growth of HgCdTe film, which is infrared detector material, due to its lattice match. In the past few years, CdZnTe has also been investigated extensively for its potential usage as radiation detector operated at room and elevated temperature (Egarievwe, Chen, Burger, James, Lisse, 1996; Chen, Shi, Morgan, Collins, Burger, 1997). Commercially available bulk CdZnTe crystals are usually grew by Bridgman or high pressure Bidgman (growth from melt phase) (Triboulet, Neu and Fotouhi, 1983; Bruder, Schwartz, Schmitt, Maier and Möller, 1990; Cheuvart, El-Hanani, Schneider and Triboulet, 1990) which often induced structure defect (strain, stress) and deviation from stoichiometry due to the high growth temperature and higher partial pressure of Cd compared to Zn and Te. Improved growth conditions with lower growth temperature to limit defect formation and composition variation may be achieved by employing physical vapor transport method. Physical vapor transport (PVT) growth method is accomplished by first vaporization of material, and then re-solidification back to solid in a single crystalline form. The growth temperature employed by PVT method is lower than the melting temperature of the material. Therefore the chemical variation and defect formation on the growth interface and post-growth cooling is expected to be lower than Bridgman method. Atomic force microscopy is a real-time imaging technique that can produce topographic images of a surface with atomic resolution in three-dimension. The information that derives form AFM image can be correlated to material processing conditions. In CdZnTe system, defect formation and stoichiometry variation may be present as precipitation or inclusion. A typical example for CdZnTe system is the cleavage surface exhibiting inhomogeneities in the form of Te-rich inclusions. These Te-rich inclusions originate from the higher vapor pressure of Cd during crystal growth leading to a Te-rich composition in the final stage of crystal growth. These inclusions has been observed by atomic force microscopy (AFM) to be in the order of nm size depending on various growth conditions (Palosz, George, Collins, Chen, Zhang, Hu and Burger, 1996). In this study, PVT crystal growth method was employed to grow high quality, in terms of purity and stoichiometry, $Cd_{0.8}Zn_{0.2}Te$ single crystal. Atomic force microscopy was also employed to reveal the surface morphology of as-grown crystals and its correlation with crystal growth conditions.

EXPERIMENTAL

High purity quartz tubing was used as ampoules for material processing and crystal growth. The ampoules were pre-cleaned with aqua regia and rinsed with distilled water. The ampoules were then outgassed under 10^{-7} Torr vacuum at 1000 °C. The CdTe and ZnTe source materials were purchased from Alfa, Co. with 5N (99.999%) purity. The ternary compound, $Cd_{0.8}Zn_{0.2}Te$ was synthesized from stoichiometric amount of CdTe and ZnTe at 1000 °C for 2 weeks. The ternary compound was then ground into powder and loaded into crystal growth ampoule and sealed under 10^{-7} Torr vacuum. The crystal growth process was performed in a three-zone furnace and the temperature gradient were controlled by three separate temperature controller. Figure 1. shows the configuration of crystal growth apparatus employed in this study. The left side of Figure 1 shows the configuration of the crystal growth system, and the right side shows the temperature profile inside the growth furnace. The growth temperature was 970 °C with a temperature difference of 10 °C than the temperature of source material. The crystal growth

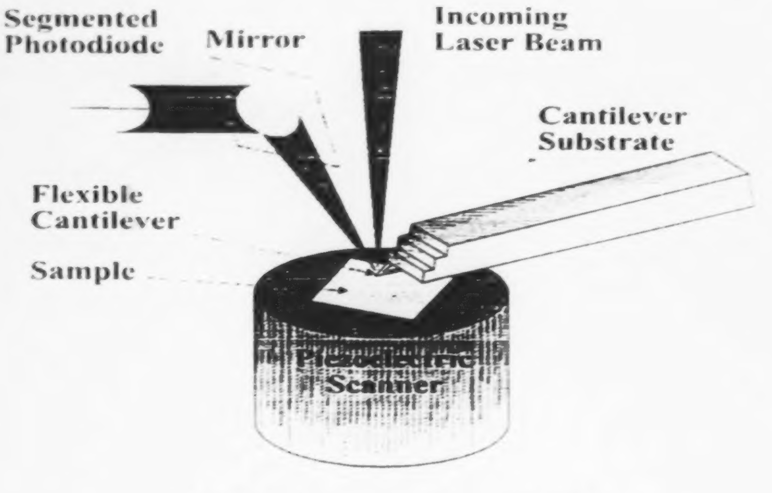

Pulling mechanism
Quartz ampoule
Three-zone furnace
Cd0.8Zn0.2Te Single Crystal
Cd0.8Zn0.2Te Source Material
Distance along Furnace (cm)
970 °C
980 °C
Temperature

Physical Vapor Transport (PVT)

Figure 1. Experimental Arrangement of PVT Crystal Growth System.

ampoule was hang in a fixed position while the furnace was traveling upward at a speed of 8 mm/day (crystal growth rate).

Atomic force microscopy (AFM) was employed to reveal the surface morphology of wafers. The AFM is a Digital Instruments Nanoscope III consisted of a piezoelectric scanner with an effective scan range between 0.5 - 13 µm and a silicon nitride cantilever made of silicon nitride. The samples were imaged immediately after cleavage to avoid any contamination and reaction from ambient. The force constant of the cantilever was 0.12 N/m, and there were no apparent tip-induced deformation occurred on the scanning surfaces. CdZnTe is very hydrophobic since the effects of humidity on AFM image were not observed although the humidity level was typically above 50%. Figure 2. shows the schematic presentation of AFM.



Atomic Force Microscope (AFM)

Figure 2. Experimental Arrangement of Atomic Force Microscopy.

RESULTS AND DISCUSSION

A single crystal of $Cd_{0.8}Zn_{0.2}Te$ was successfully grown and was 3 cm in length with 1.2 cm in diameter. The as-grown crystal was then cut into three sections along growth direction which are at the beginning of growth, middle of growth and

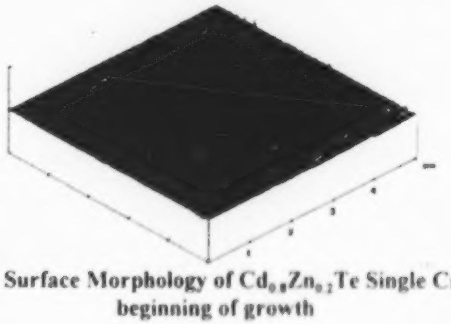


Figure 3. The Surface Morphology of $Cd_{0.8}Zn_{0.2}Te$ Single Crystal at the beginning of growth

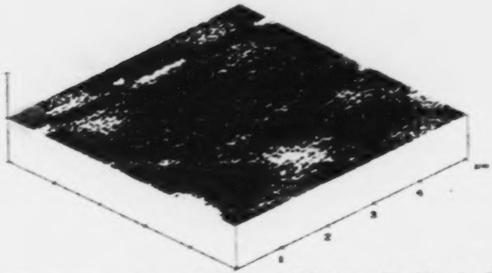


Figure 4. The Surface Morphology of $Cd_{0.8}Zn_{0.2}Te$ Single Crystal at the Middle of Growth

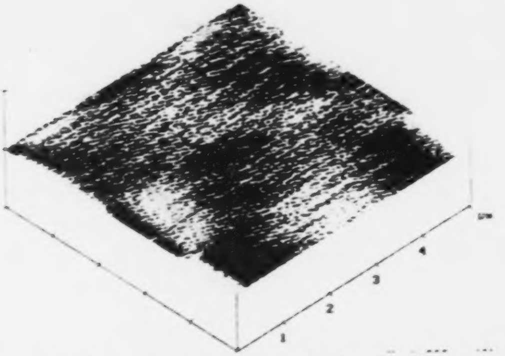


Figure 5. The Surface Morphology of $Cd_{0.8}Zn_{0.2}Te$ Crystal at the End of Growth Process.

end of the growth. For each sample, AFM images were taken on different areas, and only the typical image is shown. The Z range of all AFM images is 30 nm. Figure 3 shows the surface morphology of crystal grew at the beginning stage of growth in 5 × 5 μm area. The surface roughness is 0.3 nm and some precipitates have been observed as small white features on the right edge of Figure 3 with size ranging from nm to µm and 1 - 4 nm in height. Figure 4 and 5 show the surface morphology of $Cd_{0.8}Zn_{0.2}Te$ crystal at the middle and end of growth in 5 × 5 μm area, and the surface roughness are 0.032 and 0.044 nm respectively. No precipitates have been observed on this magnification scale. Similar studies have been performed on CdZnTe crystals grew by seeded physical vapor transport (SPVT) method under various Cd over pressures (Palosz, George, Collins, Chen, Zhang, Hu and Burger, 1996). Good compositional uniformity was achived as indicated by the 0.1 - 0.3 nm surface roughness from AFM images, and precipitates and void with sizes ranging from nano-meter to sub-micron have also been observed in their studies. They contributed this observation to the possible insufficient temperature gradient on the crystal growth interface which resulted in morphological instabilities. In our study, the surface roughness ranging from 0.03 - 0.3 nm and no present of void indicate a good crystal quality in terms structure defect and compositional homogeneity. The precipitates observed in Figure 1 may be contributed to the high vapor pressure of Cd compared to Zn and Te vapor pressures at the beginning stage of crystal growth. This phenomenon has been observed in the studies by Palosz et al. that large size precipitates (> 100 nm) were observed in crystals grew under excess Cd over pressure. After the first stage of crystal growth, the vapor pressures of Cd, Zn and Te might reached equilibrium and stoichiometric conditions in the vapor phase and on the crystal growth interface. Therefore no precipitate have been observed on crystal sections taken from the middle and the end stages of growth.

CONCLUSION

A $Cd_{0.8}Zn_{0.2}Te$ single crystal was successfully grown from physical vapor transport method using 970 °C and 8 mm/day as growth temperature and growth rate respectively. The surface morphology of crystal was revealed by atomic force microscopy along the growth direction. Some precipitates were observed in the crystal during the first stage of growth, and might be caused by the higher Cd vapor pressure. Equilibrium growth conditions have been achieved after the first stage of growth. The results show that the overall quality of the as-grown crystal is superior in terms of structural and compositional uniformity as indicated by the surface roughness and lack of precipitate and void.

ACKNOWLEDGMENTS

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REFERENCES

Bruder, M., Schwartz, H.-J., Schmitt, R., Maier, H. and Möller, M.-O., Journal of Crystal Growth, Vol. 101, pp. 266, 1990.

Cheuvart, P., El-Hanani, U., Schneider, D. and Triboulet R., Journal of Crystal Growth, Vol. 101, pp. 270, 1990.

Chen, K.-T., Shi, D., Morgan, S., Collins, W. E., Burger, A., Proceeding of the NASA University Research Centers, Technical Advances in Education, Aeronautics, Space, Astronomy, Earth and Environment, Vol. 1, pp. 157, 1997.

Egarievwe, S., Chen, K.-T., Burger, A., James, R. B., Lisse, C. M., Journal of X-ray Science and Technology, Vol. 6, in pressed, 1996.

Triboulet, R., Neu, H.-J. and Fotouhi, B., Journal of Crystal Growth, Vol. 65, pp. 262, 1983.

Palosz, W., George, M. A., Collins, W. E., Chen, K.-T., Zhang, Y., Hu, Z. and Burger A., submitted for publication, Journal of Crystal Growth, 1996.

Avalanche Segregation of Granular Media

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When a mixture of fine sand and crystalline sugar is poured against the closed edge of a quasi-two-dimensional Hele-Shaw cell (two vertical, transparent plates held a short distance apart) the mixture forms alternating stripes of pure sand and pure sugar. The stratification patterns that emerge due to the avalanches are studied with a CCD camera and the resulting digital images are Fourier transformed to produce the structure function of the banding pattern. The segregation can then be quantitatively studied as a function of plate separation and flow rate. We have designed a computer simulation of the process that reproduces the stratification effect based on properties of the granular media.

INTRODUCTION

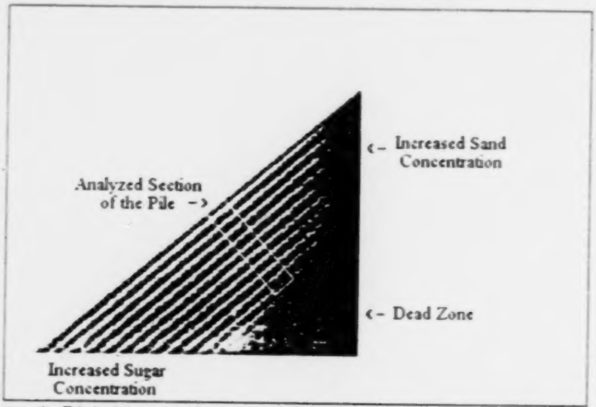
There has recently been growing interest in the dynamics of granular media such as sand or powders. An interesting property of mixtures of granular particles is their tendency to separate under conditions such as vertical shaking (Olsen and Rippie, 1964) and horizontal rotation (Oyama, 1939; Donald and Roseman, 1962; Bridgwater, 1976; Savage, 1993; Hill and Kakalios, 1994). Another variety of self segregating behavior has been observed by Makse and co-workers (1996), where a binary mixture of sand and sugar will form alternating layers when poured near the closed edge of a "quasi-two-dimensional" Hele-Shaw cell. A theoretical model for this effect has been proposed by deGennes and Boutreux (1996), extending the work of Bouchaud, Cates, Prakash, and Edwards (1994, 1995). Makse and co-workers (1997) have also reproduced the stratification effect with a numerical, computer simulation based on local height differences between rectangular particles. Current models describing avalanche segregation are explicitly for two-dimensional sand piles. The experimental studies are extended to three dimensions by systematically varying the plate width of the Hele-Shaw cell. The segregation process is also studied as a function of the flow rate of arriving particles. Furthermore, a computer simulation based on physical properties of particles has been implemented to reproduce the stratification effect.

EXPERIMENTAL TECHNIQUES

The Hele-Shaw cell (Hele-Shaw, 1898) consists of two vertical Plexiglas sheets 20 cm high and 30 cm long, mounted parallel to each other onto a Plexiglas base. One of the vertical sheets is bolted to the base. The distance between the vertical sheets is controlled by a 20 cm long strip-like spacer that closes one edge of the cell and two small block spacers at the opposite edge. By bolting the vertical plates together with various sized spacers, the plate separation is varied from 3 mm to 24 mm. A 50/50 mixture by mass of sand and sugar is poured near the closed edge of this cell, using a titration bulb with a rotating stopcock to control flow rate. The sand has been dyed blue/black for contrast in the photos without affecting the segregation process. Digital photos of experimental runs are taken with a monochrome CCD camera (Cohu 4910) in conjunction with a Scion LG-3 frame grabber and a Power Macintosh 7100/80. Data image analysis is performed with the public domain program Image from the NIH.

EXPERIMENTAL RESULTS

Figure 1 shows a digital image of the resulting sand pile formed by pouring a 50/50 sand/sugar mixture at 0.78 ± 0.08 gm/sec near the closed edge of the Hele-Shaw cell with a plate separation of 4 ± 0.5 mm. The first feature of note is the "dead-zone" of mixed sand and sugar at the lower right hand corner in figure 1. The size of this zone depends on both the plate separation and flow rate. In addition, the stratification is most apparent in the middle of the sand pile, with single species of sand and sugar collecting at the top and bottom of the pile respectively. Makse and co-workers (1996) also noted this "downhill segregation" with the larger, less dense sugar particles flowing further down the pile. Identical patterns have been observed when the mixture is poured in the center of the cell, indicating that segregation is not an edgewall effect.



<- Increased Sand Concentration
Analyzed Section of the Pile ->
<- Dead Zone
Increased Sugar Concentration

Figure 1: Digital image of the resulting sand pile formed by pouring a 50/50 sand/sugar mixture at 0.8 gm/sec near the closed, right edge of the Hele-Shaw cell (not shown) with a plate separation of 4 mm.

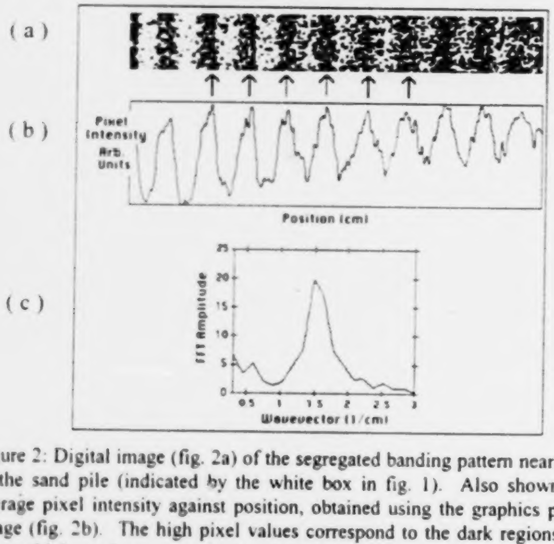


Figure 2: Digital image (fig. 2a) of the segregated banding pattern near the top of the sand pile (indicated by the white box in fig. 1). Also shown is the average pixel intensity against position, obtained using the graphics program Image (fig. 2b). The high pixel values correspond to the dark regions of the image (high sand concentration) and the low pixel values indicate regions of high sugar (white) concentration. This data is then Fourier transformed to yield the structure function of the banding pattern (fig. 2c).

Previous theories on avalanche segregation have not discussed the influence of plate separation on the segregation process. Therefore, a systematic study of varying vertical plate separation in the Hele-Shaw cell has been completed. Two trends are observed as the plate separation is increased at a constant flow rate: the degree of segregation decreases as does the spacing between segregated bands. These trends are quantified through measurement of the structure function. Figure 2a shows a digital image of the banding pattern near the top of the sand pile, as indicated by the white box in figure 1. The program Image can plot the pixel intensity against the horizontal position. Using white sugar and black sand lets us correlate the pixel intensity to the concentration of sand near the transparent vertical plate of the Hele-Shaw cell. The resulting pixel intensity graph (fig. 2b) is fast Fourier transformed to yield the structure function for the banding pattern (fig. 2c).

The location of the peak in the plot of FFT amplitude against wave vector in figure 2c gives the average wavelength of the segregated bands, while the amplitude of the peak provides a quantitative measure of the degree of segregation. Both the degree of segregation and the average wavelength of the bands decrease in a nonlinear manner as the plate separation is increased. The FFT amplitude as a function of plate width is accurately described by either an exponential or power law relationship (fig. 3a and b).

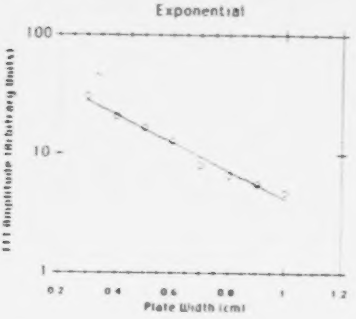


Figure 3a: Log-linear plot of the peak amplitude in the structure function for the avalanche segregation banding pattern against plate separation of the Hele-Shaw cell for a mixture of sand and sugar. The solid line is a fit to the data with an exponential dependence on plate separation.

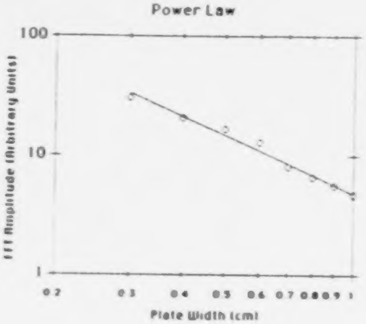


Figure 3b: A Log-log plot of the data in fig. 3a, indicating the equally good power law fit, where the power law exponent is ~ 1.6.

Ideally one would like to extend the horizontal scale for figures 3a and 3b in order to determine which functional form accurately describes the data. However, at smaller plate separations one can not force enough of the granular mixture into the Hele-Shaw cell at a uniform flow rate, while at larger plate separations the segregation effect disappears. Further experiments using alternate granular mixtures, for which the segregation effect persists at larger plate separations, are presently underway and should enable a determination of the functional form of the plate width dependence.

The width of the bands (wavelength) depends on the time interval between avalanches, which, in turn, depends on properties of the granular material (that determine the maximum angle of repose), the plate separation, and the flow rate. For a given plate separation, there is a maximum flow rate at which segregation occurs. For rates above this sharply defined maximum flow rate, a completely mixed sand pile results, due to a continuous flow regime.

A peculiar feature of the experiment that is unaccounted for in current theories is the phenomena of pairing between segregated bands of pure species at plate separations of 5 - 8 mm and flow rates of 0.75 - 1.00 g/s.

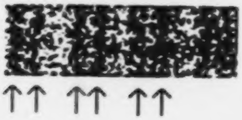


Figure 4: Example of pure species band pairing at a plate width of 6.5 mm and a flow rate of 0.832 g/s.

The observed behavior of the avalanching system described, indicates conditions at which segregation will occur. When plotting the factors governing avalanche segregation (flow rate and plate width) against each other, we find upper and lower nonlinear boundaries at which segregation ceases. This pseudo phase diagram involving plate width and flow rate quantifies the constraints needed in a system to produce segregation in disordered binary mixtures. Work is currently underway toward further understanding of the conditions governing avalanche segregation and completion of the previously mentioned phase diagram.

COMPUTER SIMULATION

Previous numerical simulations of granular media stratification have used a lattice grid of rectangular particles, where each particle must reside in a specific column. Movement of individual particles is determined by the height difference between adjacent columns, with the criteria dependent on the sizes of the moving particle and the stationary particle on which it rests. A physical simulation that incorporates material properties of the granular media, such as size, shape, momentum, and center coordinates has been developed in correlation with the experiment.

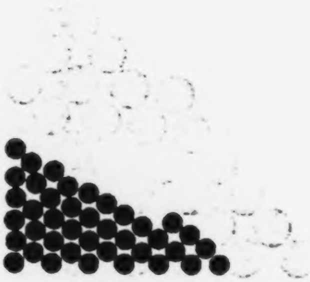


Figure 5a: Overlapping piles of pure species indicate a higher angle of repose for the larger particles, which is a necessary condition for stratification.

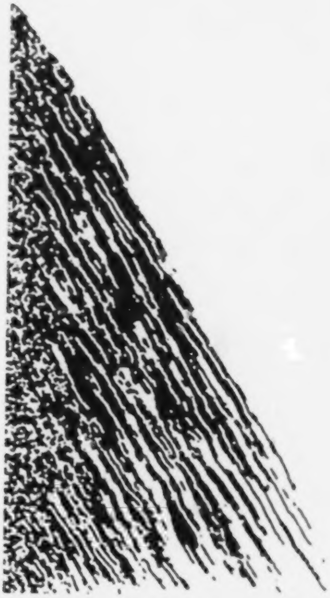


Figure 5b: Resulting stratification pattern from a simulation of 10,000 particles with a 50/50 volume ratio of the large, gray particles to the small black particles.

In the simulation, circular particles arrive near the closed edge of a two-dimensional, "virtual" Hele-Shaw cell with an initial momentum. Each particle bounces according to kinematic equations, losing a fixed percentage of momentum at each collision. When its momentum is below a critical value, its rolls until its momentum approaches zero. During the rolling phase, the particle loses a fixed percentage of its momentum each time it passes a stable position. (A stable position occurs when a particle's horizontal, center of mass coordinate lies between two, simultaneous contact points.) Preliminary results yield a stratification pattern dependent upon a larger angle of repose for the pure species of large particles (fig. 5a). This corresponds to the local height difference criteria that Makse and coworkers used in previous simulations (1997). However, the slope variation is caused by differing initial momentum values for large and small particles. Stratification results when larger particles move down the hill and build a layer up from the bottom, while smaller particles stack up at the top of the pile and eventually avalanche over the large particle band. While these initial results are encouraging, the simulations do not reproduce the sharp nearly periodic segregated layers as in figure 1. Work is continuing in order to refine the simulation algorithm to include the effects of local variations in the critical angle of repose of the pile and improve the match between simulations and experiment.

ACKNOWLEDGMENTS

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REFERENCES

Boutreux, T. and P.-G. deGennes, (1996) J. Phys. I France 6, 1295.

Bouchaud, J.-P., M. E. Cates, J. R. Prakash and S. F. Edwards, (1995) Phys. Rev. Lett. 74, 1982; *ibid*, (1994) J. Phys. I France 4, 1383.

Bridgwater, J. (1976) Powder Tech. 15, 215.

Hele-Shaw, H.S., (1898) Nature 58, 34.

Hill, K.M. and J. Kakalios, (1994) Phys. Rev. E 49, R3610; *ibid* (1995) 52, 4393.

Makse, H. A., S. Havlin, P. R. King and H. E. Stanley, (1996) Bull. A.P.S. 41, 384.

Makse, H. A., P. Cizeau and H. Eugene Stanley, (1997) to be published.

Olsen, James L. and Edward G. Rippie, (1964) J. Pharmaceutical Sci. 53, 147.

Oyama, Y., (1939) Bull. Inst. Phys. Chem. Res. (Tokyo), Rep. 5, 600.

Roseman, B. and M. B. Donald, (1962) British Chem. Eng. 7, 823.

Stuart B. Savage, in *Disorder and Granular Media*, edited by D. Bideau and A. Hansen (1993) North-Holland, Amsterdam, p.255.

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Magnetic Susceptibility (MS) and Visual Spectral Reflectance (VIS) Measurements: Paleoclimate Estimates for Pleistocene Europe

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Paleoclimate analysis from caves in Albania and Portugal, show correlation with known archaeological and climate data in these areas, using MS and VIS measurements. MS data allow determination of warm versus cold climates. The Dry–Wet index, a method combining MS and VIS data for the mineral goethite, can be used to determine variations in rainfall driving soil formation (pedogenesis). MS and VIS methods are applied here to samples from archaeological excavations at Fontéchevade and La Chaise caves, France, and allow estimates of climate during the time of the Neanderthals. Paleoclimate variations are useful in understanding site evolution by correlating MS from samples to the excavations where macro- and micro-faunal data are available. Paleoclimatic sequences are preserved in caves, sheltered from weathering effects associated with exposure. These effects produce, during times of cooler climate, soils outside the cave that have lower MS magnitudes than those produced during warmer climates. Soils, eroded and redeposited in caves undergo limited post–depositional pedogenesis and biological disturbance. Paleoclimatic estimates fro such samples can then be made for all archaeological levels.

BACKGROUND

Fontéchevade Cave is located outside the village of Fontéchevade, in the Charente district of SW France (fig. 1). Two areas are currently being excavated: the main excavation (main coupe), located toward the front of the cave and a secondary "sondage" or test excavation located well in the back of the cave. Both areas have been excavated previously by French workers and are now being re-excavated by a team of French and American workers led by Prof. André Debénath at the University of Perpignan in France and by Dr. Harold Dibble and Dr. Phil Chase at the University of Pennsylvania.

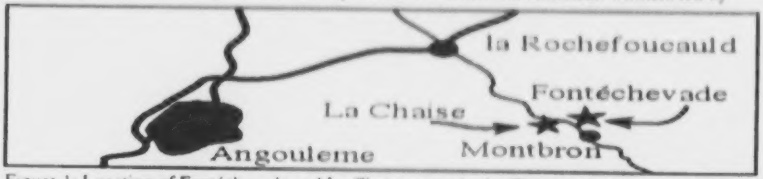

Figure 1: Location of Fontéchevade and La Chaise caves in the Charente district of SW France (not to scale). Fontéchevade and La Chaise caves are about 5 kilometers apart.

Located just a few kilometers from Fontéchevade Cave is the La Chaise Cave excavation (fig. 1). At both Fontéchevade and La Chaise, the caves evolved along a N–S trending system of fractures in a Jurassic limestone that is exposed in the area. La Chaise Cave consists of several rooms including the one, Bourgeois– Delaunay, for which data are reported here.

PREVIOUS WORK

There are many uses of magnetic geophysical data. These include the commonly known methods like magnetic prospecting where magnetometers are used to locate buried objects in environmental exploration and in archaeology as well as locating other unusual zones in the subsurface, such as geological anomalies including faults and other features. Magnetic surveys have been used to locate buried cultural features since the 1950's, but only by a few individuals (Martin et. al., 1991). The recognition and measurement of unusual magnetic anomalies in the subsurface, caused by changes in the concentration, orientation and type of iron oxides, mainly maghemite and magnetite in the soil, is the key to locating buried archaeological sites and features. Other magnetic anomalies are often found associated with storage pits, due to higher humus content, or buried, high–iron–content objects and hearths (Weymouth, 1986).

In archaeology, research in archaeomagnetism is also important, where Earth's magnetic field signature, acquired by objects such as hearths built by ancient peoples, can be used as an important relative dating tool (Ellwood, 1971; Wynn, 1986). Archaeomagnetic samples come mainly from hearths, kilns or associated sediments, but they can also include those materials that accumulated at the site during long periods of slow sediment deposition.

Magnetic susceptibility (MS) is another, but very different type of magnetic measurement. Simply stated, MS is a measure of how susceptible a material is to becoming magnetized when placed in a small magnetic field. All materials exhibit MS, but many iron–containing minerals are very easily magnetized and therefore show a strong MS signature. Quartz or calcite, on the other hand, very common minerals in sediments, show an MS response only when measured using the most sensitive instruments. MS measurements of loess and other sediments have been used recently in paleoclimate studies and as a proxy for the much slower, costly and time–intensive oxygen isotope ($\delta^{18}O$) measurements that are most often used in the analysis of deep–sea sediments (Imbrie et.al, 1984). The alteration of magnetic minerals that occurs with a changing climate allows MS to be effective as a proxy. These changes come about primarily through the process of pedogenesis (soil formation). Recently, MS measurements have been employed in the study of archaeological materials taken from caves in an effort to characterize ancient climates (Ellwood et al., 1997). This work is based on the premise that during pedogenesis, magnetic minerals such as maghemite are formed. When climate is warm, more maghemite is formed than when climate is cold. The soil formed outside of caves is washed into caves, thus filling these caves over time with sediment containing varying amounts of maghemite, depending on the climate at the time of deposition. Living in these caves were ancient people, so that the material artifacts they left behind are buried by the sediments accumulating in the cave. By analyzing the MS of sediments at different levels in the cave, the paleoclimate can be reconstructed for the time during which people were living there. In turn, the effect of climate on these ancient peoples can be studied.

It has also been shown that MS variations can be used to correlate between excavations (Ellwood et al., 1994; 1995; 1997). This is important to archaeologists because they have no easy way of correlating archaeological levels and because the sediment layers containing artifacts are often difficult to interpret. MS profiles show trends and magnitude variations (discussed below) that allow correlation when the trends and magnitudes are similar and the ages of excavations overlap. This report presents preliminary results from the Fontéchevade Cave excavations in the Charente district of SW France. Also included here are MS results from an additional excavation performed several years ago in the cave of La Chaise by Prof. Debénath.

Spectral reflectance (VIS) measurements in the visible light range have been used for the purpose of characterizing the iron mineralogy in sediments and have been shown to be very useful in archaeological studies (Ellwood, et al., 1995). This early work helped delineate paleosols within studied sections as well as helping with intra–site correlation.

METHODS

Sediment samples were collected in 8cc plastic sample boxes along continuous vertical profiles at each site studied. Continuous samples are used to reduce the chance of omission of a stratum from the data set. Each sample was given a sequential number in the profile set and the depth to the sample location was measured. This was accomplished using an electronic surveying device and a grid laid out with an arbitrary zero from which to gather the vertical, horizontal and lateral position of the top and bottom sample in each profile. Individual sample position was then calculated by extrapolation.

MS was determined using a balanced induction coil instrument commonly called a susceptibility bridge. In the susceptibility bridge each sample is exposed to a small magnetic field and a digital readout is recorded. This process is repeated 3 times, the mass of each sample is measured and then these data are fed into a computer and the MS calculated relative to a set of standards. (The bridge at UTA is calibrated to results from the National Bureau of Standards [Schwartzendruber, 1992]). The resulting MS data are then used to estimate the temperature (warm or cold climate) at the time of deposition, higher MS values indicate warmer climate while lower MS means colder climate.

VIS data were determined using the Perkin–Elmer Lambda 6 Spectrophotometer at. This process used a powdered sample, mixed to a thin slurry with deionized water and spread evenly on a standard glass microscope slide. After allowing to dry thoroughly, it was analyzed in the spectrophotometer. The first derivative of the resulting spectral peak at 435nm wavelength was used to estimate the percentage of goethite in each sample. A dry/wet (DW) index was developed for the normalized MS and VIS data sets from the expression:

$$\text{DW Index} = (\text{Norm MS})/(\text{Norm VIS}). \qquad (1)$$

RESULTS AND DISCUSSION

At Fontéchevade Cave the main coupe and sondage are stratigraphically the same at approximately 2m below the main datum. While the MS data trends at this point are similar between the two profiles, the point of overlap was not chosen based on this correlation but on the stratigraphic similarity. Figure 2 shows the profile of the two data sets with the overlapping points. The similarity between the two is evident at depths of 2m and greater. Given the horizontal separation of the two profiles, ~14m, and the high agreement between the MS data

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sets, a strong correlation can be confirmed.

MS data for Fontéchevade Cave indicate that the deposition started during glacial times (low MS magnitudes) while increasing MS values at the site indicate that climate was warming as time progressed. Within the major cycle (general trend) indicated in the data set there are many more subtle cycles that allow for correlation to other sites as well as estimates of short–term climatic variations. These cycles indicate brief periods of warming and cooling that quickly dissipate.

Three areas were sampled at La Chaise Cave and these are located within 15m of each other. Stratigraphically LC–1 and LC–2 are similar at >1.5m depth (fig. 3). As with Fontéchevade Cave, the correlation of the MS data between units is very good although the point of overlap at

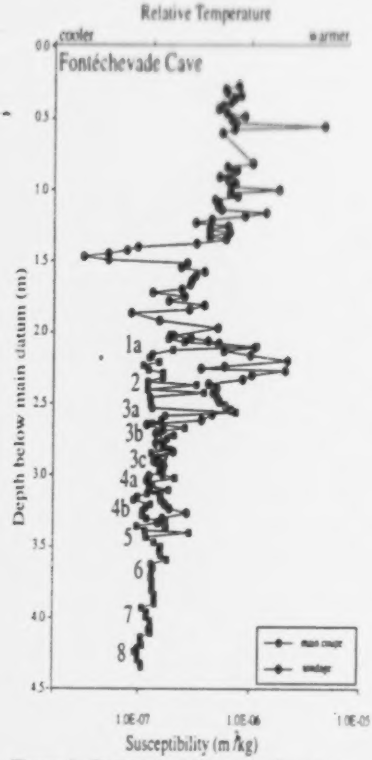

Figure 2: Composite MS profile from two excavation units within Fontéchevade Cave. There is about 14 meters separation between the main coupe and the sondage. The archaeological levels shown are for the main coupe.

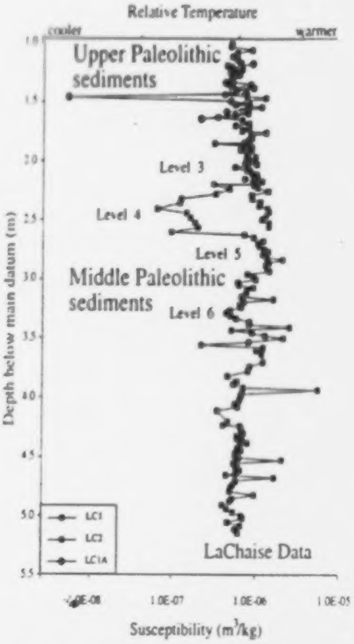

Figure 3: A composite MS profile from three excavation units, LC–1, LC–1A, LC–2, within La Chaise Cave. The single low MS value near 1.5 meters depth represents a limestone layer and is an indicator of an unconformity or missing sediments in the record. Sediments below are Middle Paleolithic while the sediments above are much younger Upper Paleolithic. The archaeological levels from LC–2 are given.

La Chaise Cave was chosen based on the MS data and not on the stratigraphy. Figure 3 shows the MS data for two areas, LC–1 and LC–2. There is a set of anomalous MS values associated with samples that were collected from loose soils filling voids between limestone blocks that fell as a single break–down event. This zone is represented as archaeological Level 4 and when the data from this level are removed, a clear correlation between the two profiles is apparent. Also plotted in Figure 3 is an additional profile from the back of the cave, LC-1A. Combining multiple profiles in this way results in a single composite profile that represents all the MS variations recovered from within the cave. These data can then be interpreted in terms of climatic variations or be used to correlate to other archaeological sites in the area.

At Fontéchevade Cave the composite MS data show a general warming trend in overall climate with times of greatest warmth evident in the shallowest sediments. There are several short–term climate variations within the overall warming trend and one period that is indicative of much colder climate (fig. 2). While the large–scale climate trend can be attributed to a Milankovitch climate cycle, the minor fluctuations may be the result of local short–term climate anomalies or they may be Neo–glacial cycles.

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The La Chaise site has MS data showing the final stages of a warming trend giving way to the beginning of a cooling trend (fig. 3). This change marks the beginning of the next glacial cycle and has been dated to ca. 120,000 years (Blackwell et al., 1983). Smaller fluctuations are again present representing minor changes in the overall climate. These minor changes have been used to correlate between the Fontéchevade and La Chaise composite profiles (fig. 4). Note the excellent agreement between the lower portions of the La Chaise MS data set and the upper portions of the Fontéchevade data set. While magnitudes and trends are similar, in particular there are three short–term climate peaks that are represented in both composites. The time separating these peaks, as well as the relative magnitudes are essentially identical between the two caves. The composite profile in Figure 4 is the result of inter–site correlation.

Examination of the MS composite profile for Fontéchevade and La Chaise caves (fig. 4) shows a cold beginning (glacial time) with warming through most of the sequence. Then late in the history represented in these sediments, climate reached a maximum (interglacial time) and began to cool once again. This long–term trend is punctuated with 3 very short–term warming events as well as one longer, but short–term very cold event that may have been similar in magnitude to the Younger Dryas, Neo–glacial cycle, ca. 12,500 to 11,500 B.P. (O'Brien et al. 1995).

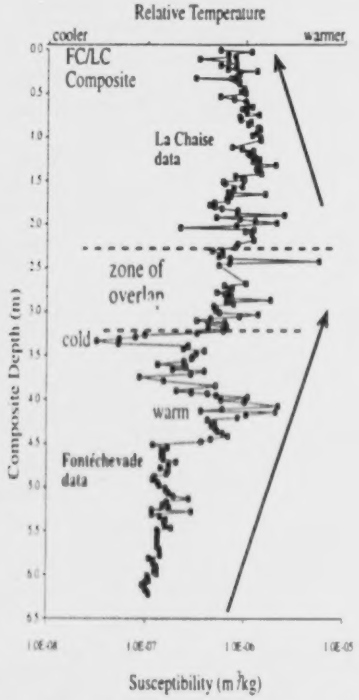

Figure 4: Composite MS profile for Fontéchevade and La Chaise caves with interpretations of warm/cool climatic conditions. The zone of overlap represents the area of the correlation between the two sites.

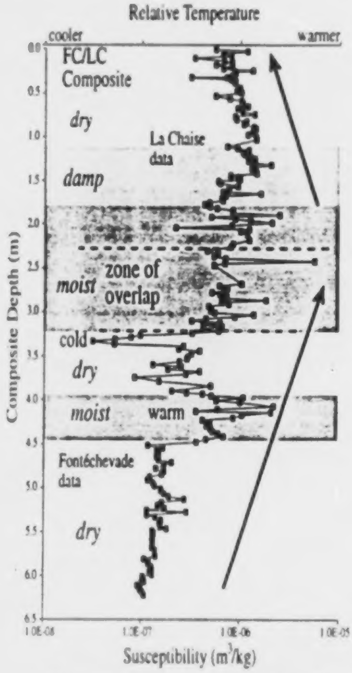

Figure 5: The composite MS profile for Fontéchevade and La Chaise caves (fig. 4) with the DW index data included indicating wet/dry climatic conditions. Overall wet/dry is shown in shaded bars is in agreement with the general trends seen in figure 4.

Using the VIS data for Fontéchevade and La Chaise caves to determine the D/W index, wet versus dry climatic periods were identified. These periods, in conjunction with the MS data give an estimate of total climate. Most of the sediment recovered from the cold climate represented at Fontéchevade Cave indicates relatively dry times. As the interglacial was approached, however (upper part of Fontéchevade and into La Chaise sediments), climate became more moist. Then, as climate once again began to cool, drier conditions reappeared (fig. 5).

CONCLUSIONS

Research from Upper Paleolithic caves elsewhere in Europe has demonstrated that MS data can yield estimates of paleoclimate and can be used to correlate between archaeological excavations if the excavations overlap in time. These earlier studies demonstrate that higher MS values indicate times of warmer climate, while lower MS magnitudes represent times of cooler climate.

Research from the middle Paleolithic caves at Fontéchevade and La Chaise in the Charente district of SW France demonstrates that MS data allow both intra– and inter–site correlation of these caves. Using this result it was then possible to develop a composite profile, using MS data, that covers the time of deposition represented by sediments deposited in the cave. This composite profile proxies for the climate in the region at the time these sediments were deposited. A preliminary paleoclimate curve for the middle Paleolithic is presented and represents deposition starting during a glacial period, extending into interglacial time, and finally beginning to return to glacial climates.

It is clear from these results that use of these methods at multiple sites can provide links to otherwise seemingly unrelated sites. This is useful in gathering the broad spectrum picture of the region and the associated climate. The sites at Fontéchevade and La Chaise, while in close proximity to each other, show little archaeological evidence to link them chronologically. Use of MS shows that the two sites to have an overlapping history. DW index data, developed from VIS measurements in these caves show that moisture changed very slightly during deposition of these sediments, with higher moisture present during warmer climates.

Caves can provide ideal environments for sediment deposition that are unaffected by in–situ pedogenesis, and from such sediments paleoclimatic trends can be extracted. Because paleoclimate analyses of this type are performed on the entire data set from which archaeological materials are extracted, we believe that MS-VIS data provide a unique opportunity to evaluate the effect of climate on the behavior of ancient peoples.

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REFERENCES

Blackwell, Bonnie, Schwarcz, H.P. and Debénath, A., 1983. *Absolute Dating of Hominids and Paleolithic artifacts from the cave of La Chaise–de–Vouthon (Charente), France.* Journal of Archaeological Science, Vol. 10, p.493–513.

Debénath, André, 1974, *Recherches sur les Terrains Quaternaires Charentais et les Industries qui leur sont Associées.* D.Sc. thése, Université de Bordeaux 1, Talence.

Ellwood, Brooks B., 1971. *An Archeomagnetic Measurement of the Age and Sedimentation Rate of Climax Cave Sediments, Southwest Ğeorgia*: American Journal of Science, Vol. 271, p.304–310.

Ellwood, B.B., Peter, D.E., Balsam, W., and Schieber, J., 1995. *Magnetic and Geochemical Variations as Indicators of Paleoclimate and Archaeological Site Evolution: Examples from 41TR68, Fort Worth, Texas,* Journal of Archaeological Science, Vol. 22, p.409–415.

Ellwood, B.B., Petruso, K.M., Harrold, F.B., and Schuldenrein, J., 1997. *High–Resolution Paleoclimatic Trends for the Holocene Identified Using Magnetic Susceptibility Data from Archaeological Excavations in Caves,* Journal of Archaeological Sciences, in press.

Ellwood, Brooks B., Zilhão, J., Harrold, F.B., Balsam, W. and Long, G., 1996b. *Paleoclimate (Temperature and Moisture) and Identification of the Last Glacial Maximum in the upper Paleolithic of Portugal Using Magnetic Susceptibility (MS) and Spectral Reflectance (VIS) Measurements of Caldeirão Cave Sediments*: In press.

Imbrie, J., et al., 1984. *The orbital theory of Pleistocene climate: Support from a revised chronology of the marine $\delta^{18}O$ record.* In: Milankovitch and Climate. A Berger et al. (Eds.) D. Reidel, Dordrecht, Netherlands, p. 269-305.

Martin, William A., Bruseth, J.E. and Huggins, R.J., 1991. *Assessing Feature Function and Spatial Patterning of Artifacts with Geophysical Remote–sensing Data*: American Antiquity, Vol. 56, No. 4, p.701–720.

O'Brien, S.R., Mayewski, P.A., Meeker, L.D., Meese, D.A., Twickler, M.S., and Whitlow, S.I. 1995. *Complexity of Holocene climate as reconstructed from a Greenland ice core,* Science, Vol. 270, 1962–1964.

Swartzendruber, L. J., 1992. *Properties, Units and Constants in Magnetism,* Journal of Magnetic Materials, Vol. 100, 573 – 575.

Weymouth, John W., 1986. *Archaeological site surveying program at the University of Nebraska*: Geophysics, Vol. .51, No. 3, p.538–552

Wynn, Jeffrey C., 1986. *Archaeological Prospection: An Introduction to the Special Issue*: Geophysics, Vol. .51. No. 3, p.533–537.

Diamond Film Coatings on Titanium Alloy Using Chemical Vapor Deposition

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Diamond film coatings have been grown on a Titanium (Ti) alloy using a microwave plasma chemical vapor deposition (MPCVD) technique. Such films were found to consistently detach from the substrate during the cooling period. This detachment is attributed to the large difference in thermal expansion coefficient between the diamond film and the metal substrate. In an effort to minimize these thermal effects, diamond films were grown on Ti-alloy at relatively low substrate temperatures. Two 10 mm diameter Ti-alloy disks were left in the MPCVD chamber for six hours with a 1% methane concentration. Temperatures across the face of these disks ranged from 700-750 °C for the first disk and from 650-700 °C for the second disk. Although film quality remained high, as determined from micro-Raman spectroscopy, the films still exhibited significant detachment. Further attempts to lower the temperature required an elevation to a 3% methane concentration. Diamond was grown on a third Ti-alloy disk at a temperature range of 600-675 °C. This sample exhibited better film adherence, but there was still significant detachment.

INTRODUCTION

Diamond has many properties that make it unique and useful in technology. It is the hardest material known to man, an electric insulator, and a thermal conductor (Martin, 1992). Diamond also has a low thermal expansion coefficient and from the infrared to the ultraviolet it is optically transparent (Ashfold et al., 1994). These qualities make growing diamond in laboratories advantageous to those in industry.

It has been possible to grow synthetic diamond since 1953. In recent years, however, diamond has been able to be grown as films at low pressures relatively cheaply. There are many uses for synthetic diamonds in the fields of optics and electronics (Field, 1991). Since the advent of low pressure diamond growth, synthetic diamonds have found uses as abrasives, coatings for cutting tools, as well as heat sinks (Ashfold et al., 1994).

An important area of research in diamond film growth is the study of growth on metals. A large problem that appears in this area is the ill-adhesion of the diamond to the metal. The large difference in thermal expansion coefficients causes residual stress at the film/sample interface. This stress can cause delamination of the film (Perry et al., 1993).

The method of diamond film growth used in this study was Microwave-Plasma-Chemical-Vapor-Deposition (MPCVD), and the gases used were hydrogen and methane. The film growth rate in this technique is a complicated function depending on pressure, temperature, methane concentration, and sample geometry. Ti-6Al-4V (Ti-alloy) was the metal used in this study. It is used in the aerospace industry and also in dental and medical implant applications (Perry et al., 1993). To prevent delamination, diamond was deposited on Ti-alloy at relatively low substrate temperatures.

EXPERIMENT

Diamond film was grown on three 10 mm diameter Ti-alloy samples. The samples were separately placed in the MPCVD system as shown in Figure 1. Deposition occurred at a pressure of 90 Torr, and each sample remained in the system for 6 hours. The samples were prepared for deposition by being polished with a polishing wheel and 1 micron alumina. The samples were then placed in a beaker with methanol and diamond powder and were agitated in an ultrasonic cleaner for 35 to 40 minutes to enhance diamond nucleation.

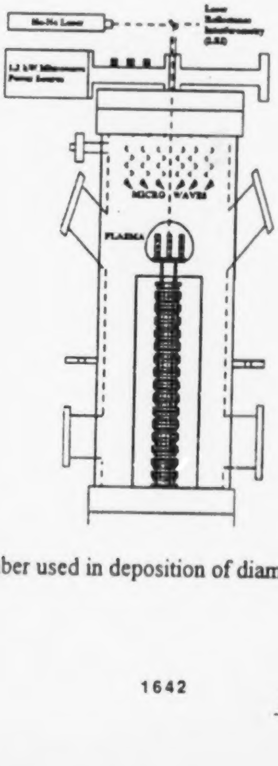

Figure 1: MPCVD chamber used in deposition of diamond films

The samples were placed in the MPCVD system and pumped down to a pressure of about 0.1 Torr. The sample was left in the chamber over night to stabilize. In the MPCVD system, microwaves from a 1.2 kW microwave power supply and hydrogen were used to form a plasma above the substrate. When the plasma appeared to be stable, the pressure and power were slowly raised until the appropriate values of each were achieved. The methane was then turned on and deposition began.

Each sample was watched closely during the 6 hours of diamond deposition, and the temperature was checked often. During the course of the 6 hours the temperature of each sample was seen to increase. It was also noted that although the plasma did cover the entire sample, the plasma sphere was leaning to one side of the sample. This may have been because the chamber is not symmetric. This plasma shift caused a non-uniform temperature across the substrate. The temperature on the side of the sample where the plasma was leaning was, at times, almost 100 degrees higher than the temperature in the middle of the substrate.

The differences in each run were in the temperature of diamond deposition and the methane concentration. The specific conditions for each of the three samples can be seen in Table 1. The temperatures reported are those that were measured in the middle of the substrate over the course of the 6 hour deposition period.

Table 1: Temperature, Power, and Methane Concentration used in deposition of alloy samples

	Temperature (°C)	Power (W)	Methane Concentration
Sample 1	700-750	605	1%
Sample 2	650-700	421	1%
Sample 3	600-675	430	3%

After 6 hours had elapsed, the methane was turned off. The sample was then left in the hydrogen plasma for about 5 minutes. After this the power was turned down slowly over 30 minutes in hopes that a slower temperature change would prevent the diamond film from separating from the Ti-alloy. When the plasma disappeared, the hydrogen and microwave power supply were turned off and the chamber was backfilled with argon.

After deposition, the diamond quality was tested using micro-Raman methods. The spectra was taken using the 514.5 nm line of an argon laser with an output power of around 100 mW. Because crystalline diamond has a sharp Raman peak at 1332 cm^{-1} it is easy to recognize (Knight and White, 1989). The spectra were taken for 60 seconds. The microscope used gave 100x magnification so many points on the sample could be examined.

As previously mentioned, a concern with Ti-alloy samples is that the diamond will not stay adhered to the sample. On Sample 1 diamond pieces were seen to pop off of the substrate as the power was being turned down. This delamination is typical and is shown in Figure 2. The dark spots in the figure are diamond deposits and the lighter spots are the Ti-alloy sample. Despite delamination, the micro-Raman results showed good diamond quality on Sample 1. In addition to the removed diamond pieces, the diamond remaining on the sample was not well adhered and could easily be removed using only finger pressure.

Sample 2 was tested at a lower temperature in an attempt to avoid delamination. The plasma was not uniform and the diamond completely came off on the side of the sample that was at a higher temperature. The diamond on the remaining side of the sample did stay adhered. It also had a high diamond quality as shown by micro-Raman spectroscopy.

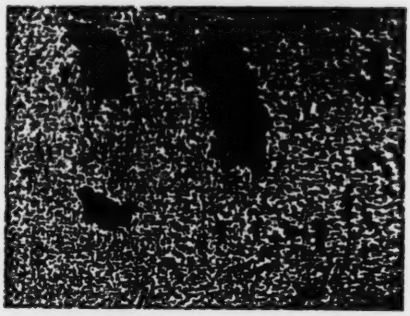

Figure 2: Photomicrograph of Ti-alloy surface after diamond deposition. Image width is 5mm.

Because the power used on Sample 2 was so low, a lower temperature at the same pressure would have been difficult to achieve. Instead, Sample 3 was put in the MPCVD chamber at a temperature close to that of Sample 2. It, however, had a higher methane concentration (3%). The visual results of Sample 3 were close to those of Sample 2 with total delamination on the high temperature side of the sample and diamond on the other parts. The micro-Raman spectra of Sample 3, however, did not show as high of a diamond quality as that found on the previous two samples. A typical micro-Raman graph is shown in Figure 3. The spike at 1332 cm^{-1} on the sloped background is the diamond peak. The broad peak at 1550 cm^{-1} is indicative of an amorphous diamond-like phase coexisting with the diamond crystal.

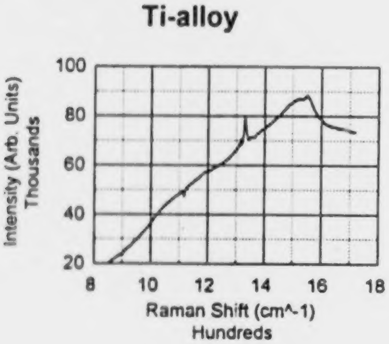

Figure 3: Raman spectrum of diamond coated Ti-alloy taken by 514.5 nm laser

CONCLUSIONS

The experiment resulted in fairly high quality diamond deposits on the Ti-alloy. Despite lower deposition temperatures the stress caused by the difference in thermal expansion coefficients of the diamond and the Ti-alloy was great enough that the diamond did not stay well adhered to the sample. The present MPCVD chamber does not enable a uniform temperature across the sample so complete diamond coverage and adhesion is not easily achieved. The temperature cannot easily be lowered because of the amount of power required to form a stable plasma. Perhaps a layer between the diamond and Ti-alloy is required. The substance making this layer should have a thermal coefficient closer to that of diamond than Ti-alloy has. Research in this area continues, and hopes are high that a method for adequately coating Ti-alloy will soon be found.

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REFERENCES

Ashfold, M. N. R., May, P. W., Rego, C. A., and Everitt, N. M., "Thin Film Diamond by Chemical Vapor Deposition Methods," *Chemical Society Reviews*, 21-30 (1994).

Field, J. E., "Natural Diamond: The Standard," in *Diamond and Diamond-Like Films and Coatings*, edited by R. E. Clausing, et al. (Plenum Press, New York, 1991) pp 17-35.

Knight, Diane S. and White, William B., "Characterization of diamond films by Raman Spectroscopy," *J. Mater. Res.*, Vol. 4, 385-93 (1989).

Martin, L. Robbin, "Diamond Film Growth: What is really happening?" *Am. Ceram. Soc. Bul.*, Vol. 71, 1419-23 (1992).

Perry, Scott S., Ager, Joel W. III, Somorjai, Gabor A., McClelland, Robert J., and Drory, Michael D., "Interface characterization of chemically vapor deposited diamond on titanium and Ti-6Al-4V," *J. Appl. Phys.*, Vol. 74, 7542-50 (1993).

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Purification and Crystal Growth of Lead Iodide

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Lead iodide source material has been purified using zone-refining process. The zone-refined ingot shows a darker region in the last-to-freeze zone compared to middle and first-to-freeze zone indicating the accumulation of impurities at the last-to-freeze region. A single crystal of lead iodide was grown by the Bridgman method using the middle region of zone-refined ingot as source material. The as-grown crystal shows a bright yellow color revealing the high purity and stoichiometry. Low temperature Photoluminescence technique has been employed to investigate the defect, composition and impurity distribution of as-grown crystal as well as regions along zone-refined ingot. The results shows that purest material can be obtained from the middle section of zone-refined ingot. The as-grown PbI_2 reveal a improved crystalline structure compared to the starting material.

INTRODUCTION

Lead Iodide, PbI_2, was first introduced in 1971 (Roth and Willing, 1971) as potential material as a radiation detector with high efficiency for gamma ray. The wide bandgap of PbI_2, 2.55 eV, along with its high resistivity, 10^8 - 10^9, promise the room temperature operation and low background noise. The high atomic number (Pb = 82, I = 53) and high density (6.2 g/cm3) of PbI_2 also provide a high stopping power for radiation. The structure of lead iodide consists of molecular layers of Pb-I-Pb where the Pb ions are octaherally coordinated (Palosz, 1983). The bonding between layers is of the type of weak van der Waals forces. The weak bonding makes PbI_2 easy to cleave between layers, and is also been categorized as layer compound semiconductor. Various polytypic phases exist in lead iodide solid solution and have been studied extensively (Palosz, 1983, Rao and Srivastava, 1978, Chaudhary and Trigunayat, 1983). It has been established that the high purity and stoichiometry is the 2H phase (Rao and Strivastava, 1978; Chand and Trigunayat, 1977) with a melting temperature of 408 °C. Among layer compound semiconductor, mercury iodide (HgI_2), has similar optical and electrical properties to lead iodide, and has been extensively for its use as room temperature radiation detector. Currently HgI_2 has been implanted in industry and commercial application. Because of the solid phase transition between the orthorhombic and tetragonal phases at 130 °C, detector grade HgI_2 can only be grown from vapor phase which limits the growth rate compared to PbI_2. The lack of any solid phase transition in PbI_2 solid solution up to its meting temperature allows single crystal of PbI_2 to be grow from melt phase (Bridgman method).

Impurities incorporated from source material during crystal growth is a common problem exists and as a consequent result of decreasing the structural, optical and electrical properties of as-grown crystals. Therefore the purification process employed to decrease the impurity concentration in source material is vital to grow high quality single crystal. Among all the purification process, the zone-refining process has been developed for purification of source materials since 1951 (Pfann, 1951). This process has become one of the important technique to produce large quantity of elemental and compound semiconductors. Zone-refining process has been successfully employed to purify HgI_2 recently (Chen, Salary, Burger, Soria, Antolak, James, 1996), and the results show that the impurities with distribution coefficient less than 1, $k < 1$ such as Ag, Cu, Cr, Fe, Mg, Ca, Zn and Al, were accumulated at one end of zone-refined ingot leaving the rest of the material with high purity. Therefore zone-refining process has been employed in

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this study to purify the PbI_2 source materials to decrease the impurity level for crystal growth. The crystal growth method used in this study is Bridgman method which is a melt growth method. The source materials were enclosed in a pre-cleaned, evacuated and sealed quartz ampoule and placed in a furnace. The materials were first completely melt at a temperature which higher than the melting temperature. Then the ampoule was subjected through a temperature gradient with a temperature lower than its melting temperature and the molten source materials solidified into single crystal. The material characterization technique employed in this study is low temperature Photoluminescence (PL). The results from this spectroscopic technique is to reveal information of quality (defect and impurity), stoichiometry and structure (vacancy, Interstitial) of as-grown crystal and zone-refining ingot. The objectives of this research are to purify the PbI_2 source materials, crystal growth by Bridgman method and investigation of effectness of zone-refining process and quality of as-grown crystal by low temperature Photoluminescence. The final results will be analyzed and correlations will be made to optimize the purification and crystal growth conditions.

EXPERIMENTAL

The PbI_2 source materials are purchased from Alfa, Co., with 4N (99.99%) purity. The ampoule was made from high purity quartz tubing and pre-cleaned by two steps. First the ampoule were soaked in a aqua regia solution (25 Nitric acid + 75 % Hydrochloric acid) and then rinsed with distilled water to clean possible contamination on the surfaces of ampoule. Second step was to baked out ampoule at 500 °C under vacuum (~ 10^{6} Torr) to drive out any residual gases inside quartz wall. A zone-refiner has been constructed and employed to purify the source materials. The heaters traveled from right to left with a speed of 8.5 cm/hour and a temperature of 500 °C. The heaters only melt part of the PbI_2 materials but all other materials along ampoule are still in solid form. After the heater reached the left end of the ampoule, they will traveled back to the right end of the ampoule with a much faster speed which did not melt materials again in reverse direction. Therefore for those impurities with distribution coefficient, k, less than 1, they were swept (in the molten zone) from right (first-to-freeze) to the left size (last-to-freeze) during each circle. The distribution coefficient is defined as k = (solubility in solid /solubility in liquid). The experimental arrangement of Bridgman crystal growth system and the as grown PbI_2 crystal are shown in Figure 1. The starting material for crystal growth was taken from the middle section of zone-refined ingot. These material was then loaded into growth ampoule and sealed under 10^{-6} Torr vacuum. The growth ampoule was then inserted in crystal growth furnace, shown in figure 1, at 420 °C temperature to melt the starting material. The furnace was then translated upward at a speed of 10 mm/day leading the growth ampoule through a temperature gradient which has a temperature zone lower than the melting temperature of PbI_2 (408 °C). Figure 2 show the schematic experimental arrangement for Photoluminescence (PL) measurement. The samples were cooled down to about 10K using an APD Cryogenics Inc. system equipped with a dual HC-4 MK1 helium compressors. An ILT 5500A air-cooled argon laser was employed as excitation source and the wavelength of the laser line is 514.5 nm. A cylindrical lens was used to focus the

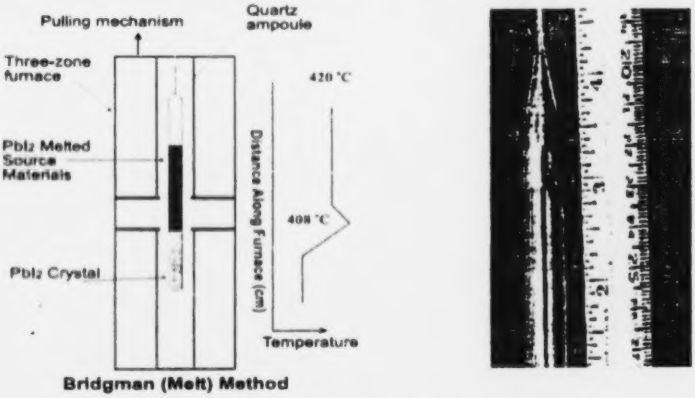

Figure 1. The Bridgman crystal growth system (left) and as-grown PbI_2 single crystal in ampoule.

beam so that the laser beam-illuminated area on the sample was about 1 mm wide. The emitted light passes through two lenses before enters a SPEX 1877 0.6 m Triplemate spectrometer. The detector was a liquid nitrogen cooled CCD detector with a working temperature of 160 K. After each measurement, the emission lines temperature of PbI_2 (408 °C). Figure 2 show the schematic experimental arrangement for Photoluminescence (PL) measurement. The samples were cooled down to about 10K using an APD Cryogenics Inc. system equipped with a dual HC-4 MK1 helium compressors. An ILT 5500A air-cooled argon laser was employed as excitation source and the wavelength of the laser line is 514.5 nm. A cylindrical lens was used to focus the beam so that the laser beam-illuminated area on the sample was about 1 mm wide. The emitted light passes through two lenses before enters a SPEX 1877 0.6 m Triplemate spectrometer. The detector was a liquid nitrogen cooled CCD detector with a working temperature of 160 K. After each measurement, the emission lines from a mercury lamp were used for calibration purposes. The photoluminescence spectra were recorded and analyzed by a personal computer using the SPEX DM3000 program mode.

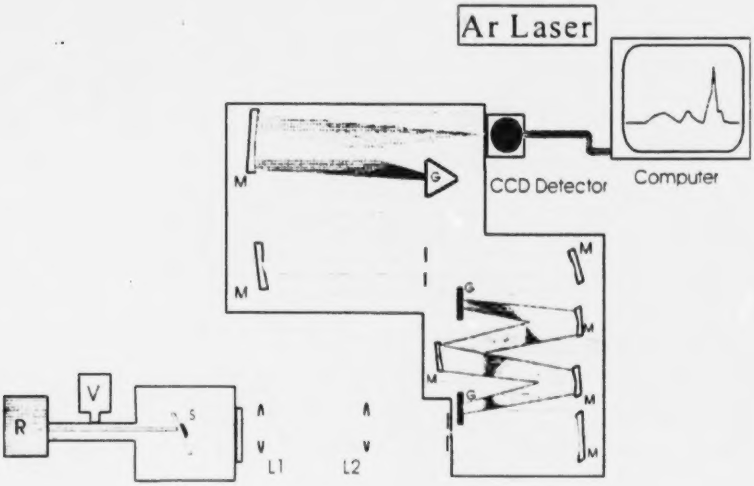

Figure 2 Experimental Apparatus of Low Temperature Photoluminescence

RESULTS AND DISCUSSION

The zone-refined ingot show a darkest color in the last-to-freeze zone and a slightly dark yellow color in the first-to-freeze zone. The material at middle of the zone-refined ingot reveal a bright yellow color. These results from visual inspection show that most of impurities with *k*⟨1 accumulated in the last-to-freeze region, and some other impurities with *k*⟩1 may accumulated in the first-to-freeze section by the reverse zone-refining effect leaving the purest material in the middle region. The as-grown crystal show a more bright and shiny yellow color compared to the starting material because of its better crystallinity. Figure 3 show the PL spectra of as-grown PbI_2 single crystal, first-to-freeze, middle and last-to-freeze sections along zone-refined ingot. The peaks in the region of 2.3 - 2.4 eV are the characteristic emissions of PbI_2, and can serve as a qualitative measurement of the quality of PbI_2 in terms of purity and crystallinity. The last-to-freeze material show no characteristic emission , while the materials from first-to-freeze and middle sections reveals the characteristic peaks centered around 2.36 eV with increasing PL intensity. These results indicates that the last-to-freeze section accumulated more impurity with

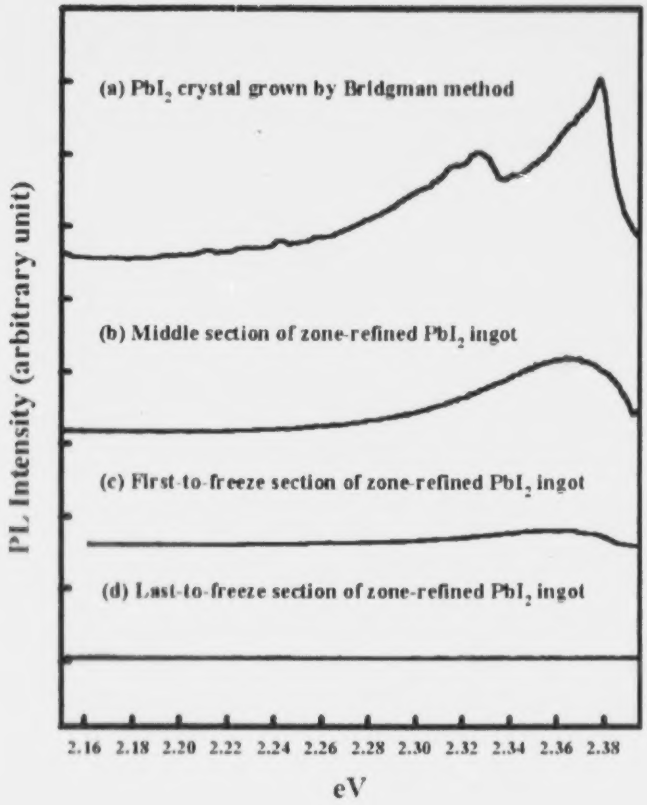

Figure 3. PL spectra of as-grown PbI$_2$ single crystal and materials from zone refined ingot

$k<1$ than other region along zone-refined ingot. Figure 3 also show that the intensity of the first-to-freeze material is much lower than the intensity of the middle material. This result indicate that the first-to-freeze region also contained some level of impurity ($k>1$) leaving the middle region to be the purest material. The well-resolved doublet peaks at 2.33 and 2.37 eV from as-grown crystal shows the superior crystallinity compared to the material from the middle region of zone-refined ingot which the PL spectrum can not resolve the doublet due to its polycrystalline structure. The results from PL measurements are in agreement with the results from visual inspection.

CONCLUSION

Zone-refining process has been applied to purify lead iodide starting material. Bright yellow high purity, compared to original material, PbI$_2$ material was obtained from zone-refined ingot for single crystal growth by Bridgman method. A single crystal of PbI$_2$ was successfully grown. The results from low temperature photoluminescence measurements revealed that the last-to-freeze zone did accumulated more impurities. The first-to-freeze zone also contained some other impurities leaving the material at the middle zone to be the purest along zone-refined ingot. The as-grown crystal also show a improved and superior crystalline structure compared to the purest material from zone-refining process

ACKNOWLEDGMENTS

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REFERENCES

Roth, S and Willing, R, Applied Physics Review, Vol. 18, pp 328, 1971
Palosz, B., Physics of Statistical Solid, Vol 80, pp. 11, 1983
Chaudhary, S. K., and Trigunayat, G. C., Journal of Crystal Growth, Vol 39, pp 398, 1983
Rao, M and Strivastava, O. N., Journal of Physics D: Applied Physics, Vol. 11, pp 919, 1978
Chand, M and Trigunayat, G. C., Journal of Crystal Growth, Vol 39, pp 299 (1977)
Pfann, W. G., Transaction, AIME, Vol 194, pp 747, 1951
Chen, K.-T., Salary, L., Burger, A., Soria, E., Antolak, A., James, R. B., Nuclear Instrument and Methods in Physics Research A, Vol 380, pp 53, 1996

Recalibration of the Wilson-Bappu Effect Using the Singlely Ionized Magnesium k and h Lines

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This study presents a new calibration of the Wilson-Bappu effect using the data from a survey of the the Mg II h and k lines (centered at about 280 nm) taken from the archives of the International Ultraviolet Explorer satellite. It was found that only well exposed spectra were allowed to observe the full base width of the Mg II h and k lines. An additional selection criterion is the elimination of spectra with missing or contaminated data bins. This study derives a calibration using a sample of approximately 70 stars. Absolute magnitudes are derived either from angular parallaxes greater than 0.040" or from their Ca II K line width measurements and application of the Wilson-Bappu effect.

BACKGROUND

This study incorporates the Wilson-Bappu effect for singlely ionized magnesium (Weiler and Oegerle, 1979; Mena-Werth, 1990). The Wilson-Bappu effect was first documented in 1957 using singlely ionzied calcium (Ca II). This effect relates the absolute magnitude of a star, M_V, with the corresponding width of the Ca II K line emission from the star's chromosphere (Wilson and Bappu, 1957). It was shown that the absolute magnitude of a star correlates linearly in response to the logarithm (base 10) of the full line base width of the Ca II K line . A similar approach has been developed with the chromospheric Mg II k and h lines. These lines are centered in the ultraviolet portion of the spectrum at 279.55 nanometers and 280.27 nanometers, respectively. The reasons for using the Mg k an h II lines include a greater abundance of the element as compared to calcium within most stars, their corresponding greater emission strength, and the availability of measuring devices for the lines Mg II k and h lines.

The data for the Mg II k and h lines comes from International Ultraviolet Explorer (IUE) satellite. This satellite was a joint American and European venture deployed by NASA in 1978 to measure the ultraviolet portion of the spectrum. The reason for its deployment is because most of the ultraviolet portion of the spectrum is cut off by the atmosphere. Thus, direct ground-based observations of stellar UV radiation is not possible. The IUE uses an 18-inch reflecting telescope that is used in conjunction with other equipment to detect ultraviolet radiation, which is in turn connected to a television camera (Heavens, 1991). The data is then sent and stored into archives at NASA's Goddard Space Flight Center, and this data can be accessed remotely as needed.

DATA

The data from the IUE was reported in a flux versus wavelength format. The emissions for the Mg II k and h line widths, at the base, were then measured using the standard IUE data reduction package at NASA's Goddard Space Flight Center. The working data for this study came in three stages. A graph of the region containing both the k and h lines was one stage and isolation of the k and h lines, reported separately, were the other two stages. The star identification and the line width were taken from this set-up. Other relevant information, such as apparent magnitude and spectral class, were then taken from the Bright Star Catalogue (BSC).

When working with the Wilson-Bappu effect, the width of the k and h lines is reported in a (km/s) format, which can be obtained by the following formula:

(delta wavelength/lab wavelength)=((width in km/s)/c), (1)

where the lab wavelength is the same as the centered wavelength reported previously, delta wavelengths are measured across the base of the emission for the k and h lines, and c is the speed of light (Bohm-Vitense, 1989).

The absolute magnitude of the corresponding star was then determined in one or more the the following ways: (1) by the trigonometric parallax as reported by the BSC, (2) by the trigonometric parallax as reported by the General Catalogue of Trigonometric Parallaxes (GCTSP) (van Altena, et al., 1991), (3) from Wilson, 1976 and the absolute magnitude values as determined by using Ca II K line.

When using parallax, the absolute magnitude of the star can be formulated as follows:

$$M_V = m_V + 5 + 5 \log_{10} (pi), \qquad (2)$$

where m_V is the apparent magnitude and pi is the parallax in arc seconds (Bohm-Vitense, 1989).

The absolute magnitudes as reported by (Wilson, 1957) have a dependence upon the Hyades modulus. This modulus was found to be 3.40 based upon the 156 light-year distance as reported in by Torres, et al., (1997) as compared to the 3.03 modulus as used by Wilson, 1976. The linear correction for the absolute magnitudes was then corrected as proposed by Wilson (Wilson, 1976).

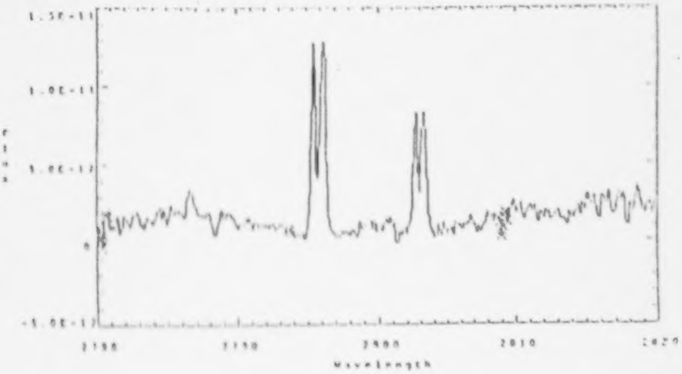

Figure 1: Data from HD161096 as reported from the IUE satellite archives. The k line is centered at 279.55 nm while the h line is centered at 280.27 nm.

ANALYSIS

The first step in the analysis involved a determination of usable data. The factors for selection of the k and h line widths for a star were determined by the following criteria: (1) an absolute magnitude either reported by another study (Wilson, 1976) and/or having a parallax of more than 0.0400 arc seconds, (2) a significant signal-to-noise ratio, and (3) k and h lines devoid or nearly devoid of Reseaux marks, or places where data was lost during the exposure. By using these criteria, the study was able to involve approximately 70 stars into the selection for each section of comparison.

Once the stars and data were determined fit for use, the width of the k and h lines and absolute magnitudes for a selected star were determined as stated previously. Then a comparison of the absolute magnitude versus the logarithm (base 10) of the width of the lines (in km/s) was constructed. The k and h lines were handled as separate and independent entities. This allowed for the two emissions to obtain separate and independent relationship with respect to absolute magnitude. This was a slightly different approach that in previous studies with Mg II which found a relationship using the k line only (Weiler and Oegerle, 1979; Mena-Werth, 1990).

The possible avenues for comparison involved the lines widths in correlation with the absolute magnitude sources as given earlier. Two more comparisons were made using combined sources of Wilson and the parallax sources. These final sections allowed for a large range of stars to be included into a comparison that was not achievable by the other three sections separately.

Each exposure was handled as a separate data point in comparison to the absolute magnitude of the star. In other words, no attempts to average the line widths for multiple exposures of the same star were taken. Some stars in this study only contributed one exposure while some stars had contributions of three or more exposures.

After the scatter plots were constructed, then a linear fit of the following form was performed:

$$M_V = A + B \log_{10} W_{((k \text{ or } h)\ \mathrm{km/s})}, \qquad (3)$$

where A and B are constant coefficients determined by a least squares fitting of the data. The following table gives the results of the forementioned sources for absolute magnitude versus the logarithm of the k and h line widths.

Table 1: Results of various absolute magnitude sources versus associated line widths.

Source of M_V	Equation	r_p	Data pts.
BSC	$27.554 - 11.096 \log W_k$ km/s	0.75713	120
BSC	$21.844 - 8.5946 \log W_h$ km/s	0.6949	120
GCTSP	$28.006 - 11.333 \log W_k$ km/s	0.7433	110
GCTSP	$22.772 - 9.0459 \log W_h$ km/s	0.6946	110
Wilson, 1976	$33.080 - 14.307 \log W_k$ km/s	0.85117	74
Wilson, 1976	$27.894 - 12.289 \log W_h$ km/s	0.76988	74
BSC and Wilson, 1976	$36.997 - 15.727 \log W_k$ km/s	0.89702	194
BSC and Wilson, 1976	$31.691 - 13.591 \log W_h$ km/s	0.85213	194
GCTSP and Wilson, 1976	$37.053 - 15.781 \log W_k$ km/s	0.89798	184
GCTSP and Wilson, 1976	$32.331 - 13.902 \log W_h$ km/s	0.85764	184

The best recalibration of this study was the result for the Mg II k line obtained by combining Wilson's 1976 data with combined with the absolute magnitudes as determined by the parallaxes reported by the GCTSP.

$$M_V = 37.053 - 15.781 \log W_k \ \mathrm{km/s} \qquad (4)$$

This result then compares favorably with the results as determined by Weiler and Oegerle (1979). Their results using the Mg II k line were as follows:

$$M_V = 34.93 - 15.15 \log W_k \ \mathrm{km/s} \qquad (5)$$

with a linear correlation coefficient of 0.91.

The error analysis was handled in a similar manner as with Weiler and Oegerle (1979). Stars with a parallax of 0.100" or greater were taken and the values of absolute magnitude were compared as obtained by parallax and by our main relation for k line width used to determine M_V. We then looked at the standard deviation to obtain a sense of range for M_V with errors. By using this method, we were able to incorporate 21 stars and forty-five data points. The error amount was then found to be 1.16 magnitudes.

DISCUSSION

The relations obtained by using the Mg II k and h lines and various sources for absolute magnitude follow a similar pattern as first one found

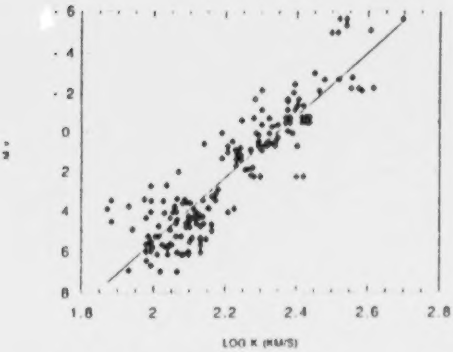

Figure 2: Correlation of the absolute magnitudes from GCTSP and Wilson, 1976 versus logarithm of the k line width with a least squares linear fit.

by Wilson and Bappu in 1957 and others thereafter. Both the k and h line widths correspond well with changing intrinsic brightness. Values for these relations are close to those determined in other studies, of which both Ca II and Mg II are used (Wilson, 1976; Weiler and Oegerle, 1978; Mena-Werth, (1990). The relations displayed a behavior that was intermediate for the absolute magnitudes, for a given line width, than in previous findings. While this study's values would exceed those as found by Weiler and Oegerle (1979), the would be exceeded by the values as determined by Wilson (1976) and Mena-Werth (1990).

The error range is slightly larger than one would like to see with this type of process. Having a range of greater than one magnitude could change things significantly in some situations. However, the error range is still small enough that the process is not rendered meaningless. Such as its use as a guide to checking other techniques to determine absolute magnitudes.

When comparing the absolute magnitudes as determined between the k and h lines, the k line generally more highly correlated. The Wilson-Bappu effect followed the h line, but with less of a correlation than that established by the k line on the same group of stars and M_V. This relation of lesser correlated h line widths with absolute magnitudes as compared to k line widths permeated all subsections of this study. The main reason for this distinction was the way the UV radiation is detected by IUE. The Mg II h line is near the edge of the viewing camera. Thus, distortions and errors are introduced into the h line width. Therefore, when possible, it would be advisable to use the k line width when incorporating the Wilson-Bappu effect with Mg II.

For certain stars, multiple exposures were used use in this study. When dealing with some of these multiple exposures, a spread in the k and/or h line widths existed. For some stars, such as HD222107, a possible relation of line width with exposure time may be supported as found by Mena-Werth (Mena-Werth, 1990). With other stars, the spread may only develop as a result of more noise in the signal than an another exposure.

CONCLUSION

This study's purpose was recalibrate the Wilson-Bappu effect by using various sources of absolute magnitude in correspondence with Mg II k and h line widths as determined by the International Ultraviolet Explorer satellite. The study was able to include several more stars into the study than in previous surveys, especially in the main sequence portion. It was found that the k line width correlation gave a better result than the same technique used with the h line width of Mg II. Also, the relations calculated in this paper were in good agreement with those found by other researchers, most notably Weiler and Oegerle, 1979.

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BIBLIOGRAPHY

Bohm-Vitense, Erika. *Stellar Astrophysics*. Cambridge University Press, 1989; Vol 1 and Vol 2: 70, 11.

Hoffleit, D. and Jaschek, C. *The Bright Star Catalogue*. (New Haven: Yale University Observatory), Fourth Ed., 1982.

Heavens, The. The World Book Encyclopedia of Science. World Book, Inc., Chicago, 1991. 133.

Mena-Werth, Jose. *Cool Stars, Stellar Systems, and the Sun*. 1990; Vol 9, 125.

Torres, Guillarmo, Robert Stafanik, and David Latham. *The Astrophysical Journal*. January 1, 1997, 256.

van Altena, et al. *General Catalogue of Trigonometric Stellar Parallaxes*, 1991.

Weiler, E.J. and Oegerle, W.R. 1979, *Ap. J. Suppl.*, 39, 537.

Wilson, O.C. and Bappu, M.K.V. 1957, *Ap. J.*, 125, 661.

Wilson, O.C. 1976, *Ap. J.*, 205, 823.

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Analysis of X-ray Sources in Galaxy Clusters

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We studied X-ray images of galaxy clusters taken by the ROSAT satellite in an effort to detect, identify, and analyze sources. Galaxies are large systems of stars and gas held together by gravity. The vast majority of galaxies are found in clusters containing many galaxies gravitationally bound together. Most sources of visible light in galaxy clusters are stars. X-rays, being of much higher energy than visible light, are emitted by hot gas in these clusters. Sources could be galaxies in the cluster, clumps of hot gas stripped from galaxies by some process, or distant galaxy clusters. The purpose of our research is to identify and analyze these sources and their environments. Many sources could not be identified, meaning their positions did not correspond to any catalogued galaxy found in optical images. Some unidentified sources are yet to be discovered distant clusters of galaxies. By analyzing the environments of these sources, we hope to learn how they were formed. If gas removal was caused by ram pressure, we would expect more sources in areas of higher gas density. If the cause is tidal interactions with the cluster, we would expect more sources near the center of the cluster.

SOURCE DETECTION

Unlike images in visible light, X-ray images show the hot gas in between galaxies. This cluster emission acts to hide sources. To locate sources in the images, wavelet analysis was used to amplify small variations in the intensity. A function (equation 1) is used to calculate values for a grid representing the pixels in the image. This grid is centered on each pixel and the intensity of each pixel is multiplied by the corresponding grid value. We used the "Mexican Hat" wavelet, shown in figure 1. As you can see, it is sharply peaked and has negative values toward the edges. This works to enhance bright variations and dim small ones. The width of the base, denoted as 'a', is a rough measure of the size of the sources that are best revealed. We used wavelets of for a = 10, 20, 40, 80, and 160 arcseconds to reveal sources on different scales.

$$g\left(\frac{x}{a},\frac{y}{a}\right)=\left(2-\frac{x^2+y^2}{a^2}\right)e^{-(x^2+y^2)/2a^2} \qquad (1)$$

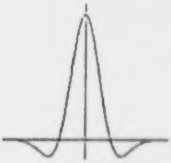

Figure 1: Mexican Hat Wavelet

Contour plots for each convolved image were made showing sources with signal to noise ratios above 3.5. This cutoff was chosen because it has been shown to include very few spurious sources (Grebenev, Jones, Forman 1995). Sources were compared on each plot to find which size wavelet yielded the highest signal to noise ratio. This gave us the approximate radius of the source.

$$size \approx a\sqrt{2} \tag{2}$$

For this project, we are only interested in extended sources since point sources such as stars and quasars are unlikely to be associated with the galaxy cluster. Sources were marked as extended if their approximate size was greater than the full width at half max for a point source. This is the width at a point where the intensity is ½ the maximum. For the ROSAT PSPC instrument, this depends on its distance, θ, from the center of the image.

$$FWHM = \sqrt{409.65/1.2 + 69.28 \cdot 1.2^{2.88} + 66.29 + (.29 \cdot \theta^{1.74})^2 + (2.355 \cdot 1.5)^2} \tag{3}$$

The positions for extended sources were found and compared with the NASA/IPAC Extragalactic Database. This allowed us to separate identified sources from unidentified sources so that we may study the environments of each separately and conclude whether unidentified sources prefer different conditions.

ANALYSIS

While analyzing sources, the goal is to determine the nature of the unidentified sources and the process by which they formed. We hope to do this by examining the environment around these sources to see if they prefer certain conditions. An overabundance of unidentified sources found close to the cluster center, where the gravity is strongest, would suggest tidal interactions as a mechanism. Alternatively a preference for areas of higher gas density would indicate hot gas stripped from galaxies by ram pressure. Gas density is proportional to the square root of the x-ray luminosity. Thus a graph showing both the location and luminosity of the surrounding cluster emission would be a useful tool.

The location can be found from the image and simple trigonometry. The angular separation between the source and the center can be found from the image. To convert this angle to an actual distance, one needs the distance to the cluster. This can be found from Hubble's Law, which describes the expansion of the universe.

$$d = v/H \tag{4}$$

H is the Hubble constant, for which I assumed a value of 65 km/s*Mpc. The velocity, v, can be found from the redshift, z.

$$v = \frac{(z+1)^2 - 1}{(z+1)^2 + 1} c ; c = speed\ of\ light = 3x10^8 m/s \qquad (5)$$

Simple trigonometry can then be used to convert angular measurements to parsecs.

$$r = d \tan(\theta) \qquad (6)$$

The flux for the cluster emission surrounding each source was found by fitting its spectrum with a theoretical model which took into consideration redshift, neutral hydrogen column density, and temperature. The flux is dependent on distance so it was converted to luminosity.

$$L = 4\pi d^2 F \qquad (7)$$

CONCLUSION

Figure 2 is a graph comparing identified and unidentified sources for the galaxy clusters Abell 1367 and Abell 514. As expected, the cluster emission, and therefore the gas density, decreases toward the edge of the clusters. However, unidentified sources do not seem to prefer a different environment than identified ones. At least three more clusters will be analyzed to search for a statistical difference between the two groups of sources.

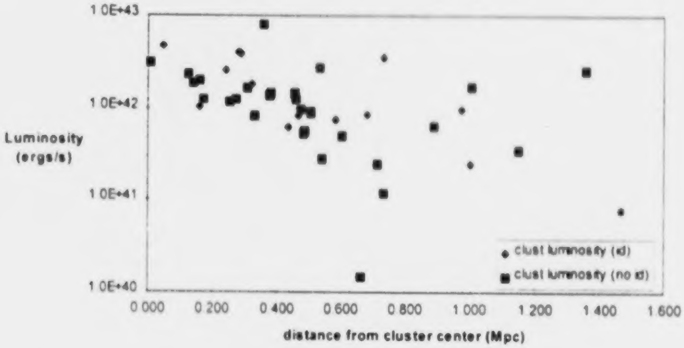

Figure 2: Cluster emission vs. position for sources in A1367 and A514

ACKNOWLEDGEMENTS

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REFERENCES

Grebenev, S. A., Formam, W. and Jones, C., The Astrophysical Journal, Wavelet Transform Analysis of the Small-Scale X-ray Structure of the Cluster Abell 1367, Vol. 445, June 1995. pg. 607-623

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Using FTIR-Reflection Absorbance Spectroscopy to Study the Structure of Thin Ice Films

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Heterogeneous processing on ice particles plays an important role in the chemistry of the earth's atmosphere. To better understand this chemistry, grazing angle Fourier Transform-Infrared Reflection Absorbance Spectroscopy (FTIR-RAS) is used to study the structure and reactivity of vapor-deposited ice films in a high vacuum chamber. In particular, FTIR-RAS is used to examine the surface roughness of vapor-deposited ice films between 160-185 K. Above 165 K, absorbance spectra show the onset of scattering between 4000-7000 cm^{-1}, a region in which water-ice does not absorb light. Scattering is interpreted as evidence for increased surface roughness. The loss of light due to scattering increases with temperature and film thickness and decreases with deposition rate. Collectively, these data suggest that ice roughens between 165-185 K and that a "rough" surface is lower in energy than a "smooth" one.

BACKGROUND

In recent years there has been considerable interest in the chemistry of ice films. This interest has been stimulated, in part, by the discovery that polar stratospheric clouds (PSCs) play an important role in the ozone depletion leading to the event referred to as the "ozone hole." The water-ice clouds re-partition the large reservoir of unreactive chlorine species (HCl and $ClONO_2$) to more reactive forms (HOCl and Cl_2) that can go on to destroy ozone.[1] Type II PSCs, composed largely of water-ice, appear to be more efficient in this interconversion process than their Type I counterparts, composed of water-ice, nitric acid and sulfuric acid. While the reasons for this are still under investigation, this finding suggests that the pure water-ice surface is more chemically reactive than an ice surface that has been passivated with HCl or H_2SO_4.

What is it about the surface structure of ice clouds that make them so reactive? This question has prompted scientists to investigate both the chemistry[2-5] of water-ice as well as the structure and morphology[6-11] of the crystalline ice surface. Laboratory-based studies typically use ice films to simulate ice particles in clouds. While not a perfect match, it is reasonable to assume that ice films capture the significant reactive properties of their ice-cloud counterparts. Initial theories postulated that the reactivity may be due to "dangling bonds," or non-hydrogen bonded OH groups at the surface of water-ice films. Experimental evidence, however, suggests that the number of dangling bonds at the surface of ice films deposited at temperatures approaching those of the stratosphere (> 160 K) are few to none.[7,11] Indeed, the surface appears to be a dynamic and mobile one. Haynes et al.[12] have suggested that above 180 K, between 10-1000 monolayers of water are evaporated and condensed each second. Even studies done at much colder temperatures (90 K) indicate that the upper most layer of water molecules vibrate more rapidly than the underlayers, indicative of increased mobility.[13] Moreover, both experimental[14] and theoretical[6] data suggest that the surface structure of ice at temperatures above 180 K becomes rougher and more disordered. If surface roughness does increase, so does the amount of exposed surface area. Since surface area is a parameter needed to determine gas uptake coefficients of molecules on ice.[15] it is important to have a well-characterized film surface.

In this work, grazing-angle Fourier Transform Infrared-Reflection Absorbance Spectroscopy (FTIR-RAS)[16] is used to study the morphology of water-ice films at temperatures approaching those in the stratosphere. In accord with works by Keyser[14] and Devlin,[6] results indicate that ice becomes more disordered as deposition temperatures increase above 160 K. The infrared scattering signature of water-ice (between 7000-4000 cm^{-1}) is used to infer roughness, where increased scattering corresponds to a rougher surface. Specifically, the dependence of the scattering signature on temperature, film thickness, and deposition rate is analyzed. The implication of this work on the heterogeneous processing of ice films is discussed.

EXPERIMENTAL

All experiments were conducted in a newly constructed FTIR-RAS apparatus. Briefly, the high vacuum instrument (base pressure = 8×10^{-8} Torr) consists of two stainless steel chambers separated by a gate valve. The top chamber supports a vertically mounted, optically flat aluminum (Al) substrate (d = 6.4 cm) upon which water-ice is condensed, KBr windows for the passage of infrared light, a Bayard-Albert ionization gauge, and a Baratron capacitance manometer. The ionization gauge pressure (P_{IG}) was calibrated for water using the absolute pressure of the capacitance manometer (P_{CM}), resulting in $P_{CM} = 1.15 \times P_{IG}$. Errors in pressure are estimated to be ± 15%. The bottom chamber houses an Edward's diffusion pump (230 L/s) and two precision leak valves (Lesker). Water is introduced through a leak valve after undergoing at least three freeze/pump/thaw cycles on an attached vacuum glass line.

Infrared spectra were collected using a Nicolet 550 Magna II FTIR spectrometer with a silicon-carbide source and a liquid nitrogen cooled HgCdTe detector. Spectra represent the co-addition of 16 scans at 4 cm^{-1} resolution. At grazing-angle the infrared light reflects off the aluminum substrate at 83° from normal (Fig. 1). The substrate is cooled through thermal contact with a liquid nitrogen filled cryostat, then resistively heated to the desired temperature using a programmable temperature controller. The substrate temperature is measured using a T-type (copper-constantan) thermocouple. Radial gradients across the surface are ≤ 2 K, and absolute temperatures are within ± 2 K. The Al surface is vacuum-sealed into a differentially pumped stainless steel sleeve maintained at temperatures above the ice frost point. In this way, the Al substrate is the only surface in the chamber cold enough to condense ice. Ice deposition rates were determined according to the equation[17]

$$dx/dt = \alpha P/[\rho(T)(2\pi m k T_g)^{1/2}] - [v_0/\rho(T)]\exp[-E_d/RT_s] \qquad (1)$$

where α is the estimated sticking coefficient ($\alpha = 1$),[17] P is the partial pressure of water, $\rho(T)$ is the temperature dependent density of the ice ($\rho = 0.93$ g/cm^3),[12] v_0 is the zero-order desorption pre-exponential (2.8×10^{30} molecules/(cm^2 s)),[12] m is the molecular weight of H_2O (18.016), T_g is the impinging gas temperature (298 K), k is the Bolzmann constant, E_d is the desorption activation energy (48.12 kJ/mol),[12] and T_s is the substrate temperature. Thus, for example, for $P = 1.0 \times 10^{-5}$ Torr and $T_s = 165$ K, dx/dt = 1 nm/s.

Film thickness (d) was determined by comparison of the observed infrared absorption spectra with absorption spectra derived theoretically.[16] At grazing incidence, spectral peak shapes undergo characteristic changes with thickness that make the assignment of film thickness relatively straightforward. Errors in film thickness are estimated to be ± 20%.

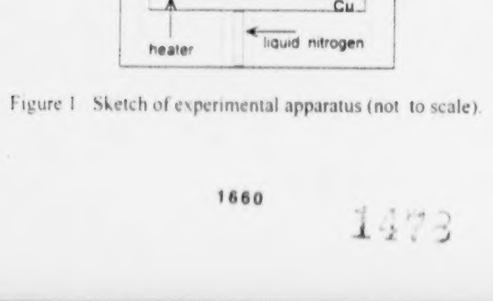

Figure 1 Sketch of experimental apparatus (not to scale).

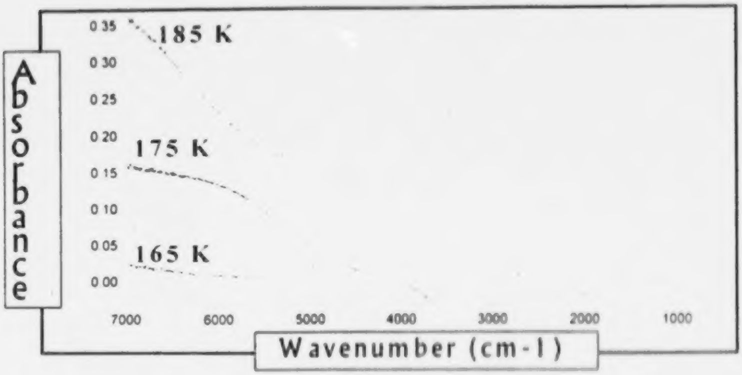

Fig. 2. Preliminary water-ice absorbance spectra which illustrate the changes in scattering (7000-4000 cm^{-1}) with temperature. Films are ~ 600 nm thick and were deposited at ~ 1 nm/s

RESULTS AND DISCUSSION

Changes in the absorbance spectra of water ice films as a function of temperature (Fig. 2), growth rate (Fig. 3), and film thickness (Fig. 4) were examined. Specifically, changes were examined in the scattering region of the spectra (7000-4000 cm^{-1}) where water-ice does not absorb infrared light. As shown in Fig. 2, the absorbance due to scattering increases as the substrate temperature at deposition is increased from 165 K to 185 K. Fig. 3 indicates that there is a slight increase in scattering when ice is vapor-deposited at 1 nm/s (slow) rather than at 10 nm/s (fast). This result is slightly more pronounced at 175 K than 185 K. Finally, in Fig. 4, more scattering is observed in thick films (600 nm) than in thin ones (100 nm).

Any increase in scattering is interpreted as evidence for ice film roughening. A rougher, more disordered and particle-like surface presumably scatters light more efficiently than a smooth and ordered one. Given this assumption, results indicate that ice films become increasingly rougher (more particle-like) at temperatures above 165 K. This observation suggests that a rough surface is lower in energy than a smooth one. Water molecules must overcome a barrier to rearrangement before the surface can "roughen," hence roughness is observed only at the warmer temperatures. This interpretation is further supported in the growth rate data. Under conditions of slow growth, water molecules with sufficient energy to diffuse have more time to sample the surface before they are buried by incoming adlayers, thereby increasing their probability of finding a more favorable (lower) energy site. The

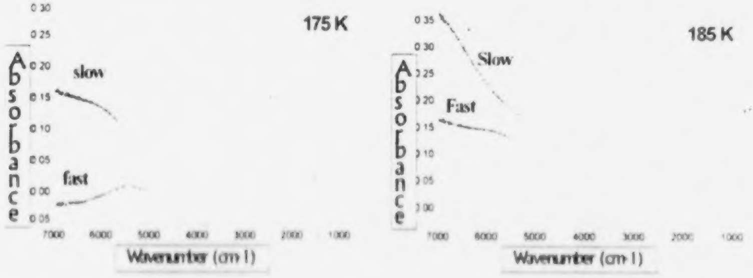

Fig. 3. Preliminary water-ice absorbance spectra which illustrate the changes in scattering (7000-4000 cm^{-1}) with growth rate at 175 K and 185 K. Films are ~ 600 nm thick.

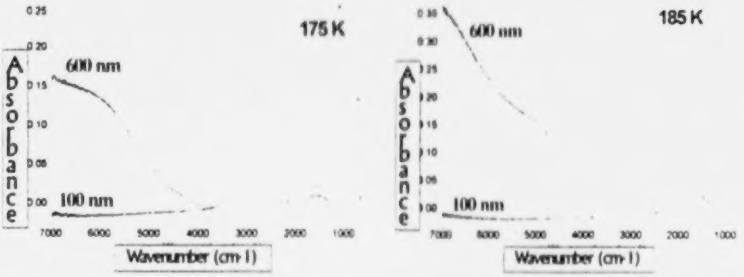

Figure 4. Preliminary water-ice absorbance spectra which illustrate the changes in scattering (7000-4000 cm^{-1}) with film thickness at 175 K and 185 K. Films were deposited at ~ 1 nm/s.

growth rate dependence is most pronounced at 175 K, where more time allows more molecules to make it over the diffusion barrier. At 185 K, most water molecules have sufficient energy to traverse the barrier, hence the growth rate dependence is less pronounced.

As shown in Fig. 4, scattering also increases with film thickness. This finding suggests that a rough surface retains its disordered character as it is buried by incoming adlayers. Thus, light entering the film encounters fissures, cracks, and irregularities within the bulk structure. Multiple encounters with such irregularities increase the probability of light scattering, since a thick film has more chances to scatter the incoming (or outgoing) light than a thin one.

CONCLUSIONS

Results suggest that ice films roughen at temperatures characteristic of the earth's stratosphere (> 188 K), in accord with recent experimental[14] and theoretical work.[6] This roughening is of interest both to physicists interested in the fundamental properties of ice, as well as to the atmospheric community. Roughness can influence the heterogeneous processing of ice films, both with respect to their ability to adsorb gases (sticking coefficients) as well as their chemical reactivity. In future work, the dependence of scattering on angle of incidence and light polarization will be examined. In addition, efforts will be made to quantify how increased scattering correlates to changes in the surface area of the ice film.

ACKNOWLEDGMENTS

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REFERENCES

1. Solomon, S. Rev. Geophys. 1988, 26, 131.
2. Horn, A. B.; Chesters, M. A.; McCoustra, M. R. S.; Sodeau, J. R. J. Chem. Soc. Faraday Trans. 1992, 88, 1077-1078.
3. Graham, J. D.; Roberts, J. T. J. Phys. Chem. 1994, 98, 5974-5983.
4. Banham, S. F.;Horn, A. B.; Koch, T. G.; Sodeau, J. R. J. Chem. Phys. 1995, 100, 321.
5. Gertner, B. J.; Hynes, J. T. Science 1996, 271, 1563-1566.
6. Devlin, J. P; Buch, V. J. Phys. Chem. 1995, 99, 16534-16548.
7. Schaff, J. E.; Roberts, J. T. J. Phys. Chem. 1994, 98, 6900-6902.
8. Horn, A. B.; Koch, T. G.; Chesters, M. A.; McCoustra, M. R. S.; Sodeau, J. R. J. Phys Chem. 1994, 98, 946-951.
9. Xiao, R.-F.; Ming, N.-B. Phys. Rev. E 1994, 49, 4720-4723.
10. Callen, B. W.; Griffiths, K.; Norton, P. R. Surf. Sci. Lett. 1992, 261, L41-L48.
11. Zondlo, M.A.; Onasch, T.B.; Tolbert, M.A. In review, J. Phys. Chem. 1997.

12. Haynes, D. R.; Tro, N. J.; George, S. M. J. Phys. Chem. 1992, 96, 8502-8509.
13. See Science, 1996, 274, 2012.
14. 14. Keyser, L.F.; Leu, M.-T. J. Colloid Interface Science. 1993, 155, 137-145.
15. Hanson, D.R.; Ravishankara, A.R. J. Phys. Chem. 1992, 96, 2682-2691.
16. Greenler, R. G. J. Chem. Phys. 1966, 44, 310-315.
17. Brown, D. E.; George, S. M.; Huang, C.; Wong, E. K. L. Wong; Rider, K. B.; Smith, R. S.; Kay, B. D. J. Phys. Chem. 1996, 100, 4988-4995.

Large DNA Fragment Sizing by Flow Cytometry

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ABSTRACT

In previous research, sizing fragments using laser flow cytometry was successfully applied to small DNA fragments ranging from 1.5 to 150 kilobase pairs (kb) (Goodwin et al.). The focus of this research was the sizing of large DNA fragments ranging in size from 50 to 2000 kb. Cohesive termini of bacterial DNA and viral DNA were ligated in order to create large oligomers. These large DNA fragments were analyzed using the following techniques: agarose gel electrophoresis, pulsed field gel electrophoresis, and laser flow cytometry. The goal of this research was to demonstrate that the size of ligated DNA fragments could be measured more accurately, consistently, and with greater ease using the laser flow cytometry method than by other methods.

INTRODUCTION

Laser flow cytometry and PFGE have the ability to bridge the resolution gap between cytogenetic methods (>5Mb) and DNA analysis (<50-100kb). These methods could prove to be a powerful tool in diagnosis of chromosomal rearrangement. There are two main areas of practical applications to medical genetics: (1) detection of affected chromosomes in genetic disease, and (2) detection of chromosomal malignancies due to deletions and translocations involving oncogenes (Van Ommen et al.)

Pulsed Field Gel Electrophoresis

Agarose gel electrophoresis uses a three dimensional polymer network to separate charged biological macromolecules based on the magnitude of the electric field, the net charge of the molecule, and the size and shape of the molecule as characterized by its frictional coefficient (Tinoco). DNA molecules greater than 50kb have gel electrophoresis mobilities independent of their length due to reptation. The solution to this problem was to make DNA molecules change direction during electrophoresis by using a pulsed field that alternates in direction. The problem with this method is that it takes from 16 - 24 hours to run one gel experiment.

Laser Flow Cytometry

To circumvent this problem flow cytometric DNA sizing was developed which is based on measurement of fluorescence intensity from single fragments stained with noncovatlently bond dye (Petty). Individually TOTO-1 stained DNA fragments passed through a low power, focused, continuous laser beam. Fluorescence bursts were recorded and the collected data was used to create a histogram that allows sizing of DNA fragments (Figure 1). The DNA-dye interaction is probably noncovalent. There are two contributions to the interaction: electrostatic attraction and intercalataion.

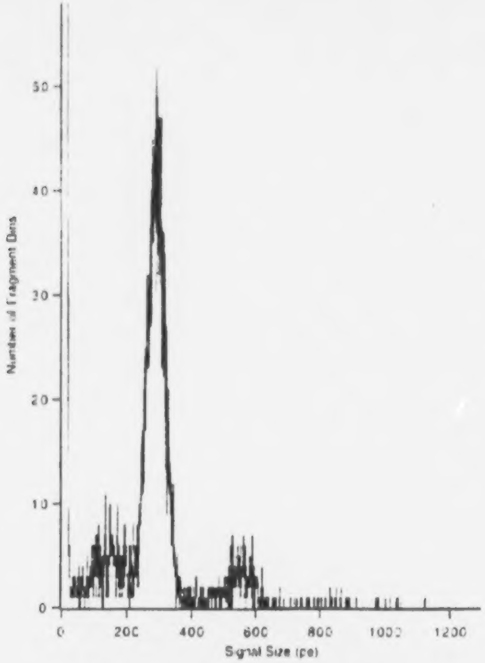

Figure 1: Histogram of λ DNA

Ligation of Cohesive Termini

Ligation involves formation of new bonds between phosphate residues located at the 5'-terminal of double stranded DNA and adjacent 3'-hydroxyl moieties. The formation of the phosphodiester bonds between adjacent 5'-phospate and 3'-hydroxyl residues was catalyzed by bacteriophage T4 DNA ligase. Ligation is a biomolecular reaction whose velocity under standard conditions is determined solely by the concentration of compatible DNA termini (Maniatis). At low concentrations of DNA, recircularization of the plasmid DNA will occur with high efficiency. At higher concentrations the initial products of ligation will be dimers and larger oligomers of the plasmid because a given end of DNA is more likely to encounter a terminus located on another molecule before intramolecular ligation occurs. j/i ratios were used to calculate the appropriate DNA concentrations where $j/i = (51)/([DNA](MW)^{1/2})$ (Dugaiczyk). When $i>j$, linear oligomers are favored. When $i<j$, recircularization should occur.

MATERIALS AND METHODS

There were two types of ligation reactions: ligation of λ DNA and ligation of SV40 DNA. There were three types of analyses: agarose gel electrophoresis, PFGE, and laser flow cytometry. The ligation of λ DNA was analyzed using PFGE and laser flow cytometry. Ligation of SV40 was analyzed using gel electrophoresis and laser flow cytometry.

Ligations using T4 Ligase

The following materials were added to five cuvettes: 8μL sterilized water and 2μL 5X T4 ligase buffer. Next, 2μL λ DNA of varying concentrations was added to the cuvettes (Table 2).

Table 2: Concentration of λ DNA used during ligation reactions.

Cuvette Number	Concentration of DNA (μg/μl)
1	0.5
2	0.25
3	0.005
4	0.0005
5	1.0

The cuvettes were gently spun in a centrifuge. They were then heated in a 65°C water bath for 20 minutes. 1.0-2.0mg of DTT was then added to each cuvette. 2μL T4 DNA ligase was added to each cuvette. The cuvettes were centrifuged gently and then placed in a 4°C refrigerator overnight. These samples were then analyzed using PFGE and flow cytometry.

For the PFGE, a 0.6% agarose gel was made. 2μL from each ligation reaction were loaded in adjacent lanes. In the three remaining lanes, 2μL of each of the following size markers were loaded: coliphage T4 DNA, coliphage T5 DNA, and the λ pulse marker® DNA. The gels was run at 145 volts for 13 hours with a 3 second positive pulse and a 1 second negative pulse. A pump was used to circulate the buffer through plastic tubing which was immersed in a 15°C water bath. The gel was stained in a 0.5μg/μL ethidium bromide bath for 30 minutes and then photographed.

The DNA was analyzed with laser flow cytometry. The fragments were first reacted with TOTO. The contents of each cuvette, were stained, diluted, and run through the laser separately. To stain the DNA, 180μL TE and 0.2μL TOTO was added to the cuvette. It was allowed to sit for 30 minutes to allow the dye to interact with the DNA. It was then loaded into the syringe for injection. Five base pairs of DNA to one TOTO dye is the protocol for staining. For analysis with the laser the optimal concentration is 1 X 10^{-13}moles of fragments per liter. Once optimal flow was achieved, data, in the form of bursts (Figure 2), was collected and then converted into a histogram.

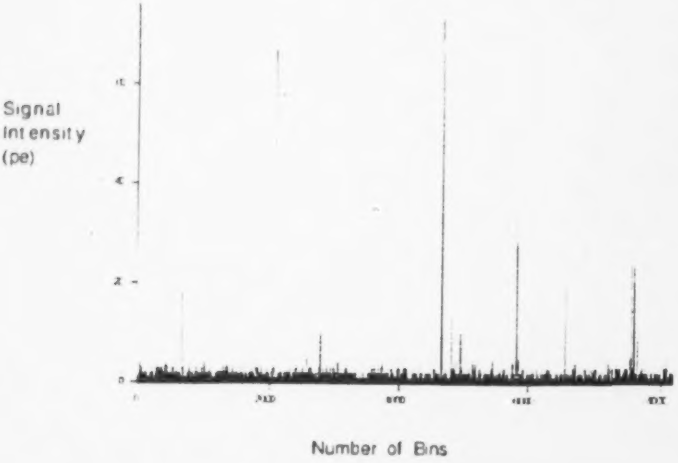

Figure 2: Observed Fluorescence from large λ oligomers: fluorescence was reduced by 1000x, and very large fluorescence bursts were still observed.

Ligation of SV40 DNA

A similar approach was used in the ligation of SV40 DNA. However, before the ligation was performed, the DNA was cut with EcoRI restriction enzyme. It was necessary to cut the SV40 DNA with the restriction enzyme in order to create the "sticky ends" necessary for the creation oligomers. After ligation, the DNA was analyzed using agarose gel electrophoresis and laser flow cytometry.

RESULTS AND DISCUSSION

Lambda DNA

Simple gel electrophoresis did not separate the λ DNA into the ladder of fragments. However, it was not expected to work because the oligomers were greater that 50kb. This separation problem should have been corrected with the use of the field inversion, but it was not. There are two possible reasons why this could have occurred: (1) The PFGE apparatus was not working properly, and/or, (2) the ladder of fragments were not produced. Computer modeling of the reptation motion of DNA during PFGE allows for the calculation of the optimum pulse length to separate a given size range (Smith et al.) In this model, the molecule was represented by a chain of charged beads connected by entropic springs, and the gel was represented by a segmented tube surrounding the beads. This model predicted that for a 20V/cm electric field, a migration in the positive direction of 3 seconds and a migration in the opposite direction for 1 second should give a good separation in the size range of 50kb to 2000kb, the target range for this research. In order to check if the field inversion pulse times or the temperature of the buffer contributed to the problem of separation, these parameters were changed systematically. Changing these parameters had little effect on the separation. In most of the gels either one or two discrete bands were observed in the lanes containing the lambda concatomers. The gel size markers used during the PFGE experiment indicated that the size the DNA was greater that 170kb. This means that λ concatomers were formed. It can be concluded from this that something was occurring in the reaction tube that resulted in the favorable production of one or two specific concatomer lengths. This leads to the possibility that, do to the statistical nature of the reaction, concatomers of a specific length are somehow favored over the formation of concatomers of random length which produce the ladder. This theory was substantiated be data from the laser. The histograms of all of the lambda concatomers generally detect two distinct sizes of concatomers. At first, the DNA was so fragmented after delivery to the laser beam, that initial experiments proved unsuccessful. More dilute samples were used and the problem of fragmentation was not as pronounced.

SV40 DNA

The same problems that were experienced using the lambda DNA were experienced with the SV40 DNA. Gel electrophoresis generally produced two bands. The histogram showed that there were concatomers there, but no distinct sharp peaks were seen. The purpose of using SV40 was to cut down on the problems associated with fragmentation because SV40 is much smaller than lambda.

CONCLUSION

Even though gel electrophoresis and PFGE did not successfully produce a lambda ladder, there was evidence that concatomerization did take place. Based upon this it was reasonable to conclude that the experimental problems resulted from an imperfect apparatus set-up. The laser experiments proved promising. In changing the delivery system to electroosmotic flow, the problem of fragmentation upon delivery to the system should be alleviated. The electroosmostic injection system works by using an electric current to move the DNA into the laser beam. This is a more gentle was to deliver the DNA. This research clearly demonstrates that there are inherent problems with the use of PFGE for this specific experiment

1485

as well as in general. Although past PFGE research shows adequate separation of large DNA fragments, there are too many questions left unanswered. Disadvantages to PFGE include: 16 hours to run, cannot size supercoiled or open circular DNA, and reproducibility and accuracy from gel to gel was difficult to replicate. Advantages to laser flow cytometry include: rapid acquisition of data (less that three minutes), sensitivity (0.4pg compared to 0.2μg), measures both linear and supercoiled DNA, and can measure fragment length as well as the number of fragments.

ACKNOWLEDGMENTS

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REFERENCES

Dugaiczyk, Achilles, Herbert W. Boyer, and Howard M. Godman. *Journal of Molecular Biology,* 1975, 96, 171-184.

Goodwin, P.M., M.E. Johnson, J.C. Martin, W.P. Ambrose, B.L. Marrone, J.H. Jett, and R.A. Keller. *Nucleic Acids Research. 1993, 21,* 803-806.

Maniatis, T., J. Sambrook, and E.F. Fritsch. Molecular Cloning, Second Edition, Cold Spring Harbor Laboratory Press, New York, 1989.

Petty, Jeffery T., Mitchel E. Johnson, Peter N. Goodwin, John C. Martin, James H. Jett, and Richard A. Keller. *Analytical Chemistry,* 1995, 67, 1755-1761.

Smith, Steven B., Christoph Heller, and Carlos Bustamante. *Biochem.* 1991, 30, 5264-5274.

Tinoco, Igancia Jr., Kenneth Sauer, and James C. Wang. Physical Chemistry, Prentice Hall Inc., New Jersey, 1995.

Van Ommen, G.J.B., J.T. Den Dunnem, H. Lehrach, and A. Poustka. "Pulsed-field Gel Electrophoresis: Application to Long-range Genetics." Electrophoresis of Large DNA Molecules. Cold Spring Harbor Laboratory Press, New York, 1990.

Enhancement of Asymmetric Induction in the Aqueous Diels-Alder Reaction of (L)-Menthyl Acrylate with Cyclopentadiene by β-Cyclodextrin

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β-Cyclodextrin has been shown to significantly improve the *endo* diastereofacial selectivity in the aqueous Diels-Alder reaction of (*l*)-menthyl acrylate with cyclopentadiene.

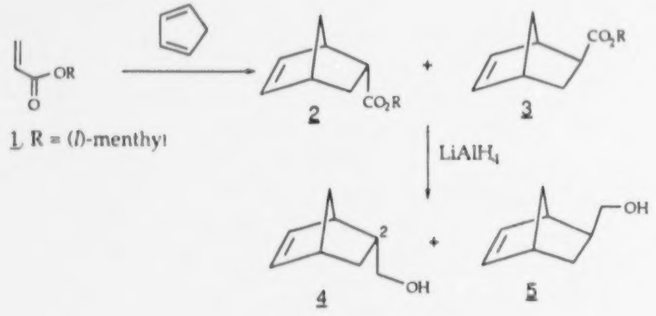
BACKGROUND

Because of increasing efforts in environmental conservation, there has been an interest to develop organic reactions that can be performed in environmentally friendly solvents, such as water (Li, 1993; Lubineau et al., 1994). Through the work of Rideout and Breslow (1980), Breslow et al. (1983; 1984), Grieco et al. (1986), Lubineau et al. (1985; 1986), Schneider and Sangwan (1986; 1987), and Sternbach and Rassana (1982), it has become apparent that the course of Diels-Alder reactions can be markedly influenced by the use of aqueous solvents, including the use of various modifiers such as salts (Breslow et al., 1984), acids (Otto and Engberts, 1995; Kobayashi et al., 1993), and inclusion complexes such as β-cyclodextrin (Breslow and Maitra, 1984). Due to a combination of solvophobic forces and/or intracavity inclusion in the cyclodextrin, aqueous Diels-Alder reactions have been shown to have an increase in the rates of reaction and *endo* selectivity (Schneider and Sangwan, 1982; 1985; Sternbach and Rassana, 1982). Breslow and coworkers (1980; 1983; 1984) and Schneider and Sangwan (1982; 1985) have further demonstrated that the products from reactions of simple dienophiles with cyclopentadiene in the presence of β-cyclodextrin show some enantioselectivity. For example, in the reaction of methyl vinyl ketone and acrylonitrile with cyclopentadiene, the *endo* adducts of both reactions were reported to have a few percent enantiomeric excess (e.e.) (Breslow and coworkers (1980; 1983; 1984).

As part of our interest in developing methods to enhance the diastereofacial selectivity in aqueous Diels-Alder reactions, we have studied the reaction of (*l*)-menthyl acrylate with cyclopentadiene under various aqueous conditions. These reactions were done in the presence of either a salt (lithium chloride), or a Bronstead-Lowry acid (hydrochloric acid) (Otto and Engberts, 1995) or a Lewis acid (scandium triflate) (Kobayashi et al., 1993), or β-cyclodextrin (Breslow and coworkers, 1980; 1983; 1984). For comparison, the reactions were also performed under "neat" conditions, and in methylene chloride solutions, either in the presence or absence of titanium (IV) chloride. The reaction of (*l*)-menthyl acrylate 1 with cyclopentadiene was chosen as our model for this investigation because it has been widely studied (Lee et al., 1995; Farmer and Hamer, 1966; Oppolzer et al., 1981) even under aqueous conditions (Cativiela et al., 1992). Specifically, using a 60% methanol:water mixture the ratio of *endo*:*exo* products was reported to be 9:1, and the diastereomeric excess (d.e.) of the *endo* product was 13.7% (Cativiela et al., 1992).

RESULTS AND DISCUSSION

In our studies, as depicted in Scheme 1, all reactions were performed using an excess of 2.5 mole equivalents of freshly cracked cyclopentadiene to each mole of acrylate 1. The relative amounts of the *endo* 2 and *exo* product 3 were determined by GC analyses (see Figure 1). The retention times for these *endo* and *exo* isomers were 27.5 min and 28.5 min, respectively. For the "neat" reaction (entry 1 in Table 1), the ratio of the *endo:exo* products was verified by reduction of the products with lithium aluminum hydride to yield the diastereomeric alcohols 4 and 5. The ratio of these *endo:exo* alcohols was found by a ^{1}H-NMR analysis to be 3:1, respectively. In our studies, the *endo* product was produced preferentially, and in the case of the titanium (IV) chloride and hydrochloric acid catalyzed reactions (entries 3 and 6), virtually no *exo* product was observed. This observation is not surprising because both these reagents have been shown to significantly enhance the *endo* selectivity in Diels-Alder reactions (Otto and Engberts, 1995; Lee et al., 1995; Farmer and Hamer, 1996; Oppolzer et al., 1981). For all of the other aqueous reaction conditions, the effects on *endo* selectivity was small.



Scheme 1. Synthesis of Alcohols 4 and 5

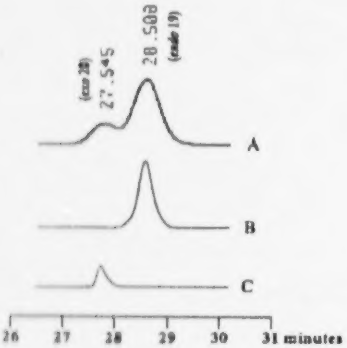


Figure 1. GC Chromatograms of Adducts 2 and 3

The isomeric adducts 2 and 3 were separated by silica gel column chromatography, and their structures were unambiguously characterized by IR and ^{1}H-NMR spectroscopic studies (Otto and Engberts, 1995; Lee et al., 1995; Farmer and Hamer, 1996; Oppolzer et al., 1981). The *endo* adduct 2 from the titanium (IV) chloride catalyzed reation was reduced with $LiAlH_4$ to alcohol 4, and its specific optical rotation was determined to be *plus*, indicating that the absolute configuration of the major enantiomer was 2R (Lee et al., 1995; Oppolzer et al., 1981).

Table 1. Diels-Alder Reactions of (*l*)-Menthyl Acrylate with Cyclopentadiene

ENTRY	CONDITIONS	% Yield *endo* product 2	ratio of *endo:exo*	d.e. *endo* 2 (± 4 %)
1	Neat, rt 24 hrs"	64	2.8:1	5.1[a]
2	CH_2Cl_2, rt 24 hrs	34	2.5:1	9.0
3	$TiCl_4$, CH_2Cl_2, -23 °C 5 hrs.	62	19:1	46
4.	Water, rt 24 hrs	61	2:1	5.1
5.	MeOH:water, (1:3), rt, 24 hrs	48	5.7:1	4.9
6.	0.01M HCl, water rt 24 hrs	>98	>19:1	12
7.	0.01M LiCl, water 53°C 24 hrs	56	2.3:1	10
8.	1:9 THF:Water, $Sc(OTf)_3$, rt 24 hrs	75	4.0:1	5.4
9.	1:3 $MeOH:H_2O$, rt 24 hrs, β-cyclodextrin	24	4.9:1	27
10.	1:1 $MeOH:H_2O$, rt 24 hrs β-cyclodextrin,	75	4.1:1	9

[a] The major diastereomer has the 2R configuration in all cases.

The diastereomeric excess (d.e.) values for the reactions in Table 1 were determined by ^1H-NMR analyses of the purified *endo* product 2 (see Figure 2) using integration of the signals of the diastereomeric olefinic protons at 5.87 ppm (for the major 2R-(*l*)-menthyl diastereomer) and 5.92 ppm (for the minor 2S-(*l*)-menthyl diastereomer).

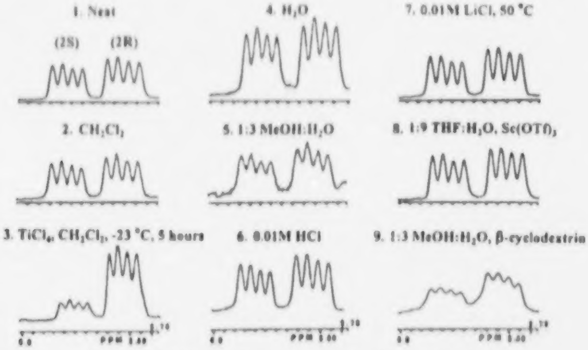


Figure 2. 300 MHz ^1H-NMR analysis of adducts 2 and 3

As expected, the titanium (IV) chloride catalyzed reaction gave the highest d.e., and this could be attributed to stabilization of the *s-trans* conformation of acrylate 1 by the Lewis acid (Lee et al., 1995; Farmer and Hamer, 1966; Oppolzer et al., 1981). The aqueous reactions (entries 4 and 5) did not show significant increase in diastereofacial selecitivitiy over the neat (entry 1) and methylene chloride (entry 2) reactions, although in the presence of methanol a slight increase in *endo* selectivity was observed. The lithium chloride promoted reaction (entry 7) also did not improve either the d.e. value or the *endo* selectivity. The use of scandium (III) triflate (entry 8), a water stable Lewis acid (Kobayashi et al., 1993), also did not produce any enhancement in the d.e value. However, the percent chemical yield of 2 was increased. Hydrochloric acid (entry 6) had a dramatic effect in raising the chemical yield of 2, *endo* selectivity, as well as a small increment on the d.e. value. These effects could be due to protonation of the acrylate (Otto and Engberts, 1995). The highest diastereofacial selectivity in the aqueous reactions studied was the β-cyclodextrin promoted reaction (entry 9), which gave a 27 percent d.e. This reaction also produced an enhanced *endo* selectivity over the water reaction (entry 4). The low chemical yield for this reaction was due to the large volume of solvent used, and some of the products being trapped in the sugar cavity. In a separate β-cyclodextrin promoted reaction (entry 10), when the volume of solvent was reduced, and the percent recovery of product improved; but, with the use of a 1:1 water:methanol solution, the value of d.e. was slightly reduced to 19 percent.

The above results on the aqueous reactions indicate that the course of the stereo and diastereofacial selectivities of Diels-Alder reactions performed in aqueous conditions can be influenced by the type of solvents and modifiers used. With these encouraging results, our efforts are now turned towards investigating aqueous Diels-Alder reactions using dienophiles that are devoid of the *s-cis* and *s-trans* isomerization problem, and also at reactions wherein the rates can be accelerated by the presence of water and cyclodextrins.

EXPERIMENTAL

General Procedure for the reactions given in entries 1,2,4-8, 10.

A solution of acrylate 1 (76 mg, 0.36 mmol) was made up in the appropriate solvent (5 mL), except no solvent was used for the "neat" reaction, and for entry 10, 14 mLs of solvent was used. Also in entry 10, β-cyclodextrin (331 mg, 0.29 mmol) was added. The reaction vial was sealed and the solution was vigorously stirred. Freshly cracked cyclopentadiene (75 μL, 0.55 mmol) was added. After stirring at room temperature for 24 hrs, the reaction was extracted with chloroform (3 times, 25 mL each). In the β-cyclodextrin reaction, the reaction was first filtered and then the filtrate was extracted. The combined organic extracts were dried (sodium sulfate) and concentrated. The crude product was analyzed by GC with FID detection; crosslinked methyl silicone gum column (25m x 0.53 mm i.d.); nitrogen carrier gas at 15 psi, injector temperature 230°C; detector temperature 250°C; oven temperature was programmed from 190°C (held for one min) at 2°C min^{-1} to 180°C, and then 1°C min^{-1} to 170°C (held for 24 min). Retention time for the *endo* product 2 was 28.5 min, and for the *exo* compound 3 the retention time was 27.5 min.

The products were purifired on a silica gel column using a 0-2% ethyl acetate:hexanes solvent with the *exo* product eluting first. For the *endo* product 2: TLC (5% EtOAc/hexane) R_f 0.32. ^{1}H-NMR ($CDCl_3$): For the major diastereomer (2R) of some of the resolved signals: δ 6.20 (dd, 3.0, 5.7, 1H), 5.87 (dd, 2.7, 5.4, 1H), 4.58 (dt, 6.2, 12.3, 1H); for the minor (2S) diastereomer 6.18 , 5.92, and 4.60. IR (Neat): ν 3063, 2954, 2867, 1730, 1632, 1453, 1365, 1333, 1273, 1175, 1104, and 1022 cm^{-1}. For the *exo* isomer 3: TLC (5% EtOAc/hexane) R_f 0.45. ^{1}H-NMR ($CDCl_3$): Signals for the diastereomers on 3 were not resolved: δ 6.13 (dd, 3.0, 5.6, 1H), 6.09 (dd, 3.0, 5.6, 1H), 4.73 (dt, 4.3, 10.8, 1H). IR (Neat): v 3075, 2955, 2870, 1732, 1632, 1455, 1370, 1333, 1261, 1170, 1097, 1038 cm^{-1}.

Lithium aluminum hydride reduction of adducts 2 and 3 from entry 1 (see Lee et al., 1993)

Alcohols 4 and 5 were obtained in 78% yield. ^1H-NMR of alcohol 4: ($CDCl_3$): δ 6.15 (dd, 3.0, 5.7, 1H), 5.96 (dd, 2.8, 5.7, 1H). For 5: 6.11 (d, 2.9, 5.5, 1H), 6.07 (dd, 2.8, 5.6, 1H).

REFERENCES

Breslow, R. J. and Maitra, U., Tetrahedron Lett. Vol 25, 1984. pg. 1239-1240

Breslow, R. J., Maitra, U. and Rideout, D., Tetrahedron Lett. Vol 24, 1983. pg. 1901-1904

Cativiela, C., Garcia, J. I., Mayoral, J. A., Royo, A. J., Salvatella, L., Assfeld, X. and Ruiz-Lopez, M.F., J. Phys. Org. Chem. Vol 5, 1992. pg. 230-238

Farmer, R. F. and Hamer, J. J., J. Org. Chem. Vol 31, 1966. pg. 2418-2419

Grieco, P. A., Galatsis, P. and Spohn, R. F., Tetrahedron Vol 42, 1986. pg. 2847-2853

Kobayashi, S., Hachiya, I., Araki, M. and Ishitani, H., Tetrahedron Lett. Vol 34, 1993. pg. 3755-3758

Larsen, S. D. and Grieco, P. A., J. Am. Chem. Soc. Vol 107, 1985. pg. 1768-1769

Lee, M., Garbiras, B. and Preti, C. S. J. Chem. Ed. Vol 72, 1995. pg. 378-380

Li, C. J., Chem. Rev. Vol 93, 1993. pg. 2023-2035

Lubineau, A., Auge, J. and Queneau, Y., Synthesis 1994. pg. 741-760

Lubineau, A. and Queneau, Y, Tetrahedron Lett. Vol 26, 1985. pg. 2653-2654

Lubineau, A., J. Org. Chem. Vol 51, 1986. pg. 2142-2144

Oppolzer, W., Kerth, M., Reichlin, D. and Moffatt, F., Tetrahedron Lett. Vol 22, 1981. pg. 2545-2548

Otto, S. and Engberts, B. F. N., Tetrahedron Lett. Vol 36, 1995. pg. 2645-2648

Rideout, D. C. and Breslow, R. J., J. Am. Chem. Soc. Vol 102, 1980. pg. 7816-7817

Schneider, H-J. and Sangwan, N. K., J.C.S. Chem. Commun. 1986. pg. 1787-1789

Schneider, H-J. and Sangwan, N. K., Angew. Chem. Int. Ed. Engl. Vol 26, 1987. pg. 896-897

Sternbach, D. D. and Rassana, D. M., J. Am. Chem. Soc. Vol 104, 1982. pg. 5853-5854

Effect of Lipid Peroxidation Products, 4-hydroxy-2-*trans*-Nonenal and Malondialdehyde, on Erythrocyte Membranes

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Beta amyloid peptides are believed to be a part of the mechanism of oxidative stress in Alzheimer's disease. These peptides have been shown to be responsible for membrane lipid peroxidation. Two products of this lipid peroxidation are 4-hydroxy-2-trans-nonenal (HNE) and malondialdehyde (MDA). The effects of HNE and MDA on erythrocyte membranes were previously unknown. In this study, the effects of HNE and MDA on erythrocyte membrane protein conformation were tested by employing the method of electron paramagnetic resonance (EPR), with the help of a protein specific spin label, MAL-6. Prevention of membrane damage by HNE and MDA was also tested with the use of glutathione ethyl ester (GEE). At concentrations of 5μM and 50μM, both HNE and MDA proved to be toxic. HNE and MDA were each more toxic at the higher concentration, 50μM. A 2mM solution of GEE prevented the protein conformational changes caused by both 50μM HNE and MDA. These results are discussed with relevance to oxidative stress in Alzheimer's disease.

INTRODUCTION

Alzheimer's disease, a neurodegenerative brain disorder, is characterized by the presence of senile plaques in the brain tissue of afflicted individuals. These senile plaques have been shown to contain aggregations of amyloid beta peptides (Aβ) (1,2,3). Our laboratory showed that Aβ is associated with free radical oxidative stress (4,5). Besides the initial damage caused by protein oxidation and lipid peroxidation, products of these processes can also be toxic to cells and may also contribute to cellular damage or death (9).

Two aldehyde products of free radical-induced lipid peroxidation are 4-hydroxy-2-*trans*-nonenal (HNE) and malondialdehyde (MDA) (10). It has been found that the level of the lipid peroxidation product, HNE, increases greatly in cultured hippocampal neurons in the presence of Aβ peptides (10). HNE and MDA are reactive aldehydes which can interact with membrane proteins. HNE and MDA are electrophiles that attack nucleophilic sites on amino acids and consequently alter protein conformation (11). HNE has been found to be much more reactive than MDA (9). In studies on the effects of HNE on membrane proteins, it has been shown that HNE can even change protein conformation by cross linking membrane proteins (12).

This study employed human erythrocyte membranes as the source of membrane proteins. Erythrocytes are unique in that they have a higher protein to lipid ratio than most cells. Erythrocytes also have an extensive network of cytosolic membrane proteins. It is this protein network and high protein content which make erythrocytes a good model in the study of the effects of HNE and MDA on the conformation of membrane proteins.

This study also employed the use of glutathione ethyl ester (GEE). The ethyl ester form of glutathione allows the glutathione molecules to penetrate the cell membrane and enter the cytosol. Glutathione is a tripeptide antioxidant that can combat the effects of some reactive species. HNE and MDA have been shown to react with thiol compounds such as glutathione (9), and it is this reaction which serves to protect cell membrane proteins from attack by HNE and MDA. Glutathione has previously been shown to form an adduct with HNE (13), and neuronal death caused by HNE decreases with the treatment of GEE (10).

The effects of HNE and MDA on protein conformation can be evaluated through the use of electron paramagnetic resonance (EPR) techniques of spin labeling. EPR is a good method for studying such protein conformational changes because EPR is sensitive to small changes in protein conformation and opaque samples can be studied. In order to detect these protein conformational changes, a protein specific spin label, MAL-6, was used to label the erythrocyte membranes. EPR with a MAL-6 label has been used is previous studies to determine the effects of toxins on protein conformation (14,15).

The purposes of this study were to determine: a) if HNE and MDA caused protein conformational changes in erythrocyte membranes; b) the dose response effect of HNE and MDA; and c) whether membrane proteins were protected from HNE and MDA toxicity by GEE. We found that HNE and MDA caused protein conformational changes at both 5µM and 50µM concentrations, and these changes were the greatest at the 50µM concentration. HNE showed a greater toxicity than MDA. We also found that GEE provided protection to the erythrocyte membrane proteins against the effects of HNE and MDA at both concentrations.

MATERIALS AND METHODS

Human blood was obtained from healthy donors by venipuncture and placed in heparinized tubes and immediately put in ice. Ghosts were prepared and spin labeled with MAL-6 as previously described (15). Briefly, intact red blood cells were diluted with 10 volumes of phosphate buffered saline (PBS: 5 mM sodium phosphate (mono- and di- basic) and 150 mM sodium chloride; pH 8.0). Samples were washed 3 times in PBS by centrifugation at 600 X g for 5 minutes at 4°C. Following each wash the buffy coat and the supernatant were removed by aspiration. Hypotonic lysis in 5P8 (5 mM potassium phosphate (mono- and di- basic)) buffer yielded the erythrocyte membranes. Cells were treated with 20 volumes of 5P8 and incubated for 30 minutes and subsequently centrifuged at 4°C and 27,000 X g, for 10 minutes. The process was repeated until all the hemoglobin was removed. The protein concentration of the ghosts was determined by methods described by Lowry et al. (16) and was adjusted to 8 mg/ml. At this point the ghosts were treated with either 5 or 50 µM HNE or MDA. Controls were treated with the vehicle for HNE and MDA, i.e., ethanol. The incubation was carried out for 60 minutes. The samples then were diluted to 3 mg/ml and spin labeled with MAL-6 as previously described (15). One volume of sample was added to 51 mM MAL-6 in 5P8 and incubated for 14-16 hours at 4°C. Excess spin label was then removed by washing six times with 5P8 and centrifuging each time at 27,000 X g and 4°C.

GEE effects were studied with the following procedure. The samples were divided into six aliquots. One aliquot was treated with ethanol alone. The second aliquot was treated with 50 µM HNE. The third aliquot was treated with DMSO, which was used as the vehicle for the glutathione ethyl ester (GEE), and ethanol, and the fourth aliquot was treated with ethanol, DMSO, HNE and GEE. The fifth aliquot was treated with 50µM MDA. The sixth aliquot was treated with ethanol, DMSO, MDA, and GEE. The samples were pre-treated with the GEE to give a final GEE concentration of 2 mM. This incubation was carried out for 3 hours. After this time 50 µM HNE or 50 µM MDA was added and further reaction continued for 1 hour. The samples were then centrifuged, spin labeled, and later analyzed with EPR spectroscopy, as described previously (14).

RESULTS

Analysis with EPR spectroscopy using MAL-6 leads to a spectrum that reflects membrane protein conformation. Two kinds of MAL-6 labeling sites are found in erythrocyte proteins: those in which the motion of the spin label is severely restricted (S sites) and those in which the motion of the spin label is only weakly immobilized (W sites). An EPR spectrum can be analyzed for changes in protein conformation by measuring the ratio of the low field resonance line intensity of the weakly immobilized spin label to that of the strongly immobilized spin label. Decreases in this W/S ratio have been found to correlate with alterations in protein conformation, and this alteration in protein conformation is a measure of toxicity. In all measures of oxidative stress thus far studied in our laboratory, including free radical generation, stroke, hyperoxia, accelerated aging, and Alzheimer's disease [reviewed in (17)], a common pathway, i.e., HNE production and subsequent reaction with proteins might explain this.

The first part of this study investigated the dose dependent effect of HNE on erythrocyte membrane protein conformation (Figure 1). The 5µM samples (n=6) showed an average W/S decrease of 8.5 ± 2.5%. Samples (n=6) treated with 50µM HNE showed a W/S decrease of 15.7 ± 3.7%. It is clear that higher levels of HNE (50µM) are substantially more toxic than low levels of HNE (5µM). The results for MDA were similar: the 5µM MDA samples (n=4) showed a decrease in W/S of 4.1 ± 1.85, while 50µM MDA (n=4) led to a W/S decrease of 15.7 ± 3.7%. Both are more toxic at high concentrations (50µM) than at low concentrations (5µM) (Figure 1).

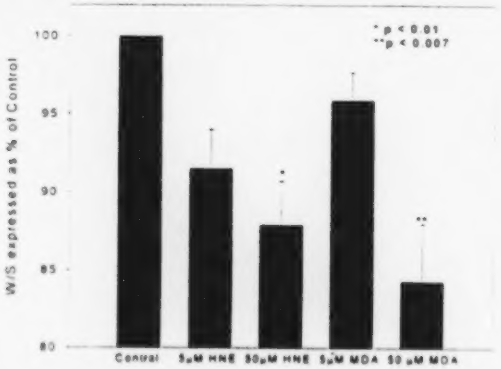

Figure 1: MAL-6 labeled Erythrocytes treated with HNE or MDA

The final part of this research focused on the antioxidant glutathione ethyl ester (GEE) (Figure 2). Samples (n=3) treated with GEE alone did not show a decrease in W/S ratios. Samples treated with 50µM HNE showed a W/S decrease of 11.7 ± 0.8%, while GEE treated HNE samples showed a reduction in decrease to only 2.0 ± 1.1%. Samples treated with 50µM MDA showed a W/S decrease of 9.0 ± 0.9%, while GEE treated HNE samples showed a reduction in decrease to only 1.0 ± 1.1%. These results demonstrate that GEE did, in fact, prevent erythrocyte membrane protein conformational changes by HNE and MDA.

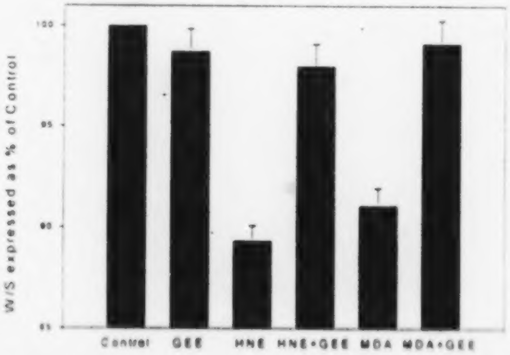

Figure 2: MAL-6 labeled Erythrocytes treated with HNE, MDA, and GEE

DISCUSSION

It is possible that the toxic effects of Aβ peptides are only the first step in the demise of cells in Alzheimer's patients. Products of lipid peroxidation may also contribute to cell dysfunction. Lipid peroxidation products, such as HNE and MDA, are important because HNE and MDA may be strong contributors to the cell damage and death that is characterized in Alzheimer's disease.

HNE and MDA were able to induce significant changes in the measured parameter for protein conformation (*viz.* W/S ratio), at both concentrations, with the percent decrease in W/S ratio being larger at higher concentrations of HNE and MDA. All samples were treated with the vehicle (ethanol) added to the erythrocyte membranes at 5μM and this did not cause any significant change in the W/S ratio of the MAL-6 spectrum. The data are consistent with HNE inducing slower motion of spin labeled proteins, concordant with the hypothesis that HNE can bind to and/or cross-link proteins.

It has been proposed that glutathione protects neurons against HNE and MDA toxicity (9). If HNE- and MDA-induced protein conformational alterations were thought to be important in neurotoxicity, glutathione should modulate the effect on protein conformation caused by HNE or MDA. Erythrocytes were treated with 2 mM glutathione ethyl ester (GEE) for 3 hours and then treated with 50 μM HNE or 50μM MDA. Consistent with the expectation of GEE protection, GEE did protect against the HNE or MDA induced decrease in the W/S ratio of MAL-6 labeled proteins, i.e. prevented the conformational alterations by HNE and MDA.

This study shows that HNE and MDA, at physiological levels, significantly alter the conformation of erythrocyte membrane proteins as assessed by W/S ratio of MAL-6 labeled membrane proteins using EPR spectroscopy. Decreases in W/S ratio observed in dose-response studies of HNE and MDA are due to structural modification or protein cross-linking due to HNE. The reactive sites on HNE (aldehyde functionality, double bond and hydroxy functionality) can cause protein side chains to become conjugated to HNE by Michael addition and cause further cross linking through the e-amino group on the side chain of lysine residues on other protein molecules via formation of a Schiff's base (9). These reactions have been well characterized and it is well known that HNE and MDA can react with cysteine, histidine and lysine residues on protein side chains (9). Modified and/or cross-linked proteins lead to proteins with altered conformation and cause increased protein-protein interactions and are likely explanation for the observed decrease in W/S ratio of MAL-6 labeled erythrocyte membranes treated with HNE or MDA. The production of HNE and MDA during lipid peroxidation occurs within the lipid bilayer. It is reasonable that protein conformational changes reflected by a decrease in W/S ratio would be expected in a membrane undergoing lipid peroxidation.

HNE and MDA are thought to react with glutathione by forming a thio-ether linkage at the double bond, followed by cyclization to a five-membered hemiacetal. The thio-ether linkage is highly stable compared to Schiff's base linkage. Therefore the protection against HNE or MDA induced protein conformational changes afforded by GEE is likely to the inhibition of HNE or MDA reactivity upon forming this cyclic adduct.

The Aβ-associated free radical hypothesis of Alzheimer's disease (4-8,17), suggests that Aβ, the major component of the senile plaques observed in AD brain, is associated with free radicals, which are neurotoxic and cytotoxic (4-8,17). Our laboratory previously established that Aβ-derived free radicals can cause both lipid peroxidation and protein oxidation (5,7,8). Based on these studies a model was proposed to explain the multiple membrane dysfunctions in AD. In a recent study, it has been shown that Aβ can also induce the formation of HNE in hippocampal neuronal cell cultures and synaptosomal membranes (10). That study also further established that HNE or MDA by itself is capable of inducing several of the oxidative-stress responses as that of Aβ, such as disruption of ion-homeostasis and neuronal death (6,10).

Based on this evidence, it is now proposed that even though the generation of free radicals by Aβ will still serve as the first toxic messenger of AD pathology, impairment of protein functions by the lipid peroxidation products HNE or MDA, the second toxic messengers in the cascade, may be of critical significance. This laboratory has shown in a separate study that Aβ can cause structural alterations of membrane proteins in both erythrocyte membranes and brain membranes (data not shown) similar to that observed due to HNE and MDA, and that such alterations in the physical state of the membrane proteins due to Aβ is free radical mediated. HNE or MDA, generated due to the initial free radical insult from Aβ, can subsequently conjugate with various membrane proteins. If generated at high concentrations, HNE or MDA can also lead to alteration in the physical state of lipids, which can affect the function of other transmembrane proteins. The proteins conjugated with HNE or MDA are structurally and functionally modified. Although further work is necessary, these results are consistent with the concept that HNE or MDA could be the ultimate cause of multiple membrane dysfunctions, including Ca^{++} accumulation, observed in AD brain membranes.

ACKNOWLEDGEMENTS

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REFERENCES

1. D.J. SELKOE, Neuron 6, 487 (1994).
2. B.J. CUMMINGS, J.H. SU, J.W. GEDDES, W.E. VAN NOSTRAND, S.L. WAGNER, D.D. CUNNINGHAM, and C.W. COTMAN, Neurosci. 48, 763 (1992).
3. J. KANG, H.G. LEMAIRE, A. UNTERBECK, J.M. SALBAUM, C.L. MASTERS, K.H. GRZESHIK, G. MULTHAUP, K. BEYREUTHER, and B. MULLER-HILL, Nature 325, 733 (1987).
4. K. HENSLEY, D.A. BUTTERFIELD, M.P. MATTSON, M. AKSENOVA, M. HARRIS, J.F. WU, R.A. FLOYD, and J.M. CARNEY, Proc Natl Acad Sci USA 91, 3270-3274 (1994).
5. D.A. BUTTERFIELD, K. HENSLEY, M.P. MATTSON, and J.M. CARNEY, Biochem Biophys Res Commun 200, 710 (1994).
6. R.J. MARK, K. HENSLEY D.A. BUTTERFIELD, M.P. MATTSON, J. Neurosci. 15, 6239-6249 (1995).
7. M. HARRIS, K. HENSLEY, D.A. BUTTERFIELD, R.A. LEEDLE, J.M. CARNEY, Exp Neurol. 131, 93-202 (1995).
8. M.E. HARRIS, Y. WANG, N.W. PEDIGO JR, K. HENSLEY, D.A. BUTTERFIELD, and J.M. CARNEY, J. Neurochem. 67, 277-286 (1996).
9. H. ESTERBAUER, R.J. SCHAUR, and H. ZOLLNER, Free Rad. Biol. Med. 11, 81-128 (1991).
10. R.J. MARK, M.A. LOVELL, W.R. MARKESBERY, K. UCHIDA, and M.P. MATTSON, J. Neurochem. 67, 001-0010 (1996).
11. T.J. MONTINE, V. AMARNATH, M.E. MARTIN, W.J. STRITTMATTER, and D.G. GRAHAM, Am. J. Pathology 148, 89-93 (1996).
12. B. FRIGUET, E.R. STADTMAN, and L.I. SZWEDA, J. Biol. Chem. 269, 21639-21643 (1994).
13. D.P. HARTLEY, J.A RUTH, and D.R. PETERSEN, Arch. Biochem. Biophys. 316, 197-205 (1995).
14. K. HENSLEY, J. CARNEY, N. HALL, W. SHAW, and D.A. BUTTERFIELD, Free Radic. Biol. Med. 17, 321-331 (1994).
15. C.H. TRAD, D.A. BUTTERFIELD, Toxicol Lett. 73, 145-155 (1994).
16. O.H. LOWRY, N.J. ROSEBROUGH, A.L. FARR, R.J. RANDALL, J. Biol. Chem. 193, 265-275 (1951).
17. D.A. BUTTERFIELD, Chem. Res. Toxicol. (1997) in press.

The Synthesis and Decomposition of Single Source CVD Precursors

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Abstract:

Magnesium-aluminum isopropoxide, $Mg[(AlOPr^i)_4]_2$, has been shown to undergo pyrolytic decomposition to produce films of Spinel Proper ($MgAl_2O_4$). The thermal decomposition of $Mg[(AlOPr^i)_4]_2$ was investigated using Evolved Gas Analysis monitored by Fourier Transform Infrared Spectroscopy. Small amounts of isopropanol were evolved from 297-370K as the sample reacted with traces of water in the system. Decomposition began at 665-680K with the production of propene. Propene reached a maximum around 750-755K and then declined. 2-propanone was first observed at 730 to 740K. The amount of acetone produced increased as the temperature was increased. The decomposition followed a Langmuir surface reaction mechanism and has an apparent activation energy of 78.3±8.9 KJ/mol.

Introduction:

Chemical Vapor Deposition (CVD) is used to coat objects from the gaseous phase with a solid of known composition. Recently, interest has developed in devising a process to generate a CVD process that will produce Spinel Proper. Spinel is a mineral that is has excellent thermal, chemical, and shock stability. Current industrial applications center on using spinel as a coating for electronic sensors in extreme environments, such as automobile oxygen sensors.[1] Vacuum pyrolytic decomposition of magnesium-aluminum isopropoxide is promising precursor for forming spinel.[1,2] Meese-Marktscheffel et al.[2] have shown that good quality spinel films can be formed using magnesium-aluminum isopropoxide in CVD processes. However, the mechanism for this thermal decomposition was not established. This study involved an investigation of the thermal decomposition mechanism of magnesium -aluminum isopropoxide. The reaction intermediates, activation energies, and products have been determined for this decomposition.

Experimental:

Apparatus:

The EGA-FTIR apparatus, which has been described in detail previously,[3] was built from a stainless steel four-way cross vacuum flange (MDC Corp.) [fig 1]. Two of the opposing arms were attached to KBr windows with o-ring connectors. One of the remaining arms was connected to vacuum (<100 microns). The other was attached to a 25 cm long piece of 9 mm glass tubing that had been sealed at one end. This tube served as the sample container. Two furnaces were used for this investigation. Each was made by wrapping 12 mm quartz tube with nichrome resistance wire. Power to the variable temperature furnace was supplied using a Perkin-Elmer regulated power supply. Heating rates of 4-8 K/ min were typically used. The constant temperature furnace was powered with a Variac. The temperature of each was monitored via Keithley digital thermometers (±3 K).

IR spectra were obtained using a Nicolet Magna 750 FTIR. This spectrometer scanned a complete IR spectrum (400 - 4000 cm^{-1}) every 2 seconds for reaction times up to 60 minutes. "Chemigrams" of selected IR bands could be made to follow the intensity observed for that species during the decomposition. The Nicolet-Aldrich FTIR library was used to help identify the molecules produced during the decomposition.

Evolved Gas Analysis Procedure:

Tenth to half gram samples of magnesium-aluminum isopropoxide were placed in the sample tube under strict anhydrous conditions and the open end of this tube was coupled to the cell. Two different experiments could be done. In the first, the reaction zone temperature was fixed while the sample zone temperature was increased. This enabled the change in the reaction dynamics as a function of the concentration of the magnesium-aluminum isopropoxide to be determined. In the second, the reaction zone temperature was changed and the sample zone temperature was fixed. This permitted the change of reaction dynamics as a function of temperature to be monitored and enabled the activation energy of each reaction to be determined.

Kinetic Parameters:

Constant Temperature Reaction Zone:

Nearly quantitative conversion of the precursor to product occurred using a hot zone temperature of 773±4K. The rate expression for the chemical reaction B→ P following simple gas phase kinetics is[4]

$$-dB/dt = k[B]^n. \qquad (1)$$

where dB/dt is the change in the pressure of B with time, k is the rate constant, and [B] is the pressure of B at time t. Since the temperature is constant, the k is constant. The flow time through the hot zone, dt, is a function of the pumping speed and is assumed to be constant. Since all of the products (P) are produced during the reaction, dB is proportional to P. Applying Beer's law gives that [P] and is proportional to the absorbance observed for P (A(P)). Applying logarithms gives:

$$-\ln(\text{Abs}) = \ln(k \bullet dt) + n\ln(B). \qquad (2)$$

Using the Clausius-Clapeyron equation[4] of the relationship between the logarithm of the pressure and enthalpy of vaporization to determine ln(B) in equation (2) and combining all constants into a single constant, C, gives:

$$\ln(\text{Abs}) = n(\Delta H_{vap} / R)\,[1/T] + \ln(C). \qquad (3)$$

Therefore, a least squares fit of this linear equation will yield a straight line if the reaction follows simple kinetics and the slope will equal $n\Delta_{vap}H/R$. If $\Delta_{vap}H$ is known, the reaction order is readily determined from this procedure.

Variable Reaction Zone:

The activation energy was found from the variable reaction zone experiments. Rearranging equation (1), taking logarithms of both sides, and using the Arrhenius equation[5] for the temperature dependence of k gives:

$$\ln[\,(dB / dt) / B^n\,] = \ln A_0 - Ea / RT \qquad (4)$$

Since

$$dB / dt \propto -dAbs / dt. \qquad (5)$$

and B^n is proportional to $(1\text{-Abs}/\text{Abs}_{max})^n$ where Abs_{max} is the absorbance observed when the reaction is quantitative,[3] equation (5) becomes:

$$\ln[\text{Abs} / (1-\text{Abs}/\text{Abs}_{max})^n] = \ln CA_0 - Ea/RT \qquad (6)$$

Plotting $\ln[\text{Abs}/(1-\text{Abs}/\text{Abs}_{max})^n]$ vs 1/T will give a straight line with a slope of $-E_a/R$.

Special Handling Techniques:

All compounds were stored and transferred under nitrogen. A rubber septum was used to maintain anhydrous conditions during the transfer of the sample tube from the drybox to

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the EVA-FTIR apparatus. A glovebag was temporarily attached to the cross vacuum flange to maintain sample purity while the EGA apparatus was evacuated. The sample tubes were scrupulously dried by flash heating with a torch while under vacuum and all tubes were transferred to the drybox while still under vacuum

Results and Discussion:

Evolved Gas Analysis:

Typical IR spectra observed for the decomposition of magnesium-aluminum isopropoxide using variable reaction zone temperatures are presented in figure 2. Decomposition began at 665-680K with the production of propene [fig 3]. The propene production reached a maximum around 750-755K, then declined until data collection was ended. The level of "background" propanol being supplied by the constant temperature source decreased as the propene formed. Shortly after propene production began 2-propanone (acetone) was observed (730-740K). Acetone evolution continued to increase throughout the data collection. Finally, the production of measurable amounts of water was observed beginning at 840K.

Small amounts isopropanol (IPA) were observed from 297-370K in the variable sample zone experiments. The amount of IPA did not increase during the solid to liquid phase change observed at 319 ±3K. However, it increased significantly as the temperature approached the boiling point, 377±3K @ ~100 microns. Peak IPA production occurred between 370 and 430K. A further increase in temperature resulted in rapid sublimation and transport of the starting compound from the sample zone. This quickly exhausted the sample providing an upper limit the experiment.

The IPA evolved during the low temperature range is attributed to hydrolysis of the starting compound by residual water. This can be accounted for by the reaction:

$$MgAl_2(OCH(CH_3)_2)_8 + xH_2O \rightarrow MgAl_2(OCH(CH_3)_2)_{8-x}(OH)_x + xHOCH(CH_3)_2 \quad (7)$$

Further reaction between the hydroxyl moieties in a Sol-gel like process, may account for the viscous residue left in the source zone of the tube.[6] The amount of IPA produced was reduced by special sample handling techniques, but was never completely eliminated.

Propene, the first pyrolysis product evolved, could form via the intramolecular transfer of a methyl proton as shown by:

$$MgAl_2(OCH(CH_3)_2)_8 \rightarrow nCH_3CHCH_2(g) + MgAl_2(OH)_n(OCH(CH_3)_2)_{8-n}(g) \qquad (8)$$

This process could continue until all the alkoxide moieties have been pyrolized, leaving an intermediate species $MgAl_2(OH)_8$. A second possible source of 2-propanone is the catalytic oxidation of IPA by spinel proper. When IPA is passed through a reaction zone coated with spinel from the bimetallic alkoxide, total conversion to acetone and propene can be achieved over the same overall temperature range of the substrate decomposition. A $\Delta_{rxn}H$ was found to be 183±10 kJ/mol for the decomposition. This compares well with values found for Al_2O_3 and MgO which were 171±17 and 177±10 kJ/mol. The Al_2O_3 produced propene from the 2-propanol. The MgO, however, produced acetone from the 2-propanol. This would suggest that the pyrolysis of the alkoxide substrate would favor the conversion of the isopropoxide groups to propene at lower temperatures with a shift towards acetone at higher temperatures. This is observed from the chemigrams for acetone and propene [fig X]. Structurally this is consistent with the alkoxide as the terminal isopropoxide groups are only singly bound by aluminum, which was responsible for propene production. More energy is required for the magnesium to exert catalytic behavior due to the two bonds associated with the bridging alkoxide, hence propene was observed before acetone.

The water observed at higher temperatures could form from pyrolysis of this spinel precursor:

$$MgAl_2(OH)_8 \rightarrow MgAl_2O_4 + 4\ H_2O \qquad (9)$$

Acetone could form from the pyrolysis of the starting material or from a gas phase reaction between the propene and the OH on a spinel precursor such as $MgAl_2(OH)_8$.

$$MgAl_2(OH)_8 + CH_3CH_2CH_2 \rightarrow CH_3COCH_3 + MgAl_2(OH)_6 + H_2 . \qquad (10)$$

Reaction (10) is favored because the acetone was observed in the spectrum after propene, the acetone continued to grow as the propene decreased in intensity after total conversion of the starting material in the variable reaction zone experiments [fig. 4], and a plot of the ln ($A_{2\text{-propanone}}/A_{\text{propene}}$) verses 1/T forms a straight line over the entire temperature range [fig 5]. This relationship is the ideal equilibrium constant for reaction 10. The straight line relationship is consistent with an equilibrium being established between these two species.

The simple gas phase kinetic plots did not give straight lines indicating that reaction does not follow a simple gas phase reaction mechanism. Langmuir rate plots [fig 6] did give the expected linear relationship.[3] However, there was a break in the curve at a pressure of 50 Pa, which may indicate that two mechanisms are occurring. The heat of vaporization was found to be 123±15 KJ/mol from the Langmuir plot.

The apparent activation energy of the decomposition reaction was found using the equations derived for the variable temperature hot zone. Because of the equilibrium between acetone and propene, the absorbances of both major products were used as a sum. The apparent activation energy (E_a) for the alkoxide was found to be 78.3±8.9 KJ/mol.

Synthesis and Characterization:

The synthesis and characterization of magnesium-aluminum isopropoxide followed the procedure given by Meese-Marktscheffel, et *al.*[7] Fifty grams of aluminum isopropoxide (0.244 mol -- Aldrich), 2.97g Magnesium shavings (0.122 mol -- J.T. Baker), and 0.665g Mecurous Chloride catalyst ($1.41{*}10^{-3}$ mol -- Coleman & Bell) were refluxed in 500ml of sodium purified isopropyl alcohol (Aldrich). The reaction was allowed to proceed for at least 96 hours. Shelenk and drybox techniques were observed for all steps. Excess solvent was removed by distillation under passive nitrogen. The product was then isolated and purified using vacuum distillation. A boiling range of 405-407K was observed during the distillation. Solidification of the viscous liquid occurred rapidly upon cooling. Proton, $^{13}C\{^1H\}$, and ^{27}Al NMR were consistent with literature values.

Conclusions:

The thermal decomposition of magnesium-aluminum isopropoxide leads to the surface deposition of Spinel Proper ($MgAl_2O_4$) in a manner consistent with the Langmuir mechanism. The gaseous products that evolved were identified as propene, acetone, propanol, and water. The propene and acetone are observed to be in equilibrium, with the acetone being favored at higher temperatures. The apparent activation energy (E_a) for the pyrolysis of the alkoxide was found to be 78.3±8.9 KJ/mol.

Works Cited:

1. Pierson, Hugh O.; Handbook of Chemical Vapor Deposition Principles ,Technology, and Applications. Noyes Publications: Park Ridge, New Jersey, 1992.

2. Meese-Marktscheffel, J. A., Fukuchi Ruth, Kido Melisa, Jensen, Craig M., Gilje, John G.; "Heterometallic Aluminum Alkoxides. The Characterization of $\{Mg[Al(OPr^i)_4]_2\}_n$ and $Mg_2Al_3(OPr^i)_{13}$." *Chem. Mater.* 1993, 5, pp755-7.

3. Crouch, M.A. and DeVore, T.C.; "Reaction between Bis(2,4-pentanedionato)lead(II) and Water Vapor: A Thermodynamic Study." *Chem Materials.* 1996, 8, pp32-6.

4. Atkins, P.W.; Physical Chemistry, 5th Edition, "Physical Transformations of Pure Substances", W.H. Freeman and Co., New York, 1994, pp198-9.

5. Atkins, P.W.; Physical Chemistry, 5th Edition, "The Temperature Dependence of Reaction Rates", W.H. Freeman and Co., New York, 1994, pp877-9.

6. Gelest, Inc. Product Catalogue, 612 Wm. Leigh Dr., Tullytown, PA, 1991.

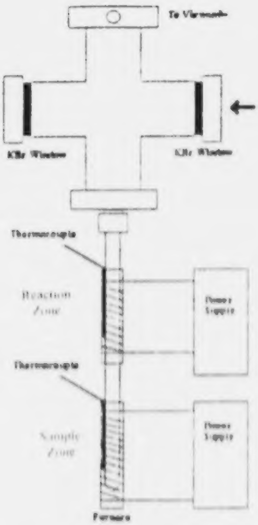

To Vacuum
KBr Window
KBr Window
Thermocouple
Reaction Zone
Power Supply
Thermocouple
Sample Zone
Power Supply
Furnace

Fig 1. EVA-FT/IR Apparatus.

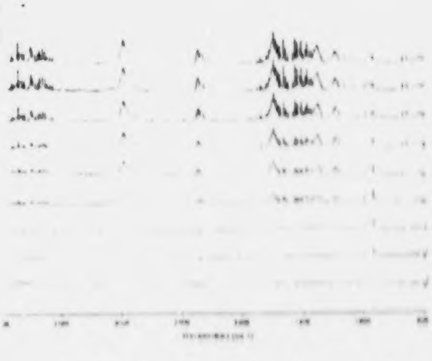


Fig 2. Selected Spectra from Reconstruction

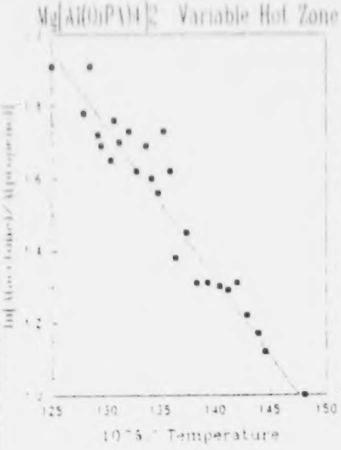


Fig 4. Kinetic plot showing and product equillibrum.

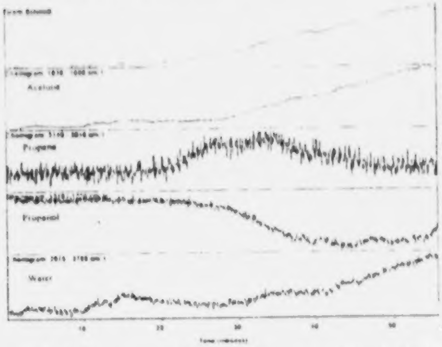
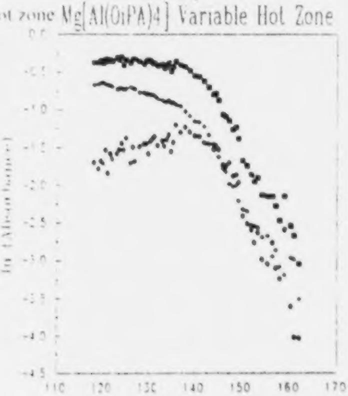


Fig 3. Reconstruction and chemigrams, variable hot zone



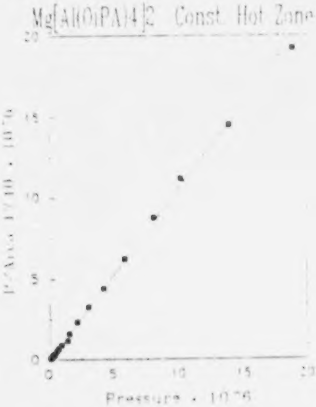


Fig 5. Kinetic plot showing ΔH of vaporization.

Fig 6. Equillibrum relationship between acetone and propene.

Thermal Remediation of Model Chloropesticides Utilizing Reactions With Sodium Salts

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ABSTRACT

The thermal reactions between chlorocarbons that can be used to model the chemical behavior of chlorine containing pesticides and several sodium salts were investigated using Evolved Gas Analysis - Fourier Transform Infrared Spectroscopy. Sodium oxalate was found to react nearly quantitatively with aliphatic chlorocarbons in flow systems at temperatures between 750 K and 900 K. The principle gaseous products were carbon dioxide and traces of carbon monoxide. X-ray diffraction analysis of the black residue confirmed that sodium chloride was present. Since the X-ray pattern did not indicate the presence of graphite, the black color is probably from amorphous carbon. Sodium carbonate also thermally degraded aliphatic chlorocarbons between 600 - 900 K. Chlorobenzene reacted with sodium carbonate at temperatures above 800 K, but the reaction was not quantitative. Sodium hydrogen carbonate did not react with chlorocarbons until the temperatures was well above its decomposition temperature; suggesting that the reaction with sodium carbonate was actually occurring..

INTRODUCTION

Use of chlorine containing pesticides has increased during the past several decades. Pesticides, such as p,p'-DDT have a high stability and tend to accumulate in the environment.[1] Several methods have been devised to destroy the chlorocarbons, but all have some drawbacks. Incineration of the compound in high temperature furnaces is commonly used, but this method is expensive.[2,3] The use of bacteria for soil remediation has merit and may become the method of choice in the future. However, bacteria currently can only break down a few pesticides, which limits the effectiveness of this method.[4] Activated carbon has been used to adsorb pesticides. While this method is effective in removing pesticides from the environment, it offers no possibility of destroying them.

Two lower cost methods have recently been advanced for remediating chlorocarbons. Combustion of chlorocarbons in catalytic furnaces may permit lower temperature operation. Oxide catalysts like U_3O_8 have shown promise in remediating a variety of chlorocarbons and have been suggested as possible systems for waste stream remediation.[2,3] Sodium oxalate has been reported to react quantitatively with fluorochlorocarbons at 550 K in circulating bed systems.[5] This process may also be effective in flow systems under the appropriate conditions. If so, then it could also be used for waste gas clean-up operations during continuous processing. Since alkaline substances are already used in the petroleum industry as HCl scavengers to reduce acidic emissions,[6] they would have the advantage of also removing the HCl produced during the catalytic combustion of chlorocarbons.

The thermodynamics expected for some simple reactions between some sodium salts and tetrachloromethane (CCl_4), trichloromethane ($CHCl_3$), and 1,2-dichloroethane ($C_2H_4Cl_2$) are summarized in Table 1. The reactions for $Na_2C_2O_4$ and Na_2CO_3 have very favorable $\Delta_{Rxn}G(298)$. If initiated, these reactions should be nearly quantitative. It is less certain that $NaHCO_3$ will react as predicted, but reaction via some additional pathway may occur. This investigation was undertaken to determine if the kinetics are also favorable and to determine the conditions where reaction would actually occur rapidly. In addition, reactions with chlorobenzene (C_6H_5Cl) where attempted to determine if these salts would also react with a aromatic chlorocarbons.

EXPERIMENTAL

Reagents

The tetrachloromethane, 1,2-dichloroethane , and chlorobenzene were Fisher ACS. The trichloromethane and the sodium salts were from Mallinckrodt. All chemicals were used as received.

Apparatus

The evolved gas analysis-Fourier transform infrared apparatus used in this investigation has been described in detail previously.[7] Briefly, the IR cell was constructed by attaching KBR windows to two opposing arms of a stainless steel four-way cross vacuum flange (MDC, Inc.) One of the remaining arms was connected to the vacuum line. The other was attached to a 9 mm glass tube that served as the sample container. The open end of this tube was attached to a glass tube that contained the chlorocarbon. A Teflon needle valve was used to regulate the flow of the chlorocarbon into the reaction vessel. A 12 mm Vycor tube, wrapped with Nichrome resistance heating wire, sliped over the sample tube and was used to heat the sample. A Perkin regulated power supply was used to power the furnace. Heating rates of 4- 10 K were used for most experiments. The temperature of the sodium salt bed was measured using a chromel-alumel thermocouple connected to a Keithly Digital Thermometer. The temperature was measured to ± 3 K over the temperature range (298 - 900 K) used.

IR spectra were obtained using a Nicolet Magna -750 FTIR. This spectrometer was set to obtain one spectrum every two seconds for reaction times up to one hour. Spectra were obtained from 4000 to 400 cm^{-1} and could be retrieved for further analysis. The Nicolet-Aldrich spectral library was used to help identify the evolved molecules.

The composition of the residue was determined using powder X-ray analysis. The ASTM x-ray library was used to help identify the components of the mixture.

Procedure

0.1 to 0.5 g of the sodium salt was placed in the center of the reaction tube and held in place with a plug of glass wool. The cell was evacuated, the flow of chlorocarbon was started, and the sample was heated at a slow constant rate. The FTIR was used to monitor the spectrum of the evolved gases as the reaction proceeded.

RESULTS AND DISCUSSION

Samples of the IR spectra obtained as $Na_2C_2O_4$ reacted with CCl_4 are presented in Figure 1. The profile of the species observed as a function of temperature are shown in Figure 2. Nearly quantitative conversion of the CCl_4 was obtained by 750 K if a large excess of $Na_2C_2O_4$ was present. IR product bands arising from CO, CO_2, and C_2Cl_4 were identified in the spectrum. The temperature profile suggested that C_2Cl_4 was a reaction intermediate and that CO_2 was the main gaseous product formed. X-ray analysis of the black residue confirmed the presence of sodium chloride and sodium carbonate. Since these compounds are white and the x-ray analysis did not indicate that graphite was present, the black color probably resulted from amorphous carbon. The carbon, CO_2 and sodium chloride are the products expected from the thermodynamic analysis given in table 1. The C_2Cl_4 was formed from partial reaction of the CCl_4 with $Na_2C_2O_4$

$$2\ Na_2C_2O_4 + 2\ CCl_4 \dashrightarrow 4\ NaCl + C_2Cl_4 + 4\ CO_2 \qquad (1)$$

The C_2Cl_4 then further reacted to give the expected products.

$$2\ Na_2C_2O_4 + C_2Cl_4 \dashrightarrow 4\ NaCl + 2\ C + 4\ CO_2 \qquad (2)$$

Sodium carbonate and CO are also products for the thermal decomposition of $Na_2C_2O_4$[8] and probably resulted from the thermal decomposition of this compound.

$Na_2C_2O_4$ also reacted with trichloromethane and 1,2-dichloroethane in this temperature range. The products observed are summarized in Table 2. These products are consistent with the reactions given in Table 1. No evidence for reaction with chlorophenol was observed. Evidence for the thermal decomposition of the $Na_2C_2O_4$ was obtained in all cases.

Since the x-ray diffraction indicated that Na_2CO_3 was present during the $Na_2C_2O_4$ reactions and the thermodynamic calculations indicated that this compound could also react with the aliphatic chlorocarbons, the reactions between these compounds and Na_2CO_3 were also investigated. The results obtained are summarized in Table 3. With the exception of the 1,2-dichloroethane, the reactions largely occurred as shown in Table 1. The 1,2-dichlorethane reaction was more complicated than anticipated. IR spectrum at 900 K of the reaction products clearly show that vinyl chloride (C_2H_3Cl), ethene (C_2H_4), and ethyne (C_2H_2) were also produced during the reaction. (see Figure 3) The product temperature profiles indicate that CO_2, C_2H_4O, and C_2H_3Cl were formed initially. The CO_2 and C_2H_4O are consistent with the reaction given in Table 1. The C_2H_3Cl must come from a different reaction. While the reaction

$$Na_2CO_3 + 2\,C_2H_4Cl_2 \text{ -------->} 2\,NaCl + CO_2 + H_2O + 2\,C_2H_3Cl \quad (3)$$

has slightly positive $\Delta_{Rxn}H(298)$ (+3.85 kJ/mol), it has a favorable $\Delta_{Rxn}G(298)$ (-95.23 kJ/mol) and is probably forming this compound. The decrease in intensity of the C_2H_4O at higher temperatures corresponded to the increase in the C_2H_4 and the C_2H_2 absorbances. Possible reactions to form these compounds are

$$Na_2CO_3 + C_2H_4Cl_2 \text{ -------->} 2\,NaCl + CO_2 + 1/2\,O_2 + C_2H_4 \quad (4)$$

$$Na_2CO_3 + C_2H_4Cl_2 \text{ -------->} 2\,NaCl + CO_2 + H_2O + 2\,C_2H_2. \quad (5)$$

Both reactions are endothermic ($\Delta_{Rxn}H(298)$= + 96 kJ/mole and + 30 kJ/mol respectively), but have $\Delta_{Rxn}G(298)$ (+24 kJ/mole; - 64 kJ/mol) which indicate that the reaction could become favorable at high temperatures.

While chlorobenzene did not react significantly with chlorobenzene over the temperature range tested, traces of benzene were observed in the spectrum at temperatures over 800 K. Since there was a corresponding increase in the absorbance of the CO_2 and H_2O and a slight decrease in the absorbance of the chlorobenzene in this region, some reaction probably is occurring. The composition of the solid products and the stoichiometry of this reaction have not been established.

Several experiments were attempted to determine if $NaHCO_3$ would also react with these compounds. Although evidence for reaction was obtained, the $NaHCO_3$ had largely thermally decomposed before the reaction with the chlorocarbons began.

CONCLUSIONS

A flow of CCl_4, $CHCl_3$, or $C_2H_4Cl_2$ reacted nearly quantitatively with excess $Na_2C_2O_4$ or Na_2CO_3 at temperatures between 750 K and 900 K. Evolved gas analysis- Fourier transform IR and x-ray diffraction have been used to identify several of the chemical reactions that occurred during each process. Thermodynamic calculations for these reactions indicated that they could provide an alternative to incineration for removing these compounds from waste gas streams, the destruction of freon stockpiles, and remediation of chloropesticide stockpiles. There was also indication that these compounds react with chlorobenzene. However, these reactions are not quantitative in the temperature range investigated and would not be effective for remediation.

ACKNOWLEDGEMENTS:

The Authors are grateful to Cynthia Kerns for assistance with the X-ray analysis and to The ACS - Petroleum Research Fund for supporting this project.

REFERENCES

1. Gruzdelewa, L.; Dokurno, P; Rak, J.; Blazejowski, J; J. Thermal Anal. "Thermal

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Behavior of Organochlorine Pesticides in the Presence of Alkaline Substances", 45, 849 - 858 (1995).

2. Petrosius, S.; Russell, D.; Vareica, Y.; Grunewald, G.; J. Am. Chem. Soc. "Low Temperature Decomposition of Some Halogenated Hydrocarbons Using Metal Oxide/ Porous Oxide Catalysts" 115, 6131 - 6137 (1993).

3. Hutchings, G.J.; Heneghan, C.S.; Hudson, I.D.; Taylor, S.H.; Nature "Uranium Oxide Based Catalyst for the Destruction of Volatile Chloro-Organic Compounds" 284, 341-3 (1996)

4. Runl, T.; Klotz, D.; Tykoa, R; Proc. SPIE - Int. Soc. Opt. Eng. "Analysis of Bioremediation of Pesticides by Soil Micro-organisms" 2504, 587 - 591 (1995).

5. Burdeniuc, J.; Crabtree, R.H.; Science "Mineralization of Chlorofluorocarbons and Aromatization of Saturated Fluorocarbons by a Convenient Thermal Process" 271 340 - 341 (1996).

6. Frounfelker, R; Solid Waste and Power "Sodium Bicarbonate Makes Sense For Small Plant Retrofit" 40 - 46 (1989).

7. Crouch, M.A.; DeVore, T.C.; Chem. Mater. "Reaction Between Bis (2,4-pentanedionato)lead (II) and Water Vapor: A Thermodynamic Study" 8, 32-36 (1996).

9. Dollimore, D; Griffiths, D.L.; J. Thermal Anal. "Differential Thermal Analysis Study of Various Oxalates in Oxygen and Nitrogen" 2, 229 - 250 (1970).

8. Wagman, D.D.; Evans, W.H.; Parker, V. B.; Schumm, R.H.; Halow, I; Bailey, S.M.; Churney, K.L.; Nuttall, R.L.; J. Phys. Chem. Ref. Data "The NBS Tables of Chemical Thermodynamic Properties: Selected Values for Inorganic and C_1 and C_2 Organic Substances in SI Units" 11 Supplement No. 2, 1982.

Table 1: Thermodynamics (in kJ/ mol) for the Most Likely Reactions Between Some Sodium Salts and Some Simple Aliphatic Chlorocarbons (Calculated Using Data From Reference 9)

Reaction	$\Delta_{Rxn}H(298)$	$\Delta_{Rxn}G(298)$
$2\ Na_2C_2O_4 + CCl_4 \longrightarrow 4\ NaCl + 4\ CO_2 + C$	-479.7	-500*
$3\ Na_2C_2O_4 + 2\ HCCl_3 \longrightarrow 6\ NaCl + 6\ CO_2 + HCCH$	-440.8	-420*
$Na_2C_2O_4 + C_2H_4Cl_2 \longrightarrow 2\ NaCl + 2\ CO_2 + C_2H_4$	-109.25	-115*
$2\ Na_2CO_3 + CCl_4 \longrightarrow 4\ NaCl + 3\ CO_2$	-460.8	-570.2
$3\ Na_2CO_3 + 2\ HCCl_3 \longrightarrow 6\ NaCl + 4\ CO_2 + H_2O + C$	-684.4	-836.7
$Na_2CO_3 + C_2H_4Cl_2 \longrightarrow 2\ NaCl + CO_2 + C_2H_4O$	-121.5	-173.2
$4\ NaHCO_3 + CCl_4 \longrightarrow 4\ NaCl + 5\ CO_2 + H_2O$	+ 52.2	-271.5
$3\ NaHCO_3 + HCCl_3 \longrightarrow 3\ NaCl + 4\ CO_2 + H_2O$	- 93.7	-334.8
$2\ NaHCO_3 + C_2H_4Cl_2 \longrightarrow 2\ NaCl + CO_2 + C_2H_4O + H_2O$	+255.9	+484.3

* Based on estimated $\Delta_f G\ (Na_2C_2O_4)$ of -1300 kJ/ mole.

Table 2: Products Observed For the Reactions of Simple Chlorocarbons With Sodium Oxalate

Chlorocarbon	Reaction Temperature (K)	Gaseous Products	Solid Products
CCl_4	750 - 900	CO, CO_2, C_2Cl_4	$NaCl$, $NaCO_3$, C
$HCCl_3$	750 - 900	CO, CO_2, C_2H_2	$NaCl$, $NaCO_3$, C
$C_2H_4Cl_2$	750 - 900	CO, CO_2, C_2H_2	$NaCl$, $NaCO_3$, C
C_6H_5Cl	No Reaction		

Table 3: Products Observed For the Reactions of Simple Chlorocarbons With Sodium Carbonate

Chlorocarbon	Temperature(K)	Gaseous Products	Solid Products
CCl_4	800-900	CO_2, C_2Cl_4, $COCl_2$	$NaCO_3$, C
$HCCl_3$	570 - 900	CO, CO_2, H_2O	NaCl, C
$C_2H_4Cl_2$	525 - 900	CO_2, C_2H_4, C_2H_4O C_2H_3Cl, C_2H_2	NaCl, C
C_6H_5Cl	800-900	C_6H_6, CO_2, H_2O	???

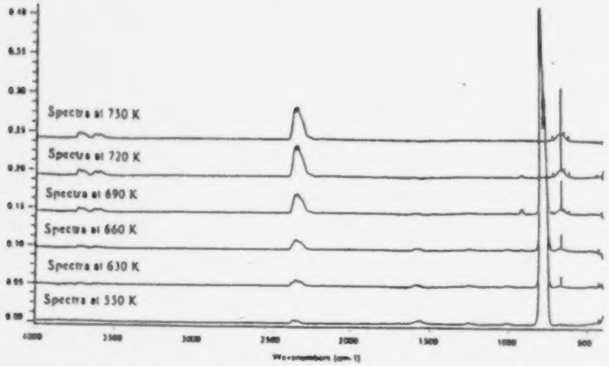

Figure 1: Infrared Spectra Observed for the Reaction Between $Na_2C_2O_4$ and CCl_4. The Reaction Temperature Is Given in the Figure. Initial CCl_4 Is Expanded to Show the Product Features.

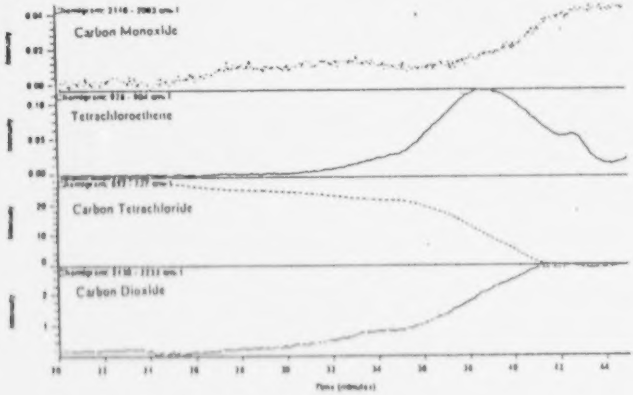

Figure 2: Absorbance Verses Temperature Profiles Observed for the Products From the Reaction Between $Na_2C_2O_4$ and CCl_4. The Sample Was Heated at a Constant Rate of 11 K/min. The Identity of Each Molecule is Given in the Figure

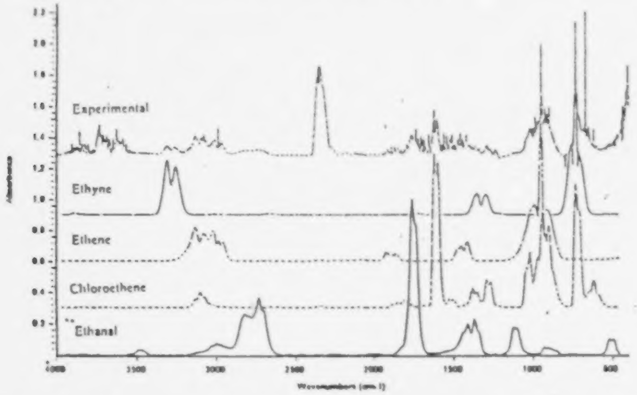

Figure 3. The IR Spectrum Obtained From the Reaction Between Na_2CO_3 and $C_2H_4Cl_2$ at 875 K. This Spectrum Is Compared to Spectra From the Aldrich/ Nicolet Library in the Figure. Library Spectra For CO_2 and H_2O are Not Given For Clarity.

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Determining the Effect of Substitutions on the Hyperpolarizabilities of Tricyanoquinoline-Dimethanes

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Theoretical studies of several substituted tricyanoquinoline-dimethane molecules have been performed in order to determine their first and second order hyperpolarizabilities. These calculations were performed semiempirically using the finite-field approach. The electron donating and withdrawing substituents added were alkyl, amino and nitro groups, respectively, because of there push-pull effect.

BACKGROUND

The potential for use of certain organic compounds in optical devices such as those found in computers and high density optical recording has lead to increased interest in determining which compounds are best suited for this use. These molecules interact with light in such a way that they are able to affect the frequency, phase or amplitude of the electromagnetic radiation (1). It has been found that large molecules with high third order polarizabilities (γ) show the greatest promise for use as optical switches in such devices. Size requirements prevent the use of ab-initio calculations in determining the third order polarizabilities of these molecules. For this reason, semiempirical methods have been employed to determine the first and second hyperpolarizabilities (β and γ) of substituted tricyanoquinoline-dimethane compounds. These molecules are known to have high third order polarizabilities (2). Using this method the effect of adding electron-donating and withdrawing groups on the hyperpolarizability has been studied. These groups have been added at various positions, separately and in pairs, and the hyperpolarizabilities were determined using the AM1 Hamiltonian .

METHOD

The first step in determining the hyperpolarizabilities was to determine the structure of the molecule with the newly substituted functional groups. Once a suitable initial structure had been obtained, the geometry was optimized using MOPAC (3) and the AM1 Hamiltonian (4) to calculate the structure with lowest bond energy.

The hyperpolarizability (β) is the second-order change of the molecular polarizations (P) which is the result of an applied electrical field (F):

$$P(F)= \mu + \alpha F + \beta F^2 + \gamma F^3 + \ldots \quad (1)$$

where, μ= permanent dipole moment; α= linear polarizability; β= second order polarizability; γ= third order polarizability. Polarization versus static field data were determined semiempirically using a static electric field within the AM1 Hamiltonian. These calculations were performed by the MOPAC program.

The data was analyzed by the HYPER program (5-6) to obtain the hyperpolarizability by the finite-field method. The uncertainties of the polarizabilities where evaluated based on the variability of the coefficients in polynomial expansions of various degrees.

RESULTS

In this research substituents that were electron-withdrawing and electron donating were added to the tricyanoquinoline molecule. From previous unpublished results it was found that the unsubstituted tricyanoquinoline had a $\beta = (653 \pm 47)\times 10^{-51}$ Cm^3V^{-2} and a $\gamma = (197 \pm 10)\times 10^{-61} Cm^4V^{-3}$.

Upon addition of an electron donating group at carbon 6 on ring I(figure 1-I), the β was reduced by 3%. Addition of a symmetrical tertiary amine at carbon 6 on ring I and a nitro group at carbon 3 on ring I (figure 1-III) increased the β by 11 %. Molecule III also demonstrated the greatest third order polarizability (γ), (figure 3) which may indicate a relationship between symmetry on the tertiary substituent and increased γ. The presence of a lone nitro group at carbon 6 (figure 1-IV), produced a β of 789 $10^{-51}Cm^3V^{-2}$, which was greater than the combination of groups in molecule III or the single NH_2 at position 6 in molecule I. It is also 21% greater than the unsubstituted molecule. From the data in figure 3, however, it seems that the electron withdrawing NO_2 group has a negative effect on the third order polarizability where Molecule IV with its lone NO_2 group produced a third order polarizability of nearly half the value for Molecule I with its single amino group.

A correlation between the $\mu\beta$ angle and second order polarizability can be seen in molecules II and IV where second order polarizabilities are greatest for those molecules with the lower $\mu\beta$ angles, which were both lower than 35° (Figure 2). Comparison of dipole moments (μ) and the second order polarizabilities (Table 2) seem to indicate the addition of an electron withdrawing group has a greater influence on the second order polarizability that the electron donating groups. Molecules II, III, and IV with all contain electron withdrawing groups all exhibited greater dipole moments, as well as higher first and second order polarizabilities than Molecule I which lacks an additional electron acceptor.

CONCLUSION

The greatest hyperpolarizability was exhibited by the combination of the asymmetrical tertiary amine at carbon 6 on ring I and the nitro group at carbon 3 on ring I (figure 1-II) which was 85% greater than the unsubstituted molecule. The results seem to show that an increased polarizability can be achieved by the addition of combinations of strong electron acceptors and donors or by a strong electron withdrawing group. Upon comparison of data collected thus far more suitable molecules may be formed which optimize the effect of increased second-order polarizability demonstrated by addition of electron withdrawing substituents and minimize the decreased third order polarizability by using a less electronegative substituent.

Future studies will explore the effect of tertiary amines without opposing electron withdrawing groups, amides and carboxyl groups on the hyperpolarizability of the tricyanoquinoline molecules.

ACKNOWLEDGMENTS

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REFERENCES

1. P.N. Prasad and J.D. Williams; Introd. to Nonlinear Optical Effects in Molecules and Polymers; John Wiley & Sons, Inc; NY 1990
2. P.Boldt, J. Wichem, S. Zippel, M. Dorr, R. Zentel; C.R. Brauchle, R. Dietrich, K. Meerholz; SPIE vol 2852, p. 2, 1996
3. QPCE Program 455, version 6.1, 1990
4. M.J.S. Dewar, E.G. Zoebisch, E.F. Healy, J.J.P. Stewart; JACS vol. 107, p3902, 1985
5. B.H. Cardelino, C.E. Moore, R.E. Stickel; JPC vol. 95, p8645, 1991
6. B.H. Cardelino, C.E. Moore, D.O. Frazier; JPC vol. , p , 1997

Table 1: Descriptions of molecules for which calculations have been performed.

Molecule	name
I	Tricyanoquinoline-dimethane + NH_2
II	Tricyanoquinoline-dimethane + NO_2 and CH_3CH_2-N-CH_3 (para)
III	Tricyanoquinoline-dimethane + NO_2 and CH_3-N-CH_3 (para)
IV	Tricyanoquinoline-dimethane + NO_2

Table 2: Preliminary results of the dipole moment (μ), the first order polarizability (α), the hyperpolarizability (β), and the third order polarizability (γ) for each molecule.

Molecule	μ	α	ave β	+/-	γ	+/-	angle uβ
I	4.49	59.71	633	53	215	32	44
II	10.68	79.35	1170	117	235	59	32
III	8.09	65.48	702	69	241	36	77
IV	12.48	69.70	789	15	120	33	21

Units: μ=Debye $\alpha=A^3$ $\beta=10^{-51}Cm^3V^{-2}$ $\gamma = 10^{-61}Cm^4V^{-3}$ Degrees

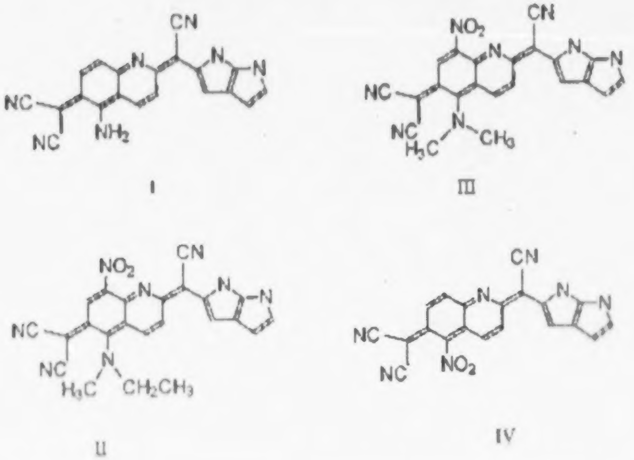
CN
NC
NC
NH₂
N
NO₂
CH₃
H₃C
CH₂CH₃
I
III
II
IV

Figure 1: Substituted tricyanoquinoline-dimethane molecules studied.

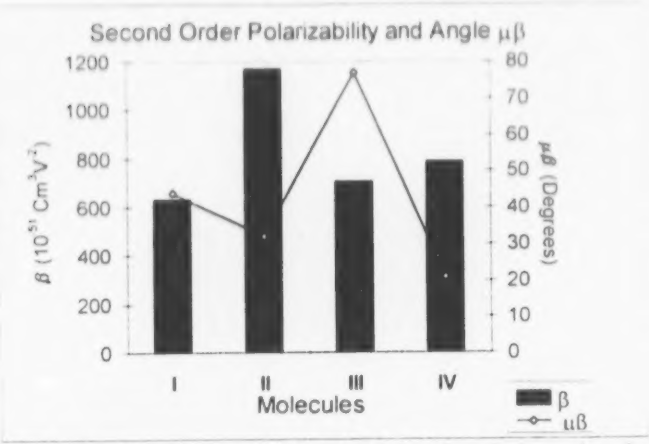

Figure 2: Graph of hyperpolarizabilities (β) and the μβ angle for each molecule studied. Angle μβ is the angle between the vector of the dipole moment (μ) and vector for the hyperpolarizability.

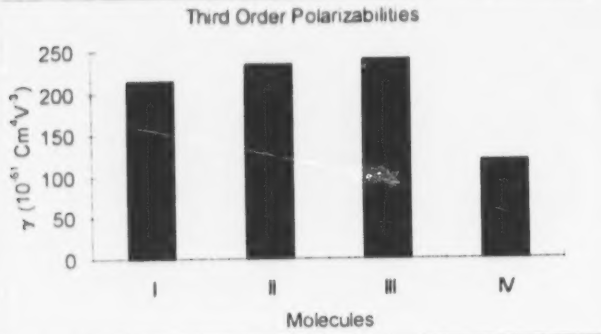

Figure 3: Third order polarizabilities (γ) of the molecules studied in $10^{-61}Cm^4V^3$.

Better Magnetic Resonance Imaging Contrast Agents for Tumor Detection

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Compounds of the metal gadolinium (Gd) are used in commercial magnetic resonance imaging (MRI) contrast agents. Relaxivity is a measure of drug effectiveness with higher relaxivity indicating a better drug. Unfortunately, the link between relaxivity and chemical properties is unclear. This research describes an efficient and accurate semiempirical quantum mechanical (SEQM) method for prediction of the chemical properties of Gd contrast agents. The SEQM method is then used to study possible decomposition pathways for Gd complexes.

BACKGROUND

Drug design is a prime example of the way in which computational chemistry can complement experimental work. Presently, most drugs are first studied with computational methods before undertaking experimental evaluation. Computation allows the medicinal chemist to screen many possible drugs in a very efficient manner, and to focus the experiments on the most promising leads. Computer-aided design of drugs thus has obvious benefits in reduced time and cost. However, this is not yet the case with metal-containing drugs because of the challenges inherent in the application of computational chemistry to metals.

Until recently, little computational research has been done with metals, particularly heavy metals like gadolinium.[1] Traditionally, most computational research has concentrated on organic compounds because of their importance in biology. However, metal-containing compounds are important in medicine and biology. For example, a platinum drug, cis-platin, is the most widely used anti-cancer agent.[2] An example of a metal's importance in biology is the iron-containing protein hemoglobin. The iron plays a pivotal role in respiration.[3]

An important family of metallodrugs is magnetic resonance imaging (MRI) contrast agents.[4] Compounds of the metal gadolinium (Gd) are currently used in all commercial MRI contrast agents. Gadolinium acts as a small magnet and interacts with hydrogen atoms on nearby waters, and this results in a lighter area in the MRI scan of the target tissue and greater contrast. Relaxivity (R_1) is a measure of this magnetic interaction. Higher R_1 indicates a better drug. The advantages of higher relaxivity include faster diagnosis, the need for less agent, and detection of smaller tumors. Unfortunately, the link between relaxivity and chemical properties is currently unclear. Computation could be used to this end, but better methods are needed to realize this goal.

The group of de Andrade et al.[5] have studied europium, the element located next to gadolinium, using computational chemical methods. Metals next to each other in the Periodic Table generally have similar chemical properties. Thus, it is reasonable to inquire whether the method developed by de Andrade et al. for europium can be extended to gadolinium, and hence be used for the study of MRI contrast agents.

HYPOTHESIS

The main goal of this research is to develop an efficient and accurate method for prediction of the geometry of gadolinium contrast agents. Once a computational method for the prediction of geometries is validated it can then be applied to new and existing systems to establish the link between chemical properties (e.g., shape, solubility in water, stability with respect to loss of Gd, etc.) and relaxivity. Being able to predict the three-dimensional geometry of a drug is the first step. The structure of a drug is an important determinant of its pharmacological properties. The present research focuses on the element gadolinium because compounds with this metal are already being used as contrast agents. However, it is desirable to establish a method to isolate compounds that are better contrast agents. The next step, once this is established, is to look at other important contrast agent properties: stability *in vivo*, the viscosity of an aqueous solution of the contrast agent, and the solubility of the drug in water.

Experiments have been conducted in our research group with a family of compounds known as DAP derivatives.[6] One example, GdDAPSC is shown in Figure 1. These compounds have higher relaxivity than current commercial agents and are thus promising for further study. Therefore, we have conducted computational studies to complement ongoing experimental research in our group.

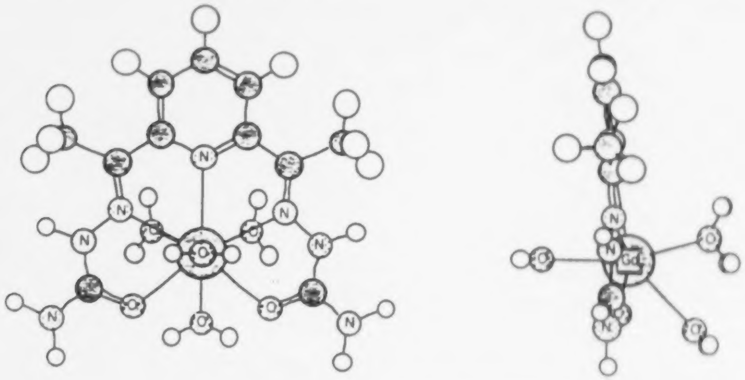

Figure 1: Top and Side Views of [Gd(DAPSC)(OH$_2$)$_4$]$^{3+}$

METHODOLOGY

Computer modeling with heavy metals like gadolinium is substantially more complicated than similar studies on compounds without metals.[7] This research uses methods based on quantum mechanics[1] to predict the geometry of gadolinium based complexes. The simplest molecule, i. e., hydrogen, is depicted in Figure 2. Quantum mechanics describes the energy of a chemical compound as the sum of the repulsions between positively charged nuclei, repulsions between negatively charged electrons, and attractions between the nuclei and electrons. Optimizing the geometry of a contrast agent with quantum mechanics involves finding the positions of the electrons and nuclei which give the most stable configuration. For the hydrogen molecule shown above, this is simple since there are only two nuclei and two electrons. If one considers that a typical contrast agent has dozens of nuclei and hundreds of electrons then it is obvious this is a very large, often intractable, computational problem.

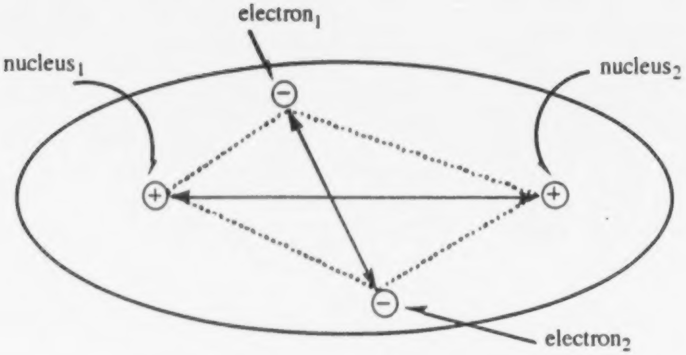

Figure 2: Pictorial Representation of Molecular Hydrogen

The two methods based on quantum mechanics used in chemistry are termed *ab initio* and semiempirical.[1,5] The *ab initio* method is very computationally intensive because all the interactions between nuclei and electrons must be calculated "from scratch." These calculations involve complicated differential equations.[1] The semiempirical approach, however, estimates the most demanding interactions using experimental data. This makes the semiempirical method a much more practical tool than *ab initio* methods for the study of large compounds of the heavy metal gadolinium.[5] As mentioned above, our first task involves extension of the semiempirical quantum mechanical (SEQM) method of de Andrade et al. to gadolinium.

RESULTS AND DISCUSSION

A number of gadolinium complexes have been synthesized in our group.[6] Most of these compounds are derivatives of diacetylpyridine and semicarbazide that are combined to form diacetylpyridinebis(semicarbazide) (DAPSC) by a simple condensation reaction, Figure 3.

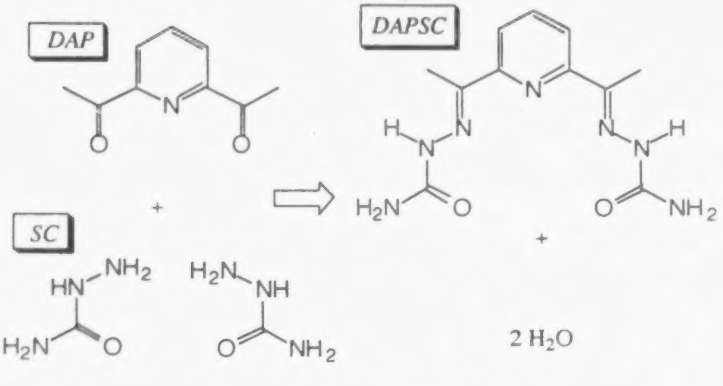

Figure 3: Synthesis of DAPSC Ligand.

DAPSC and related complexes provide an excellent base with which to assess semiempirical quantum methods as computed geometries can be compared to experimental geometries. There are two unitless parameters in the semiempirical method called ALPAM1 and AMAM1.[5] ALPAM1 models the "hardness" of the lanthanide which is inversely proportional to size and directly proportional to formal oxidation state. AMAM1 is a monopole-monopole parameter and is used in estimation of core-core repulsions.

A grid search was conducted changing both ALPAM1 and AMAM1 and observing the effect on predicted geometries. This allows for an "overlay value" to be calculated using the computational and experimental geometries. The overlay is the root-mean-square difference between corresponding atoms in the calculated and experimental structures. Clearly, it is desirable that theory and experiment agree exactly, but in practice this is an unrealistic goal, hence one wishes to change ALPAM1 and AMAM1 until the "overlay value" is minimized. An example of one of these grid searches is shown below in Table 1. Inspection of the data indicates the lowest overlay value for ALPAM1 = 2.0 and AMAM1 = 4.0, and hence best predictive ability for the SEQM method with these parameters. The best overlay is shown in Figure 4 (only heavy atoms are displayed); this agreement is within experimental error. This is just one example of the many DAP derivatives we have studied.

Table 1: Effect of ALPAM1 and AMAM1 on Predicted Geometries

ALPAM1	AMAM1	Overlay
2.0	2.0	0.234
2.0	3.0	0.230
2.0	4.0	0.229
2.5	2.0	0.300
2.5	3.0	0.308
2.5	4.0	0.312

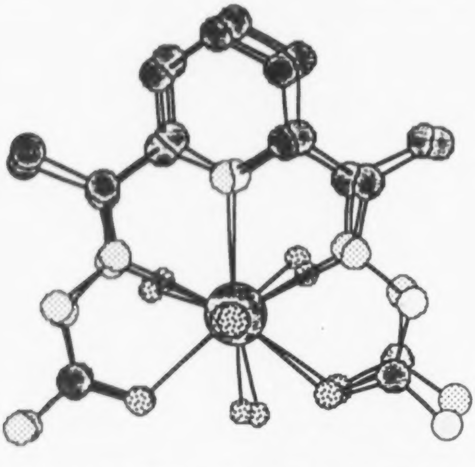

Figure 4: Overlay of SEQM-predicted and Experimental Geometry

Now that the semiempirical quantum method for gadolinium has been validated, computations can be used with confidence. For example, the geometry of DAPSC derived by our SEQM method showed that this compound is fully protonated at the semicarbazide nitrogens. The calculated geometry with protons is in better agreement with experiment than the hypothetical structure without the semicarbazide protons. This point is the subject of controversy since it is difficult to locate hydrogen by experiment.

This is due to hydrogen atoms being very small and hence very difficult to detect, particularly if located near a heavy element like gadolinium. Hence, the computations support the experimental conclusions about the DAPSC complex of Gd,[6a] and provide information not directly available from experiment.

Relaxivity is inversely proportional to the gadolinium-water proton distance. So it is desirable to make this distance as small as possible. When DAPSC is fully protonated it allows the water to be closer to gadolinium. However, if the compound is deprotonated it causes the ligand that is initially neutral to become negative and thus attracted more strongly to the positively charged metal. As the ligand and metal come together, water molecules are "squeezed out." Therefore, the calculations indicate that it is desirable to keep the DAPSC ligand fully protonated. This is an example of the way in which computation can be used to analyze existing systems and identify favorable or unfavorable chemical properties.

Now that an efficient and reliable method has been developed for geometric prediction of potential gadolinium contrast agents, these methods can be applied to the study of new systems. Future research will focus on the DAP motif given the promising results achieved with this system. Of particular interest are DAPSC derivatives where the terminal NH_2 groups have been replaced by other chemical entities. Another future goal is to use calculations to establish the link between chemical properties and relaxivity. For example, under certain experimental conditions it has been shown that the relaxivity is directly proportional to the size of the contrast agent as determined by its total volume.[4,6b] On the other hand, the Gd-water proton distance is inversely proportional to relaxivity. Both the size and Gd-water proton distance can be directly determined from our SEQM calculations. Thus, we can use the SEQM method to modify DAPSC and find derivatives in which these parameters are optimized. In this way the most promising targets are identified for further experiments directed towards better contrast agents for use with magnetic resonance imaging.

ACKNOWLEDGMENTS

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REFERENCES

1. Hehre, W. J.; Radom, L.; Schleyer, P. v. R.; Pople, J. A. "Ab-Initio Molecular Orbital Theory;" Wiley: New York, 1986.
2. Christian, M. C. Sem. Oncology 1992, 19, 720.
3. Sadler, P. J. Adv. Inorg. Chem. 1991, 36, 1.
4. Lauffer, R. B. Chem. Rev. 1987, 87, 901.
5. de Andrade, A. V. M.; Longo, R. L.; de Sa, G. F. J. Chem. Soc., Faraday 1996, 92, 1835. All Semiempirical calculations employed the MOPAC 6 program. Stewart, J. J. P. J. Comp.-Aided Mol. Des. 1990, 4, 1.
6. a) Sommerer, S. O.; Westcott, B. L.; Cundari, T. R.; Krause, J. A. Inorg. Chim. Acta, 1993, 209, 101.
   b) Benson, M. T.; Cundari, T. R.; Saunders, L. C.; Sommerer, S. O. Inorg. Chim. Acta - in press.
7. Benson, M. T.; Cundari, T. R.; Lutz, M. L.; Sommerer, S. O. in "Reviews in Computational Chemistry;" D. Boyd; K. Lipkowski (Eds.) 1996, 8, 145.

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Computational Analysis of the Electronics of Substituents on Aromatic Systems

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ABSTRACT

Many compounds with current biological and industrial applications are aromatic systems. Computational analysis of aromatic molecules can be compared to experimental data obtained via nuclear magnetic resonance (NMR) and infrared (IR) spectroscopy for the electronic effects of aromatic systems. Computational studies were performed on the 2-methoxybenzoic acid system with various substituents to ascertain the interplay between hydrogen bonding, aromatic conjugation, and steric hindrance. The Hartree-Fock self-consistent-field *ab initio* method has been used at the 6-31G* basis level for optimizing the geometries of these systems. Molecular orbitals have been calculated using Spartan 4.1. The results have shown that hydrogen bonding and aromatic resonance are found in the preferred conformation only when the steric strain of the molecule is minimal. Some correlations have been found between computational and experimental results.

INTRODUCTION

The 2-methoxybenzoic acid system has been studied with respect to hydrogen bonding and aromatic resonance as these electronic effects change with steric substitutions. The importance of both intramolecular and intermolecular hydrogen bonding is widespread in the biological sciences as well as in the polymer industry. Hydrogen bonding is essential for nucleotide interactions in DNA (deoxyribonucleic acid), amino acid structural interactions in proteins, and catalytic interactions in enzymatic proteins. Understanding the stability of the hydrogen bond and its contribution to the overall energy of a system are important to understanding the role hydrogen bonds play in larger systems.

The molecular orbital describing the conjugation of a substituent on an aromatic system is a combination of p-orbitals overlapping with π-symmetry as shown in figure 1. This assumes that the π-system is completely described by one molecular orbital. This may not be the case when the orbitals contain different types of atoms.

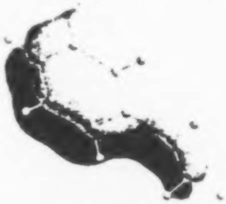


Figure 1: π-Ring System and Substituent (Phenylethene)

Another issue involving π-conjugation is the added stabilization of the molecules's geometry due to resonance with the ring. A comparison of this resonance stabilization with the stabilization due to hydrogen bonding and the opposing forces of steric hindrance allows for an assessment of the driving force in attaining the optimal geometry. The 2-methoxybenzoic acid (MBA) system used for this analysis (see figure 2) provides both a rigid framework which juxtaposes sterically hindered substituents and also resonance stabilization for the carboxylic acid and methoxy substituents.

The theoretical calculations have been compared with nuclear magnetic resonance (NMR) and infrared (IR) spectroscopy findings. They provide an experimental measure of the percent of hydrogen bonding for 3-R,2-methoxybenzoic acid (MBA-R) where R is a variety of substituents. The fraction of all possible geometric conformations that are hydrogen bonding can be compared to the computational values for the relative stability and strength of hydrogen bonding in the important conformations for each molecule.

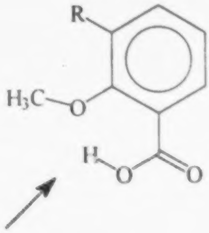


Figure 2: Top View of 3-R,2-methoxybenzoic acid (MBA-R [H,TA])
(The arrow indicates the hydrogen bonding distance.)

METHODS

Hartree-Fock self-consistent-field *ab initio* calculations at the 6-31G* basis level using Gaussian 94 provide geometry values which correlate well with experiment. Energy values obtained using this basis set are reasonable for approximating experimental values when the energy differences between molecules are compared.[1] The molecular orbital images obtained using Spartan 4.1 are calculated from the ab initio wavefunction at 6-31G* which provides a good approximation of electronic properties.[2]

DISCUSSION

Hydrogen Bonding Stabilization of Geometry

The conformation of each molecule where hydrogen bonding occurs is the trans acid (TA) form where the carboxyl group is oriented with its hydroxyl closest to the carbon-2 methoxy (this is the [H,TA] case). In the unsubstituted molecule (MBA-H), a distance of 1.806 Å is found for the hydrogen bond. Hydrogen bonding distances (see figure 2 and table 3) increase when different substituents are added at carbon-3. The length of the hydrogen bonding distance increases as the experimental fraction of hydrogen bonding decreases,[3] so both computational and experimental data suggest that hydrogen bonding strength decreases with steric substitution.

Steric hindrance caused by a substituent at carbon-3 reduces the effectiveness of the hydrogen bond. This steric effect is minimal in the MBA-H and MBA-OCH$_3$ cases. There is some compensation for steric strain as seen in changes in the dihedral angle of the carboxylic acid with the ring ("DiheAcidPlane" in table 3). The increase in the total energy for MBA-H and MBA-OCH$_3$ between the trans, [H,TA], and cis, [H,CA], cases (see table 3) demonstrates the stabilization provided by the formation of the hydrogen bond in the trans case. In the MBA-OCH$_3$ case, where the increase in energy from [H,TA] to [H,CA] is the greatest, the "Steric R-MeO" distance is the largest. This shows that the carbon-3 methoxy can move away from the carbon-2 methoxy such that steric hindrance is minimized and hydrogen bonding is favored.

The MBA-CH$_3$ and MBA-Naph (Naphthalene) cases show a decrease in energy for the [O,CA] and the [H,CA] cases compared with the hydrogen bonding case which is likely due to a relaxation of the methoxy away from the carbon-3 substituent once the disruption of hydrogen bonding allows easier movement of the methoxy group. Data from the simple formic and acetic acid systems also provide some explanation for this stabilization of the [CA] form. As shown in table 3, the change in energy between the [TA] and [CA] forms of both acids show that the [CA] form is lower in energy since no hydrogen bonding can occur. If the hydrogen bond stabilization is decreased due to the carbon-2 methoxy orientation, as in MBA-CH$_3$ and MBA-Naph, then the favored [CA] form overpowers the hydrogen bonding stabilization.

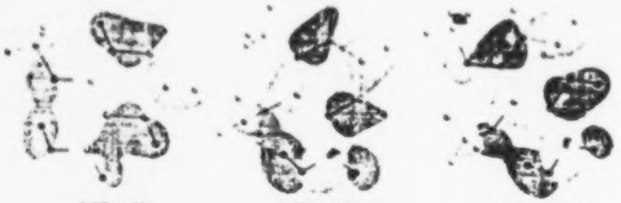
The Hartree-Fock energy values were converted to the percent of molecules in each occupied conformational state using statistical mechanics. The computational results show that the most populated conformational state of MBA-H and MBA-OCH_3 is the [H,TA] hydrogen bonding case with 74% and 59% hydrogen bonding, respectively. However, for MBA-CH_3 and MBA-Naph, the hydrogen bonding state contained only 13% and 7% of the molecules. The predominant conformation for these two cases is the [O,CA] case where the preference for the cis acid predominates due to greater steric strain. The [O,CA] state occupies 68% of the molecules in each case. When compared with NMR and IR data, these percents correlate roughly with experimental data. Certain discrepancies do exist between experiment and computation which have prompted detailed studies into these variations.

Table 3: 6-31G* Optimized Geometry and Energy Values for Formic Acid, Acetic Acid, and Substituted Benzoic Acid Derivatives

Abbreviations: ΔRHF(E) = Change in Restricted Hartree-Fock Energy in kJ/mole with respect to the reference value (all frequencies are positive), H-BondDist = distance (Å) between the carboxyl hydrogen and the methoxy oxygen, Steric R-MeO = the distance (Å) between the nearest hydrogens of the methoxy and the R-group, DiheAcidPlane = dihedral angle between the carboxylic acid and the ring plane, DiheCOOH = dihedral angle within the carboxylic acid substituent, Dihe MeO = dihedral angle of the methoxy acid to the ring plane, [,] = geometric conformation specification, H = Hydrogen of carboxyl group facing methoxy, O = carbonyl oxygen of carboxyl group facing methoxy.

Molecule	ΔRHF(E)	H-BondDist	Steric R-MeO	DiheAcidPlane	DiheCOOH	Dihe MeO
Formic Acid [TA]	25.647	N/A	N/A	N/A	180.0	N/A
Formic Acid [CA]	0.000	N/A	N/A	N/A	0.0	N/A
Acetic Acid [TA]	30.117	N/A	N/A	N/A	180.0	N/A
Acetic Acid [CA]	0.000	N/A	N/A	N/A	0.0	N/A
MBA-H [H,TA]	0.000	1.806	2.320	0.0	-180.0	180.0
MBA-H [O,TA]	32.990	4.021	2.327	-127.5	-170.9	-175.0
MBA-H [H,CA]	1.985	3.522	2.303	-0.4	-0.3	180.0
MBA-H [O,CA]	4.450	4.608	2.312	166.3	-0.8	179.8
MBA-CH_3 [H,TA]	0.000	1.872	2.435	15.6	-179.7	92.9
MBA-CH_3 [O,TA]	32.625	4.291	2.722	-137.4	-170.9	74.6
MBA-CH_3 [H,CA]	-0.422	3.589	2.430	2.0	-0.8	86.9
MBA-CH_3 [O,CA]	-2.567	4.644	2.419	157.8	-0.6	90.9
MBA-OCH_3 [H,TA]	0.000	1.837	3.720	12.7	180.0	105.0
MBA-OCH_3 [O,TA]	37.920	4.129	3.863	-128.9	-173.5	99.9
MBA-OCH_3 [H,CA]	2.137	3.580	3.752	-24.4	-2.1	105.3
MBA-OCH_3 [O,CA]	1.499	4.570	3.863	148.0	-0.5	101.3
MBA-Naph [H,TA]	0.000	1.882	2.539	14.1	-178.7	93.0
MBA-Naph [O,TA]	24.156	4.127	4.329	132.2	170.2	92.4
MBA-Naph [H,CA]	-2.144	3.584	2.577	-3.1	-1.1	89.3
MBA-Naph [O,CA]	-27.790	4.654	2.594	-198.6	-0.3	89.0

Molecular orbitals have been found in each case which clearly show the hydrogen bonding between the carboxyl hydrogen and the methoxy oxygen. Even when the hydrogen bonding conformation is not the most energetically favorable, a molecular orbital showing hydrogen bonding can be found for each substituted 2-methoxybenzoic acid. Three of these orbitals are shown in figure 4.

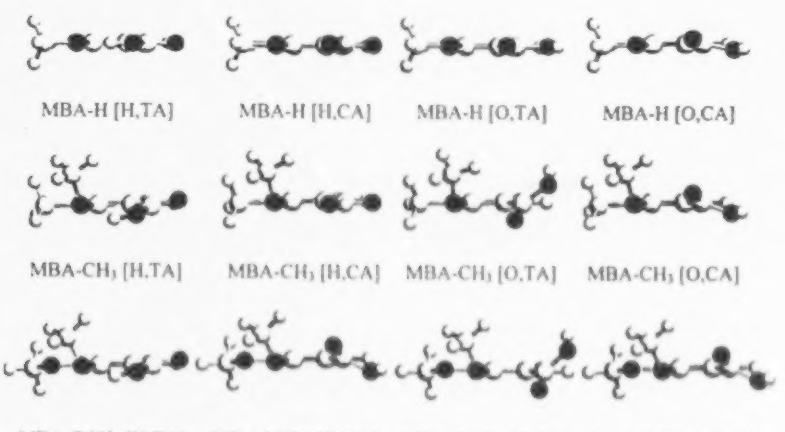


MBA-H MBA-CH_3 MBA-OCH_3

Figure 4: Hydrogen Bonding Molecular Orbitals (H, TA conformations)
(See figure 2 where the arrow indicates the location of hydrogen bonding.)

Resonance Stabilization of π-Substituents

Resonance of substituents to the aromatic system is displayed by the preference of these substituents to lie in the plane of the ring unless steric forces do not permit such a conformation. For the MBA-H cases shown in figure 5, the methoxy and the acid lie completely in plane with the ring (The numerical dihedral angles can be found in table 3 in the "Dihe MeO" and "DiheAcidPlane" columns.). The presence of the methyl group on carbon-3 in MBA-CH_3 does not allow the methoxy to lie flat. In the [H,TA] case, a small displacement of the carboxyl out of the ring plane can be seen which allows the acid to hydrogen bond with the 90 degree methoxy. Oxygen-oxygen repulsion in the [O,TA] and [O,CA] cases also disrupts the resonance of the carboxyl group with the ring. The 100 degree dihedral angle of the carbon-2 methoxy in the MBA-OCH_3 case allows hydrogen bonding in the [H,TA] case, but actually causes oxygen-oxygen repulsion in the [H,CA] case in addition to both [O] cases. However, resonance of the methoxy oxygen lone pairs and the carboxylic acid group with the ring is still evident even with some distortion from the ring plane.



MBA-H [H,TA] MBA-H [H,CA] MBA-H [O,TA] MBA-H [O,CA]

MBA-CH_3 [H,TA] MBA-CH_3 [H,CA] MBA-CH_3 [O,TA] MBA-CH_3 [O,CA]

MBA-OCH_3 [H,TA] MBA-OCH_3 [H,CA] MBA-OCH_3 [O,TA] MBA-OCH_3 [O,CA]

Figure 5: Planar Nature of Methoxy and Carboxylic Acid Substituents
Side View of 3-R,2-methoxybenzoic acid. (Arrow in figure 2 shows line of sight)

Molecular orbitals of the MBA-H [H,TA] system (see figure 6) show the π-systems in resonance with the aromatic ring. The various π-systems appear in molecular orbitals of different energies in contrast with the prediction of one conjugated π-orbital as shown in figure 1. The ring carbons appear in the π-orbital of highest energy with the carboxylic acid and carbon-2 methoxy π-orbitals following in decreasing energy. This separation into different molecular orbitals may be due to the formation of lower energy molecular orbitals when oxygen atomic orbitals are involved.

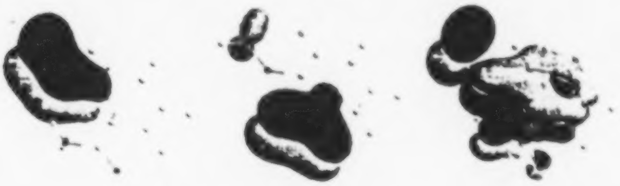


Figure 6: π-Conjugation of MBA-H [H,TA].
MO# 25 (π-System Conjugation Extending to Carbon-2 Methoxy), MO# 29 (Acid Conjugation), MO# 33 (Aromatic Ring π-System)

CONCLUSIONS

The driving force for the lowest energy conformation of these aromatic systems is the resonance of π-substituents with the aromatic ring. Aromatic resonance controls both the orientation of substituents and the stabilization of each conformation due to π-conjugation. Hydrogen bonding lowers the overall energy of a system once the components are properly aligned. Unless the steric strain becomes too great, with or without hydrogen bonding, the substituents prefer to remain in plane with the aromatic ring.

Future studies will attempt to understand discrepancies between experimental and computational percent hydrogen bonding values. The MBA-NO_2 and MBA-t-butyl cases will also be investigated.

REFERENCES

1. Gaussian, Inc. Carnegie Office Park, Building 6, Pittsburgh, PA 15106 USA.
2. Wavefunction, Inc. 18401 Von Karman, Suite 370, Irvine, CA 92715 USA.
3. Private communication. Ingeborg Schuster, Penn State University, Abington, (1997); Lloyd, H.A., Warren, K.S., and Fales, H.M., *J. Amer. Chem. Soc.*, **88**, (1966), 5544.

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ISOLATION OF A COMPOUND RESPONSIBLE FOR THE BIOCHEMICAL CONTROL OF DIMORPHISM IN *CANDIDA ALBICANS*

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Candida albicans is a dimorphic, pathogenic fungus. In fact, pathogenicity in *C. albicans* appears to be linked to its ability to switch rapidly between morphological forms. Therefore, an understanding of the biochemical regulation may prove useful in understanding pathogenicity and the design of new antifungal drugs. A bioassay was developed to follow the growth modulating activity. An extracellular, organic compound was found to exhibit biological activity in the morphological control of dimorphism in *Candida albicans* and has been partially purified through bioassay-guided fractionation. Further work on the purification and identification of the active component is being conducted.

INTRODUCTION

Candida albicans, a dimorphic fungus, is the most widely studied human fungal pathogen. *Candida albicans* is a fungus which can exist in two principal cellular forms: as yeast cells (single celled) or as mycelia (filamentous cell chains).[1] Reversion refers to *C. albicans* ability to switch between the two morphological phases. Many environmental variables such as temperature, gaseous environment and cations are known to effect the morphology of *C. albicans*,[1] but the molecular mechanism for the control of reversion has not yet been identified.

In the industrial setting, the yeast phase is preferred because growth rates of fungi are maximized in this form due to the increased surface area.[2] Yeasts are also much easier to handle mechanically in the stirring and filtering processes. The isolation of an organic chemical that controls the morphology of fungi during changing environmental conditions will be of tremendous use to industry.

In addition, a common feature of the majority of human pathogenic fungi is that they exhibit dimorphism and it is common to find that the morphology of the fungus in the infected tissue is different from that of the initial infectious agent.[3] Topical infections involving *C. albicans* are common, but systemic candidiasis is seen primarily in immunocompromised individuals. Systemic candidiasis refers to cases where *Candida* is found in the bloodstream with or without tissue invasion or to disseminated disease where single or multiple organs are sites of infection.[4] The limited number of safe, effective antifungal drugs and a growing number of resistant strains of yeast exacerbates these problems.[5]

The ability of *C. albicans* to alter its phenotype rapidly appears to allow the fungus to adapt to different host environments.[6] There is solid evidence that hyphae production is an essential factor in pathogenicity; hyphae are able to resist phagocytosis and are able to adhere and penetrate through host epithelial layers.[3,4,7] Experimentally, it has been observed that hyphae are present in most lesions and yeast cells inoculated into animals rapidly develop hyphae.[3] Since *Candida* appears to be a more effective pathogen due to mycelial formation, an understanding of the biochemical regulation would be helpful in the design of new antifungal drugs.

Previous studies indicate that regulatory control of fungal morphology is dependent upon population density.[8] It is well known that, at specific population densities, many types of bacteria will secrete autoinducers that control bacterial growth and differentiation.[9] Preliminary data from this project indicated some compound(s) present in the broth of the dimorphic fungus, *Candida albicans*, can trigger a dimorphic switch. These data suggest the biochemical control system of fungal morphology is initiated by an extracellular signal as in the bacterial systems whereas previous research on dimorphic fungi has investigated only the potential of intracellular mechanisms. Isolation of an organic compound responsible for regulating the dimorphic transition would significantly add to the understanding of this complex phenomenon.

RESULTS AND DISCUSSION

As the background of this research involved microbiology, this research was conducted in collaboration with Dr. Ellen Jensen, a microbiologist in the Biology Department at The College of St. Benedict/St. John's University.

Candida albicans, strain A-72, was grown in GPP (Glucose Proline Phosphate) growth media. Under these conditions, the morphology of the fungus can be controlled by the temperature at which the cells are incubated.[10] Cells grown at room temperature (RT) grow as yeast while those cells incubated at 37°C grow as mycelia. To detect an extracellular regulating compound, the media from either the yeast or the mycelial cells were extracted with EtOAc and concentrated. Yeast or mycelial cell cultures were then treated with concentrates and the cultures were then tested for reversion. In cultures treated with RT broth, but grown at 37°C, 84% of the cells grew as yeast. Thus, a compound in the RT broth either inhibited mycelial growth or promoted yeast morphology.

35 L of RT broth from *C. albicans* in GPP media was grown, centrifuged and then filter-sterilized. The organics were extracted from the aqueous portion with EtOAc and the organic fraction was concentrated. The organic fraction demonstrated activity when tested in the bioassay. A Modified Kupchan extraction was used as a procedure to fractionate the crude extract on the basis of polarity. The fractions were tested for activity with the reversion assay. 88% reversion was obtained from both the hexane and chloroform fractions. The combined active fraction was further purified on a 75g Sephadex LH-20 column with 1:1 MeOH/CH_2Cl_2 as the eluent. 5 mL fractions were collected and eluted on silica TLC plates. R_f values were used to combine the tubes into fractions which were subsequently assayed. Fraction 3 (tubes 36-39) contained the majority of the activity and promoted 91% reversion to yeast.

This research represents the partial purification of an extracellular signal for biochemical regulation of dimorphism. Continuation of this project will require HPLC to isolate the active growth regulating compound in *Candida albicans*. Upon obtaining a pure compound, structural determination will be performed with analytical tools such as 1-D and 2-D NMR techniques, IR, UV, MS and X-ray crystallography.

EXPERIMENTAL

Culturing *Candida albicans*. *Candida albicans* (strain A-72 from culture collection of K. W. Nickerson) was inoculated in 500 mL Erlenmeyer flasks containing 100 mL of growth media [80 mL .05 M PO_4 buffer (pH 6.0); 0.03 mL vitamin mix (20 µg biotin, 100 µg pyridoxin and 200 µg dissolved in 10 ml of 50:50 H_2O/EtOH) and 0.10 mL mineral mix (0.38 g. $ZnSO_4{*}7H_20$, 0.38 g $MnCl_2{*}4H_2O$, 0.38 g $CuSO_4{*}5H_2O$ and 0.38 g $FeCl_3$ dissolved in 75 mL .1 N HCl); 10 mL 20% dextrose solution; and 10 mL 0.1 M Proline solution]. The buffer and the minerals and vitamins were autoclaved. The proline and dextrose solutions were autoclaved at 121°C and 15 psi for 15 min. separately. After cooling to room temperature, the proline and dextrose solutions were added to the buffer solution. This growth media was inoculated at an initial concentration of $1{*}10^7$ cells/mL. The flask cultures were incubated at RT (yeast phase) or 37°C (mycelial growth) and aerated by agitation at 150 rpm for 24 hrs.

Biological Assay. 0.3 mg of the dried organic fractions were dissolved in the appropriate solvent and transferred to 25 mL sterile Erlenmeyer flasks. . The flasks were placed in a laminar flow hood until the solvent had evaporated. 5.0 mL of media was added to the flasks (0 .5 mL 0.5 M $P0_4$ buffer, 0.5 mL 20% glucose +vitamins + $MgSO_4$, .13 mL 0.1 M N-acetylglucosamine, .17 ml 0.3 M proline, 3.7 mL of H_2O) and was then inoculated to give an initial concentration of

1 E+7 cells/ml. The cells were incubated at 37°C and 150 rpm. Under normal conditions, four hours provides enough time so that at least 90% of the cells will form germ tubes. After four hours, a 20 µl sample of the media was placed on a slide and covered with a cover slip. 100 cells were counted at two different locations and the average number of cell types (hyphae or single cells) were tabulated.

Purification of the Extracellular Compound. After culturing *C. albicans* for 24 hrs at RT, the cells were centrifuged for 30 min. at 6000 rpm and 6°C. The broth was decanted off and then filter-sterilized. Each 500 mL of filtrate was extracted with 3 x 200 mL portions of EtOAc. The organic extract was dried over $MgSO_4$, filtered and concentrated. The remaining crude extract (315 mg) showed 84% reversion of mycelium to yeast. As a control, the growth media was also extracted in a similar manner and was found to have no activity. The crude extract was initially purified with a Modified Kupchan extraction using Hexane, $CHCl_3$, CH_2Cl_2, and EtOAc successively and increasing the H_2O/MeOH ratio after each solvent. 88% reversion was shown in the Hex and $CHCl_3$ fractions (154 mg) which were then eluted on a 75 g Sephadex LH-20 column with 1:1 MeOH/CH_2Cl_2 as the eluent. Each 5 mL fraction from the column was spotted on Kodak Chromagram Silica TLC plates with Fluorescent Indicator and eluted with 95:5 chloroform/methanol. The plates were visualized with UV, iodine, and phosphomolybdic acid in 95% ethanol, successively. The R_f values were used to combine fractions. The fractions were assayed and activity (91% reversion) was located in the fraction containing tubes 36-39 (21.3 mg). Future work on the purification and identification of the active component will be conducted.

REFERENCES

[1] Cutler, J. E.; Hazen, K. C.; *Yeast/Mold Morphogenesis in Mucor and Candida albicans* in "Secondary Metabolism and Differentiation in Fungi", Bennett, J. W. and Ciegler, A.; Eds., Marcel Dekker, Inc., New York, 1983, 5, 280, 282-283.

[2] Gow, N.; Crombie, T.; Gooday, W.; *Polarized Morphogenesis of Candida albicans: Cytology, Induction and Control* in "Candida and Candidamycosis," E. Tumbay, Ed., Plenum Press, New York, 1991, 13-19.

[3] Shepherd, M. G.; *Morphogenetic Transformations of Fungi* in "Current Topics in Medical Mycology", McGinnis, M., Ed., Springer-Verlag, New York, 1985, 2, 278.

[4] Odds, F. C.; Candida and Candidiosis, Bailliere Tindall, London, 1988.

[5] Magee, P. T.; Scherer, S.; *Microbiological Reviews*, 1990, 54, 3, 226.

[6] Ramsey, H.; Morrow, B.; Soll, D. R.; *Microbiology*. 1994, 140, 1525.

[7] Odds, F. C.; *American Society of Microbiologists.* 1994, 60, 313-318.

[8] Fuqua, W. C.; Winans, S. C.; Greenberg, E. P.; *Journal of Bacteriology*, 1994, 176, 269-275.

[9] Horinouchi, S.; Beppu, T.; *Molecular Microbiology*, 1994, 12, 859.

[10] Hubbard, M. J.; Markie, D.; Poulter, R. T. M.; *Journal of Bacteriology*, 1986, 165, 61.

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Adsorption Behavior of NO and CO on Pd/Al_2O_3 An FT-IR and Mass Spectrometric Study

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Both physical and chemical adsorption behavior of CO and NO on Pd/Al_2O_3 catalysts were studied using *in situ* FT-IR and mass spectroscopy A specially designed IR cell is used for this purpose where the effect of both support and metal can be simultaneously monitored Different metal loadings show strikingly different NO adsorption behavior For example, the formation of N_2O was at a maximum for 2 2% Pd, and at a minimum for 10% Pd/Al_2O_3 This behavior is consistent with the idea of having different CO adsorption energy for particles with different sizes. Furthermore, the coadsorption behavior of CO and NO indicates the formation of isocyanate species at elevated temperatures for surfaces with different metal loadings

INTRODUCTION

Recently there has been considerable interest in using only palladium as an active component for automotive exhaust gas conversion Many ultra-high vacuum (UHV) studies have focused on the nature of CO and NO chemisorption on low index planes of palladium (Chen and Goodman, 1993) The objectives of these studies were to identify the CO/NO reaction products and kinetics over polycrystalline palladium surfaces However, a few studies have examined the reactions at low temperature for different metal loadings on Pd/Al_2O_3 catalysts

In order to better understand the mechanisms of the CO/NO reaction, it is essential to identify the adsorption sites and surface coverages of the reactants Although some studies have been done to elucidate the structures of adsorbed CO and NO separately, on supported palladium above room temperature (Valden *et al*, 1996) Few studies have looked at the adsorption of NO and coadsorption of CO/NO at low temperatures

The aim of this paper is to characterize the surface reaction processes of NO, CO, and NO/CO on Pd/Al_2O_3 under different catalytic conditions using FT-IR and mass spectrometry

EXPERIMENTAL

Al_2O_3 - supported Pd catalyst samples of different metal loadings were prepared in a slurry containing $PdCl_2$ and Al_2O_3 (Degussa aluminum oxide C) in the appropriate ratio The slurry was suspended in a liquid consisting of nine parts spectroscopic grade acetone and one part distilled water The slurry was deposited by spraying through an atomizer onto one-half of a 25-mm-diameter CaF_2 disk maintained by a hot plate at 340 K The solvents evaporated rapidly, leaving a thin adherent film of $PdCl_2/Al_2O_3$ on the support disk A second sample of blank Al_2O_3 support was prepared in the same manner and deposited on the other half of the disk This method of using two different catalytic films for IR and mass spectroscopic study allow us to observe any chemistry occurring on the support itself which has been treated under identical conditions as the catalyst

The catalyst sample was then mounted inside the stainless steel ultrahigh vacuum infrared cell designed by Yates and co-workers (Beebe, Gelin, and Yates, 1984; Beebe and Yates, 1985) This cell consists of a main cell body (double-sided conflat flange) containing a CaF_2 disk that serves as the sample holder, held in place by a Cu support ring which may be cooled by $N_{2(g)}$ and heated by heating tapes The cell body is contained between two CaF_2 windows sealed in stainless steel conflat flanges, permitting IR measurements in the 4000-1000 cm^{-1} spectral range The infrared cell is attached to a bakeable stainless steel gas handling system and is typically maintained at a base pressure of $P < 1 \times 10^{-8}$ Torr Pumping is carried out by a 50 L/s turbo molecular pump (Balzers)

15

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The sample is then outgassed under vacuum at 475 K for about 12 h and subjected to 15, 30, 45 and 60 min cycles of exposure to ~ 400 Torr of H_2 at 475 K, each cycle being terminated by evacuation to 1 x 10^{-6} Torr. The reduced samples were allowed to remain under vacuum (< 1 x 10^{-6} Torr) at 475 K for ~ 8 h. For low temperature reactions, background scans were taken of the unreacted sample as it was cooled to 110 K at 20 K intervals.

The reagents used in this study, CO (99.99% purity, Matheson Gas Products, Inc.), NO (98.5% purity, Aldrich Chemical Company), and H_2 (Research Grade) were all obtained in high-pressure cylinders, and were used without further purification.

Infrared spectra were measured by use of a purged Mattson RS-1 FTIR spectrophotometer interfaced with a personal computer for data storage and manipulation. The spectra presented here were obtained with 500 scans at a resolution of 4.0 cm^{-1}. Mass spectral data of the gases were collected by introducing gases to the quadrupole mass spectrometer using a high precision leak valve during adsorption experiments.

RESULTS AND DISCUSSION

Low Temperature Adsorption of NO on Pd/Al_2O_3

Figure 1 indicates the IR spectral behavior upon sequential exposure of NO on 0.5% Pd/Al_2O_3 at 110 K. Two sets of IR bands corresponding to ν(N-O) modes (one at 1874 and 1761 and the other at 1901 and 1815 cm^{-1}) gradually developed on Pd/Al_2O_3 along with an IR feature at 2245 cm^{-1}. On the other hand, only one set of bands at 1876 and 1741 cm^{-1} are observed (not shown) along with a small shoulder at ~ 1810 cm^{-1} on blank Al_2O_3 surface. The formation of NO surface species caused the decrease in the intensity of isolated hydroxyl groups on Al_2O_3 indicating the presence of H-bonded nitrosyl groups on surfaces. Upon warming, these bands disappear on 0.5% Pd/Al_2O_3 (Figure 2) with gradual formation of the 2245 cm^{-1} feature (Valden *et al.* 1996). The band at 2245 cm^{-1} can be assigned to ν_{as} (N-N-O) for physisorbed N_2O gas. This weakly bound species desorbs at ~230 K indicating its gas phase rotational P, Q, and R modes centered at 2223 cm^{-1}.

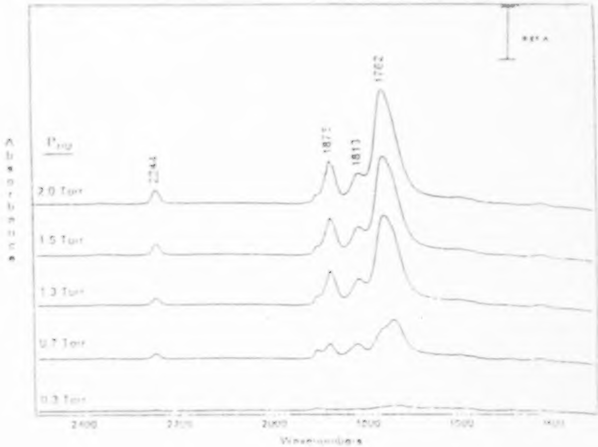

Figure 1. Infrared spectra for the sequential exposure of NO on prereduced 0.5 % Pd/Al_2O_3 at 110 K.

Assignment of Surface Species

The IR bands at 1901, 1815, and 1761 cm^{-1} may be tentatively assigned to $Pd\text{-}NO^+$ and Pd-NO, and $Pd\text{-}NO^-$ surface species respectively (Arai and Tominaga, 1975). These assignments are consistent with the studies on Rh/Al_2O_3 surface. However, the band at 1874 cm^{-1} could be due to weakly adsorbed ν(NO) mode on Al_2O_3 support. Nitric oxide can be easily oxidized into a nitrosonium ion NO^+ by donation of one electron from its antibonding orbital to the metal. A coordination of $Pd\text{-}NO^+$ is formed by an additional electron pair donation from NO^+. When ν(NO)

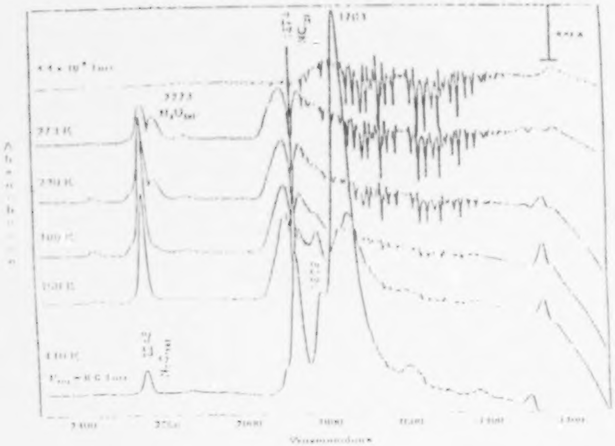

Figure 2. Infrared spectra for the exposure of NO on prereduced 0.5 % Pd/Al_2O_3 as a function of temperature.

is much lower than that of gaseous NO molecule (1876 cm^{-1}), the nitric oxide is assigned to the structure of NO^-. The frequency of $\nu(NO)$ is dependent upon the extent of donation of an electron from π^*_{NO} to the palladium d-orbital

Low Temperature N_2O Formation

The formation of N_2O was determined by measuring the integrated absorbance of 2245 cm^{-1} as a function Pd loading, temperature, and pressures of NO. The dependence on loading, temperature, and pressure is given in Figures 3, 4, and 5. The N_2O formation gradually increases with Pd loading up to 2.2 %, and then decreases dramatically for 10 % Pd. In order to understand the volcanic type behavior for N_2O formation as a function of Pd loading, it is important to focus on the fundamental aspect of the mechanism of N_2O formation at low temperature. The earlier studies suggests that the N_2O formation takes place according to two mechanisms a) breakdown of dinitrosyl species and b) dissociative adsorption (Hierl, Urbach, and Knozinger, 1992). At low temperature the energy required is not available for dissociative adsorption of NO, which can be ruled out. The breakdown of dinitrosyl species forming N_2O is not as energy intensive as the dissociative adsorption of NO. Although the formation of dinitrosyl complexes is not detected in the present low temperature study, its formation cannot be ruled out. The formation of N_2O depends on several factors: oxidation state and size of the metal particle in addition to dispersion of the active metal. The work is in progress to answer these critical questions.

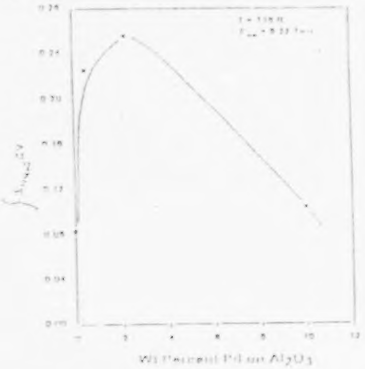

Figure 3. Formation of physisorbed N_2O as a function of Pd loading at 110 K

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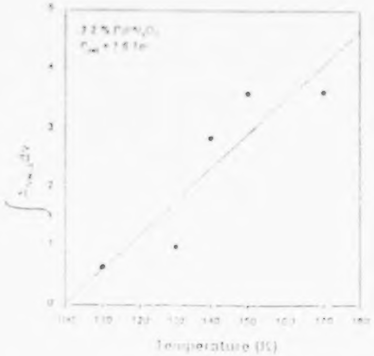

Figure 4 Formation of physisorbed N_2O as a function of temperature on prereduced 2.2 wt % Pd/Al_2O_3

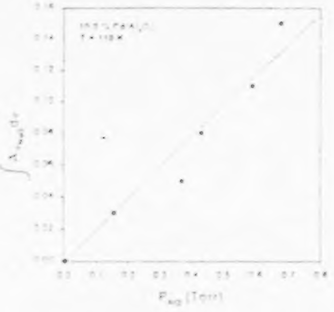

Figure 5 Formation of physisorbed N_2O as a function of pressure during exposure to NO at 110 K.

High Temperature Interaction of NO/CO

Figure 6 shows sequential IR studies of the NO/CO reaction on 0 5 % Pd/Al_2O_3 as a function of temperature Initially, upon NO/CO coadsorption the nitrosyl bands observed at 1817 and 1755 cm^{-1} in addition to very weak bands at 2134 and 2090 cm^{-1} due to adsorbed CO These linearly bound nitrosyl complexes disappeared at 460 K giving rise to nitrite and nitrato complex formation on alumina which was observed at 1600-1200 cm^{-1} Typical absorption bands were observed at 1618, 1560, 1457, and 1270 cm^{-1} The formation of CO_2 and N_2O gases are also observed at 2354 and 2220 cm^{-1} by using both FT-IR and mass spectroscopy The formation of an absorption band at 1612 cm^{-1} is probably caused by NO_2 The infrared bands of adsorbed NO_2 are normally observed at 1618, 1318, and 750 cm^{-1} (Valden *et al*, 1996) Adsorbed NO_2 species can be formed when gaseous NO reacts with oxygen bonded to Pd and created by the dissociation of NO Upon evacuation at room temperature, a strong band at 2265 cm^{-1} corresponding to ν_{as}(NCO) mode appeared indicationg the formation of iscocyanate species (Paul and Worley, 1990) Thus, NO and CO react on the surface to form N_2, N_2O, CO_2, adsorbed isocyanate, and nitrito and nitrato species

CONCLUSIONS

The following conclusions can be drawn from this work

(1) Formation of N_2O is observed at low temperature (110-278 K) as well as at high temperature and its production is maximum for 2 2 % Pd/Al_2O_3 This observation may be related to the size of Pd particles The development of the IR peak at 2245 cm^{-1}, which corresponds to N_2O physisorbed species, also depends on the NO coverage

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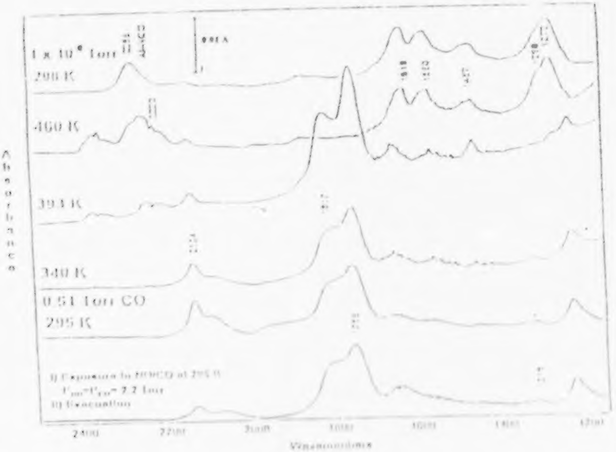

Figure 6. Infrared spectra for the reaction of NO/CO on prereduced 0.5 % Pd/Al_2O_3 at elevated temperatures.

(2) Coadsorption of both NO and CO and subsequent heat treatment produced support bound iscocyanate species (Al_2O_3-NCO) along with nitrito and nitrato complexes

(3) Formation of isocayanate may play a dominant role in catalytic reaction processes

ACKNOWLEDGMENTS

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REFERENCES

Arai, H.; and Tominaga, H. Journal of Catalysis, An Infrared Study of Nitric Oxide Adsorbed on Rhodium-Alumina Catalyst, Vol. 43, 1976, pg. 131-142

Beebe, T.P., Jr.; Gelin, P.; Yates, J.T., Jr. Surface Science, vol. 148, 1984, pg. 526

Beebe, T.P.; Yates, J.T., Jr. Surface Science, Vol. 159, 1985, pg. 369

Chen, P. and Goodman, W., Surface Science Letters, Ordered High Coverage NO overlayers on Pd(111), Vol. 297, 1993, pg. L93-L99

Hierl, P.; Urbach, H.-P and Knozinger, H. Journal of Chemical Society- Faraday Transactions, Chemisorption of Nitric Oxide on Copper-Alumina Catalysts, Vol. 88(3), 1992, pg. 355-360

Paul, D. K.; Worley, S. D.; Journal of Physical Chemistry, Influence of Oxidation of Pd/Al_2O_3 for the Reactions of CO with NH_3 and Formamide Decomposition, Vol. 94, 1990, pg. 8956-8959

Valden, M.; Keiski, R. L.; Xiang, N., Pere, J.; Aaltonen, J.; Pessa, M., Maunula, T., Savimaki, A., Lahti, A.; and Harkonen, M. Journal of Catalysis, Vol. 161, 1996, pg. 614-625

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Structural Studies of a Modified Oligonucleotide Using 2-D NMR Techniques

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In this project, two-dimensional NMR techniques were utilized to study the following nucleotide:

CGCGCTTTCGCGC
GCGCGAAAGCGCG

A modified version of the sequence, in which the central adenine was replaced by 5-nitroindole, was also studied. Partial proton assignment was accomplished using TOCSY. However, many peaks were ambiguous. NOESY and COSY experiments were used to resolve these peaks. Complete proton assignment was accomplished for the thymidine core, using these experiments. One-dimensional NMR spectra revealed that the modified oligonucleotide is less stable than the modified.

INTRODUCTION

Oligonucleotides are small segments of DNA (deoxyribonucleic acid) that can be modified by substituting one or more of the naturally occurring nucleotide bases with a "universal base". A "universal base" is one which can pair with each of the natural bases indiscriminately. In recent years, these modified oligonucleotides have become the subject of intense research for use in gene regulation and in studies of DNA and RNA (ribonucleic acid) activity. Modification of the oligomer is beneficial especially when base pairing with a target nucleic acid whose sequence is unknown. Ideally, a universal base would pair with high affinity to any of the naturally occurring DNA bases and form a stable duplex. The stability of the oligomer, containing the modified base, is determined by its structure. One common technique for determining the structure is multi-dimensional nuclear magnetic resonance (NMR).

NMR is currently the most powerful tool for determining the structure of organic molecules. Only nuclei with an odd mass number have a "nuclear spin". When these nuclei are subjected to the right combination of magnetic field and electromagnetic radiation, they will absorb the radiant energy. The absorption of radiant energy results in a reversal of their nuclear spins. The amount of energy absorbed is represented by the NMR spectrum. The location of the absorption peak in the spectrum depends on the chemical environment surrounding the nucleus. The environments of the various nuclei found in oligonucleotides are chemically diverse. This results in extremely complicated spectra. In order to obtain useful information about the structure, multi-dimensional NMR techniques are employed. Two-dimensional NMR works essentially the same as one-dimensional methods, except it spreads the interactions between the nuclei into a second dimension. Thus it clarifies the resulting spectra. Three types of NMR spectroscopy were used to detect these interactions: TOCSY (TOtal Correlated SpectroscopY), NOESY (Nuclear Overhause Effect SpectroscopY), and COSY (Correlated SpectroscopY). TOCSY, the main type of NMR spectroscopy used on this project, can detect interactions occurring between nuclei that are several atoms away. COSY detected the interactions of nuclei up to three bonds away and NOESY detected the through-space interactions of nuclei. The COSY and NOESY spectra were used to support results found in the TOCSY spectra and to remove ambiguities.

METHODS AND PROCEDURES

The oligonucleotides were synthesized on an ABI (Advanced Bioscience) DNA synthesizer using standard phosphoramidite chemistry and purified by HPLC (high performance liquid chromatography). The samples were solvated in D_2O for NMR sampling. Traditional one-dimensional spectra, as well as two-dimensional COSY, NOESY, and TOCSY spectra were obtained using a 600 MHz Varian NMR Spectrometer at the University of Akron's Chemical Instrumentation Center.

Backbone Proton Assignments

Initial proton assignments were made based on TOCSY experiments. Protons were assigned using the reported proton ranges (Brown) listed in Table 1 and the observed connectivities. The backbone protons were assigned beginning with Figure 1. A starting peak is chosen arbitrarily from this spectrum. For example, the peak located at (4.720 ppm, 4.035 ppm) was selected. This gives the locations of the H_3' and H_4' respectively (refer to Figure 2) of one backbone sugar ring. The H_1' is determined by finding the peak on Figure 3, which corresponds to the H_3'. For the above example, the H_1' is located at 5.525 ppm. Finally, the H_2' and H_5' are identified using Figure 4. Vertical lines are drawn at the H_1' and H_3' locations. Next, connectivities between peaks are found. This occurs when two peaks, one on each vertical line, can be connected by a horizontal line. Connectivities between four to six peaks should be found for each backbone ring. In the example, the two H_2' peaks are located at 1.72 ppm and the two H_5' peaks are at 2.18 ppm. Here, the H_2' peaks are located outside of the range for the H_5' peaks and are, therefore, easily assigned. However, in this region, many of the peaks will overlap, resulting in ambiguous assignments.

TABLE 1: Chemical Shift Ranges for Important Protons

Proton	Range	Molecule
H_1	5.5 - 6.1	(backbone)
H_2	1.6 - 2.8	(backbone)
H_3	4.5 - 5.3	(backbone)
H_4	3.95 - 4.4	(backbone)
H_5	1.8 - 2.8	(backbone)
CH_3	1.5 - 1.6	(thymine)
H_6	7.3 - 7.45	(thymine)

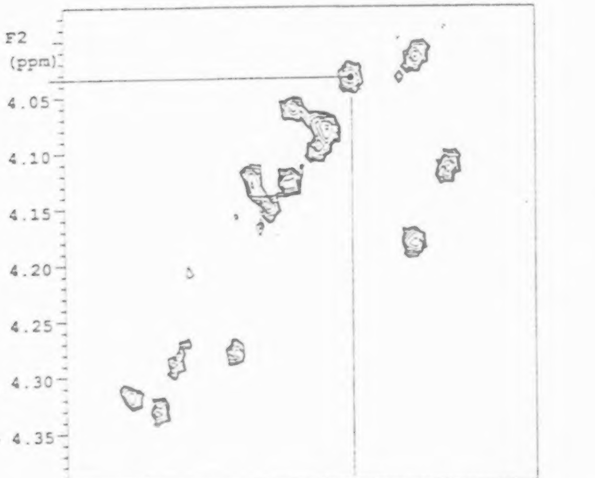


Figure 1: H_3' - H_4' Interaction

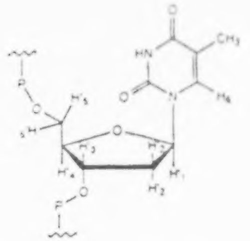

O
CH₃
HN
O
N
H₆
H'₅
O
₅H
O
H'₃
H'₂
H'₄
H'₁
O
H'₂
P
P

Figure 2: Thymidine Core

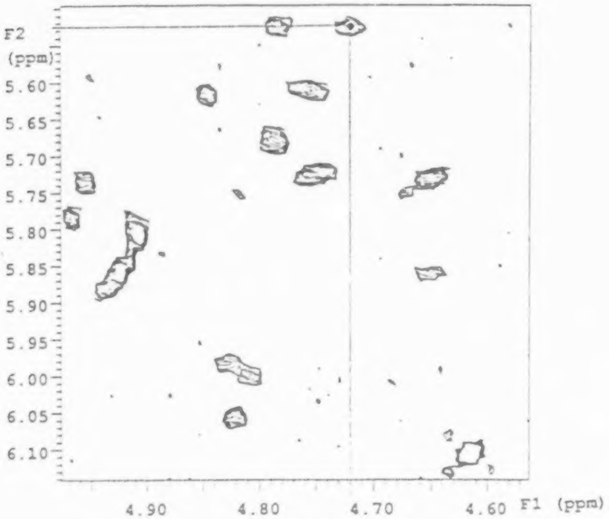


Figure 3: H_3' - H_1' Interactions

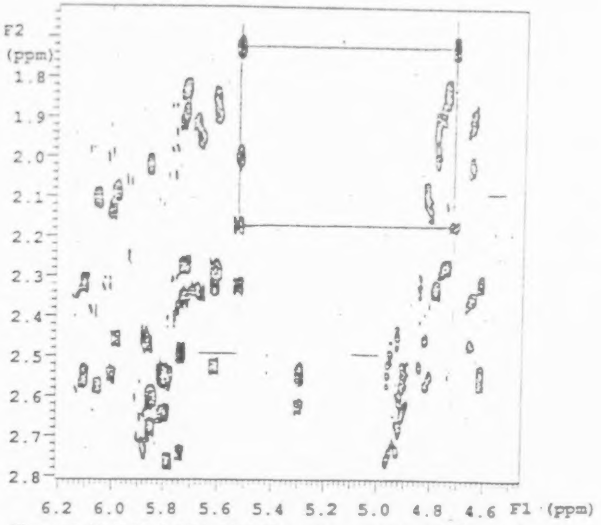


Figure 4: H_2' - H_1', H_2' - H_3', H_5' - H_1', and H_5' - H_3' Interactions

Thymine Proton Assignments

Proton assignments in Table 2 were unambiguously assigned using a similar method to the one described above using spectra obtained from NOESY and COSY experiments. These assignments were confirmed by comparison between NOESY, COSY, and TOCSY experiments.

2a

$-T_1-T_2-T_3-$
-A-A-A-

PPM	$-CH_3$	$-H_6$	$-H_1'$	$-H_2'_{CIS}$	$-H_2'_{TRANS}$	$-H_3'$	$-H_4'$	$-H_5'$
T_1	1.65	7.50	6.15	2.65	2.19	4.91	4.23	4.20
T_2	1.60	7.47	5.94	2.44	2.11	4.73	4.09	4.26
T_3	1.65	7.43	6.16	2.67	2.19	4.91	4.23	4.20

2b

$-T_1-T_2-T_3-$
-A-N-A-

PPM	$-CH_3$	$-H_6$	$-H_1'$	$-H_2'_{CIS}$	$-H_2'_{TRANS}$	$-H_3'$	$-H_4'$	$-H_5'$
T_1	1.84	7.59	6.27	2.43	2.29	4.94	4.29	4.36
T_2	1.78	7.56	6.21	2.51	2.14	4.94	4.27	4.37
T_3	1.90	7.66	6.15	2.34	2.29	4.90	4.36	4.11

2c

$-T_1-T_2-T_3-$

PPM	$-CH_3$	$-H_6$	$-H_1'$	$-H_2'_{CIS}$	$-H_2'_{TRANS}$	$-H_3'$	$-H_4'$	$-H_5'$
T_1	1.83	7.59	5.91	2.45	2.10	4.96	4.39	4.36
T_2	1.70	7.43	5.92	2.46	2.14	4.94	4.37	4.27
T_3	1.86	7.60	6.27	2.43	2.34	4.83	4.27	4.25

Table 2. Proton Assignments for the Unmodified Duplex (2a), the Modified Duplex (2b), and the Free Oligonucleotide Strand (2c) in the Region of Interest.

DISCUSSION

Figure 5 shows the one-dimensional spectrum of the unmodified and the modified oligonucleotides. The upper and lower curves represent the unmodified and modified oligonucleotides respectively. In the upper curve, the three small peaks (labelled 'A') correspond to the thymine methyls on the single stranded oligonucleotide. The two larger peaks (labelled 'B) correspond to the thymine methyls on the duplex. The thymines in the duplexed oligonucleotide are held in rigid conformation. In this conformation, the outer thymines would be chemically equivalent and produce only one peak in the spectrum. In the case of the free, or single stranded oligonucleotide, the thymines can adopt other conformations, resulting in nonequivalence of the outer thymines. This produces one peak for each of the thymines in the spectrum. These characteristics allow the identification of the peaks as belonging to either the duplexed or single stranded oligonucleotide.

In the lower curve of Figure 5, the three peaks labeled as 'A' result from the free, or single strand, oligonucleotide and the two peaks label 'B' to the modified duplex. The ratio of A to B increases when comparing the modified to the unmodified spectrum. Since the size of the peaks is directly related to amount of the species present, one can conclude that the amount of free oligonucleotide increases as well. This implies that the duplex is breaking apart signifying that it is less stable than the native duplex.

Scheme 1 outlines the destabilization process. If the 5-nitroindole assumes the position of adenine, the highlighted hydrogen comes in close proximity to the nitrogen on the thymine. Since the hydrogen carries a partial positive charge and nitrogen carries a full positive charge, they repel each other, causing the 5-nitroindole to pull away from this position allowing for hydrogen bonding with the two oxygens. The movement from the natural position causes a bulge in the oligonucleotide, forcing it to break apart. Therefore, the modified base is more structurally unstable than the native structure. Further studies will investigate the stability of the structure when the 5-nitroindole is paired with the other natural bases in the complimentary strand.

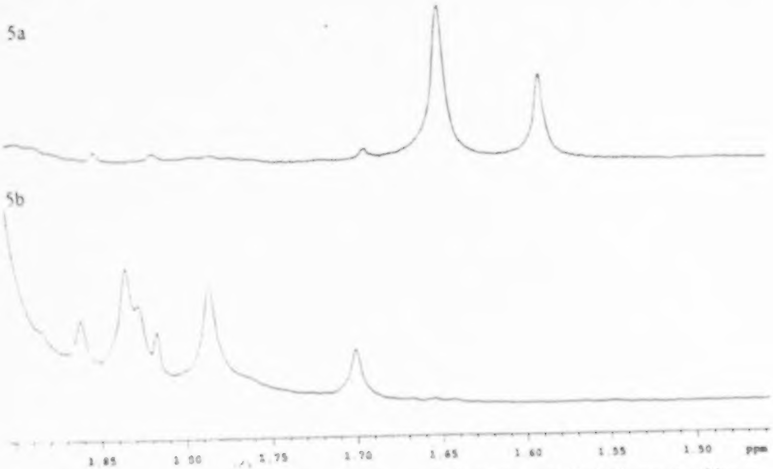
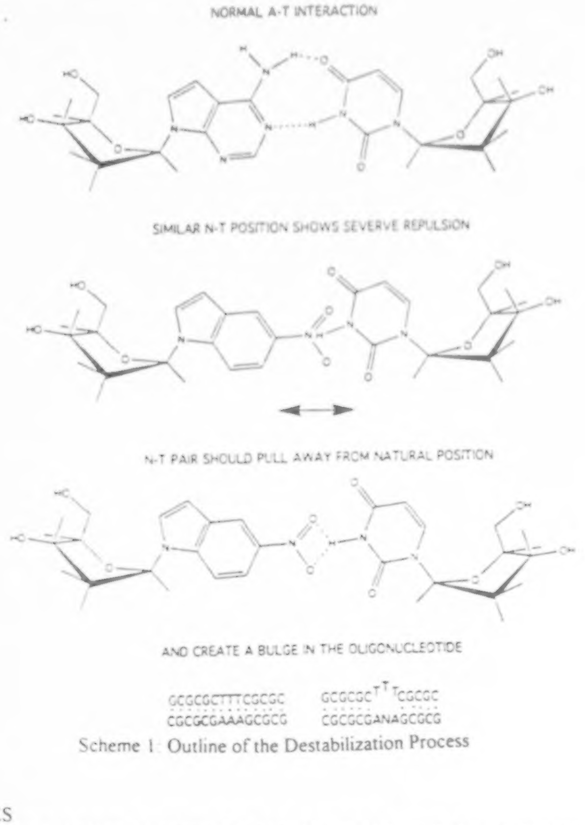


Figure 5: One-dimensional spectrum of the unmodified and modified oligonucleotides.


NORMAL A-T INTERACTION
SIMILAR N-T POSITION SHOWS SEVERVE REPULSION
N-T PAIR SHOULD PULL AWAY FROM NATURAL POSITION
AND CREATE A BULGE IN THE OLIGONUCLEOTIDE
GCGCGCTTTCGCGC
CGCGCGAAAGCGCG
GCGCGC T T T CGCGC
CGCGCGANAGCGCG

Scheme 1: Outline of the Destabilization Process

REFERENCES

Brown, D. M. and D. Loakes. "5-Nitroindole as an Universal Base Analogue". Nucleic Acids Research. 22 (1994). 4309-4043.

Ven, Frank J.M. van de. Multidimensional NMR in Liquids. Basic Principles and Experimental Methods. New York: VCH Publishing, 1995.

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Effects of Additives, pH, and Buffers on the Chemiluminescence of Phenyl Acridinium Ester

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The ability of acridinium ester to generate light has made this compound important for use as a label in immunoassays because of the high sensitivity possible with chemiluminescence detection. This study examined the effects of buffer concentration, pH, and complexing agents on the chemiluminescence of 9-phenyl acridinium ester. Concentrations of 0.200 M to 0.025 M potassium phosphate buffer at pH 6.0 to 8.0 were examined as well as similar concentrations of Tris buffer at pH 7.0 and 8.0. In general, an increase in light production was noted as buffer concentration was decreased. Using *gamma*-cyclodextrin as an additive was found to enhance chemiluminescence at pH 2.5 but *beta*-cyclodextrin had no appreciable effect.

INTRODUCTION

Chemiluminescence can be defined as the production of light resulting from a chemical reaction [1]. The study of this is important because detection of chemiluminescence is very sensitive and has a low background signal. Phenyl acridinium ester (see figure 2) was studied in this experiment for three main reasons: it is water soluble, it has a relatively high luminescent yield (approximately 0.1), and it can be conjugated to other molecules (i.e. proteins) to be used as a probe or label for immunoassays using high performance liquid chromatography. The variables studied were the effects of pH, concentration and type of buffer, and additives to the solvent. Especially, the rate of decay of luminescence versus time of the ester in solution was examined. This is a concern when doing an HPLC immunoassay. If there is a decay on the yield of luminescence of the ester, one could not accurately quantify the amount of molecule labeled with the ester without taking into account the decay. That is, one's signal would decrease with time even though the same amount of label were present.

EXPERIMENTAL

Luminometer measurements

All luminescence measurements were made using an Optocomp luminometer form MGM Instruments (Hamden, CT). Sample measurements were accomplished by the addition of two reagent solutions (75 µL each) to a test tube containing 150 µL of an acridinium ester solution. The reaction was initiated by addition of a hydrogen peroxide solution (in 0.1 N HNO_3 for stability) followed by addition of NaOH solution. The acridinium ester solutions typically contained 3×10^{-11} M phenyl acridinium ester in a pH 2.5 0.1 M phosphate buffer before dilution. Twenty-five µL of this solution was transferred into a 100 mL flask and diluted to volume with the desired solvent or buffer. The solvent or buffer was either Phosphate buffer or Tris buffer at different pHs and molarities or was water adjusted with strong acid or base to pH. Timing was initiated at the dilution time.

Reagents

9-phenyl acridinium ester (i.e. 9-phenoxy-10-methyl acridinium fluorosulfonate) was synthesized from acridine-9-carbonyl chloride as described in the literature [2]. Triton X-100 and *gamma*-cyclodextrin were from Sigma Chemicals (St. Louis, MO). Tris (Base) was from Schwarz/Mann (Orangeburg, NY).

RESULTS

Definitions: When "baseline values" or "baselines" is mentioned, this is the average of the readings taken after there was no more significant change in luminescence or the readings taken after one and a half hours in solvent. Peak values are first response readings from the luminometer. Typically, the first response was the largest one. When an unbuffered solution of a specific pH was called for, nanopure water was brought to pH with HCl or NaOH.

Additives

Because the effect of Triton X-100 on luminescence had been studied before [3], this study concentrated on comparison of Triton X-100 with unbuffered solutions and with *gamma*-cyclodextrin. The Triton did increase the total luminescence but seemed to have little or no effect on the decay of luminescence. Because the initial luminescence was relatively high compared to unbuffered solutions, but the baseline value was not as dramatically different, the decay of this curve (taken as the natural log of the curve) was faster than first order. The natural logarithm of the response versus time plot still had a very noticeable curve.

In the cyclodextrin studies, there was a linear increase of luminescence versus concentration from 0.01 to 0.1 M. Also, when in cyclodextrin and phosphate buffer (PB), there was no decay of response like with Triton X-100.

Buffers

The decay seen in response of luminometer readings versus time was not unique to one type of buffer. Both phosphate buffer and Tris (base) buffer showed a decay at different pHs with Triton X-100. Concentrations of buffer in specific pHs were studied. Results show the following general trends:

Peak Comparisons	
pH	Observation
6 (PB)	chemiluminescence decreased with decreasing buffer concentration
7 (PB)	no appreciable effect
8 (PB)	chemiluminescence increased with decreasing buffer concentration
8 (Tris)	chemiluminescence decreased with decreasing buffer concentration
Baseline comparisons	
pH	Observation
2.5 (PB)	no significant change
6 (PB)	no significant change
7 (PB)	small increase in luminescence with decreasing buffer concentration
8 (PB)	chemiluminescence increased with decreasing buffer concentration

Figure 1: general trends of luminescence with regard to pH

pH effects

Peak values and baseline values were studied. For the peak value studies, in general, unbuffered solutions demonstrated a slight rise in luminescence until pH 8. After pH 9, there was a sharp drop of luminescence. Buffered solutions showed a decline in luminescence with increase in pH from pH 6 to 11, with a leveling off from pH 10 to 11 (see figure 3). Baseline studies an increase in luminescence from pH 6 to 8 in unbuffered solutions with triton. In unbuffered solutions without triton, There was a general drop in luminescence from pH 6 to 9 and a sharp drop at pH 10. Buffered solutions once again showed a decline in luminescence with increasing pH. The decline is sharp from pH 6 to 8 and then bottoms out from pH 8 to 10 (see figure 4).

CONCLUSIONS

Additive effects

The addition of Triton X-100 and *gamma*-cyclodextrin could be enhancing the luminescence of the acridinium ester by the orientation of the ester in the micelles. Also, the hydrophobic environment provided by these micelles could be increasing the reactivity of the ester. Ion pairing increases significantly in micelles. This could explain the sharp decays in luminescence with triton.

Buffer effects

The buffers in neutral to high pHs could be forming an ion-pair with the ester. This would inhibit the luminescence by the formation of a less luminescent species. The production of light depends on reaction of the peroxide ion with the carbonyl (see figure 2). Any other ions which could pair there would block the peroxide ion from reacting, and hence block light production.

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pH effects

At very high pHs (10, 11), the phosphate buffer seems to somewhat protect the acridinium ester from attack by the hydroxide ion and formation of the pseudo-base and increasing the likelihood of the dark reaction. However, at lower pHs, no significant decay is seen unless there is a buffer present. This could be the ions in the buffer solutions attacking the micelles and preventing them from helping the luminescence.

Future studies will include a larger range of pHs. Also, the effects of borate buffer and ionic additives will be investigated. At present, kinetics studies of the binding of *gamma*-cyclodextrin to the acridinium ester are underway.

ACKNOWLEDGMENTS

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REFERENCES

1. D. S. Hage, in *HPLC Detection: Newer Methods*, G. Patonay, Ed., 1992, VCH, New York, Chapter 3.
2. I. Weeks, M. Sturgess, P.C. Brown and J. S. Woodhead, *Methods Enzymol.*, 133 (1986) 366.
3. F. Javier Bagazogita, J. Garcia, *Journal of Bioluminescence and Chemiluminescence* Vol. 2 (1988) 121-128.
4. D.S. Hage, Rodney Walters, and Herbert Hethcote, *Journal of Analytical Chemistry*, 58 (1986) 274.

Figure 2: Reaction scheme of the phenyl acridinium ester to produce light

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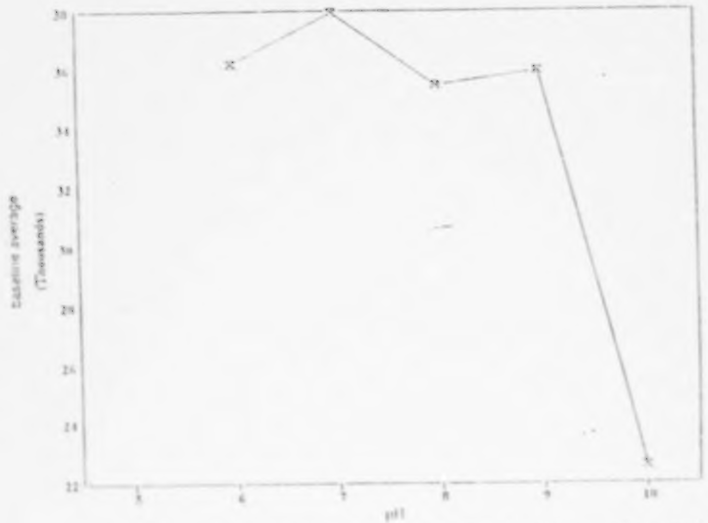

Figure 3: Baseline average versus pH in an unbuffered solution, no Triton X-100

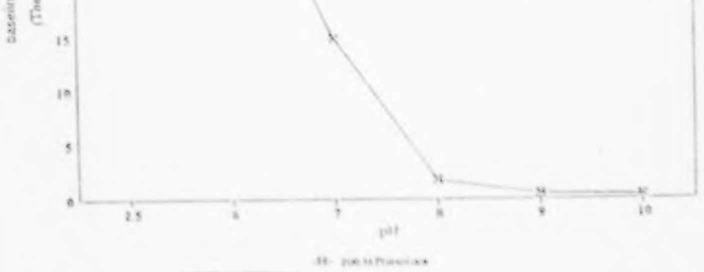

Figure 4: Baseline average versus pH in a buffered solution (PB), no Triton X-100

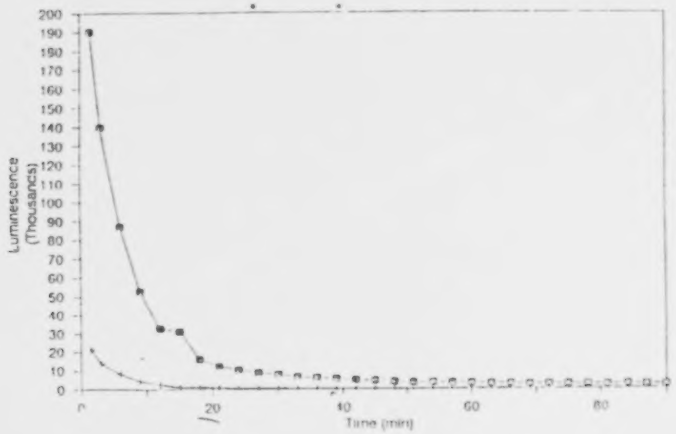

Figure 5: Sample plot of luminometer response of acridinium ester in 0.200 M PB at pH 8.0 with Triton X-100 made over the course of ninety minutes (Total response □, maximum response +)

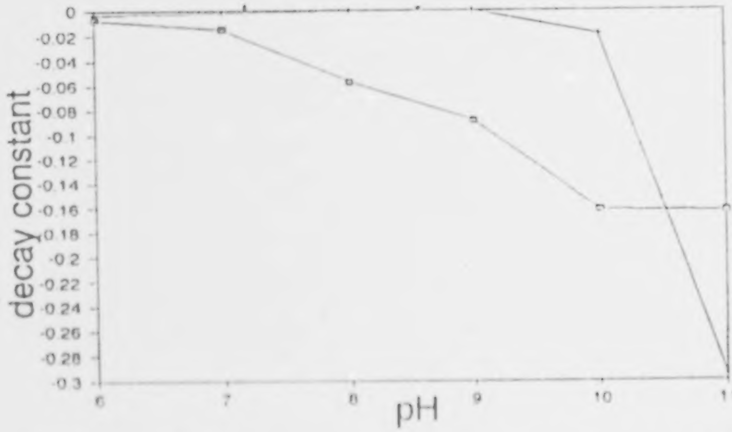

Figure 6: Pseudo first-order decay constant versus pH; decay constant taken as slope of line formed by plotting natural logarithm on initial (peak) responses versus reaction time (unbuffered +, buffered in PB □)

Dynamic Surface Tension and Surface Adhesion Detection for the Rapid Analysis of Surfactants

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It is desirable to develop a method of analyzing surfactant concentration and surface tension lowering effect without time consuming procedures or extensive preparation. Past research has shown that information can be obtained about the surface tension of a liquid by measuring the physical properties of a repeating drop formed by the flow of liquid out of the end of a capillary. This method has been suggested as a means to detect and characterize surfactants. A Dynamic Surface Tension Detector (DSTD) has been developed which is based upon measuring the pressure between the air-liquid interface of the expanding drop. This pressure-based data provides dynamic surface tension, surface adhesion, surfactant loading and viscosity data for each drop of solution. Common surfactants such as sodium dodecyl sulfate were used to characterize the detector and then industrial and biological surfactants examined and compared. Results will be presented which demonstrate the great potential the DSTD shows coupled with flow injection analysis and liquid chromatography.

INTRODUCTION

Surfactants are comprised of both polar and nonpolar functional groups. They preferentially migrate to surface interfaces to minimize unfavorable interactions with the bulk solvent. At the surface surfactant molecules disrupt the strong interactions of the solvent and lower the surface tension of the solution. Surfactants are widely used commercially as flow improvers, wetting and leveling agents, and emulsifiers.

Traditional methods of measuring surface tension such as contact angle, drop weight, and Wilhelmy plate are used under static conditions.[1] Other systems rely on secondary analyte features for detection, such as fluorescence and mass spectrophotometry, or rely on extensive sample preparation.[2] The Dynamic Surface Tension Detector can be used in real time analysis, both in industrial processes and in conjunction with flow injection analysis and liquid chromatography.

Previous research has demonstrated that surfactants can be detected by examining the drop detachment rate of drops falling from a capillary tip.[3] A previous version of the dynamic surface tension detector used a laser trigger to measure drop detachment rates.[4,5] This idea has been modified and a method of detection which offers multidimensional and kinetic data has been developed. Rather than measuring the drop detachment rate with a laser trigger, the pressure differential across the drop is measured during the entire drop cycle (drop formation, growth, and detachment). This detector yields the drop detachment information, as well as information about the formation of the drop and the kinetics of surfactant migration.

THEORY

An aqueous sample flows through a length of capillary tubing and a succession of drops are formed at the end of a capillary tip. A pressure sensor connected to the specially

The condition for drop detachment occurs when the force of gravity on the drop becomes stronger than the force of the liquid clasping on the tip. This condition is given by:

$$2\pi R'\gamma = \rho V G \qquad (1)$$

where R' is the effective radius where the liquid clasps the tip, γ is the surface tension of the solution, ρ is the density of the solution, V is the volume of the drop, and G is the gravitational force constant. All of these variables can be considered constant within a given drop except the volume of the drop (V). The density of the solution can be considered essentially that of the solvent because of the low concentrations of surfactant which produce large surface tension lowering effects. The solution is pumped at a constant flow rate, so that volume equals volumetric flow rate times time, and the surface tension is proportional to the time of detachment.

The surface tension induced pressure difference is related for a drop of radius r to the surface tension γ by the following equation:

$$P_{ST} = 2\gamma / r \qquad (2)$$

The pressure difference due to viscosity η is expressed by the Poiseuille equation:

$$P_V = 8\eta L F / (R^4 \pi) \qquad (3)$$

where η is liquid viscosity, L is the capillary length, F is the volumetric flow rate, and R is the inside radius of the capillary tip.

The signal is composed of P_{ST} and P_V and is therefore the sum of the previous two equations. The contributions of surface tension, viscosity, and adhesion of the solution to the surface of the capillary tip must be understood in order for the detector's performance to be optimized. The pressure difference due to viscosity does not vary with time or drop growth, but the pressure due to surface tension does vary with time because the drop radius r changes with time. An adhesion effect causes the force of the liquid clasping to the tip to be stronger and results in the drop clinging to the tip longer and therefore producing a longer drop detachment time (eq. 1).

EXPERIMENTAL:

The experimental apparatus is shown in Figure 1. Water was delivered with a syringe pump (Isco µLC-500, Lincoln, NE) to an injection valve (Rheodyne 7125, Cotati, CA) fitted with a fixed volume injection loop of 200 µL. The pressure sensor connected to the capillary tip is shown in Figure 2. The pressure sensor contains a thin metal membrane which is compressed and extended by less than 5 micrometers and is sensitive to pressure changes as little as 10^{-4} PSI. Detection limits vary by surfactant, but detection limits in the low parts per million have been achieved.

The pressure readings are recorded in arbitrary units which can be converted into PSI by calibration with a volt-meter. The data is collected on computer with a Keithley-Metrabyte data acquisition board. The collection rate for this work ranged from 60 to 300 points per second. The data collection rate does not appear to be a limiting factor in data precision. The signal to noise ratio is approximately three to one or better.

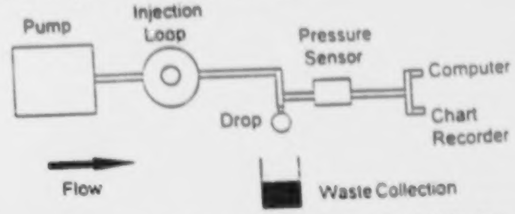

Figure 1. Instrument design. For the data presented in Figures 3-5, the flow rate was 85 µL/min, the solvent was water, and the sample volume injected was 200 µL with a capillary tube volume of 300 µL to achieve the desired diffusion. Samples are introduced to the fixed volume injection loop and injected into the flow, passing through a length of capillary tubing and forming a repeating drop at the capillary tip.

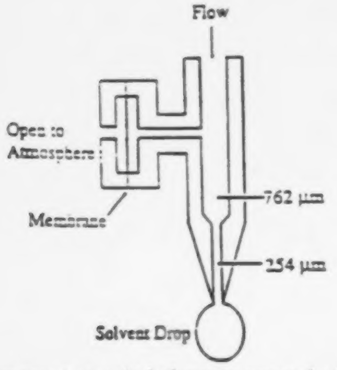

Figure 2. A pressure sensor records the pressure across the drop and passes the signal to both a chart recorder and a computer via a data acquisition board. The tip is specially machined to avoid back-pressure and a side-arm in the stainless steel tip allows the membrane in the pressure sensor to register the pressure across the air-liquid interface of the drop.

RESULTS AND DISCUSSION

The pressure signal relates directly to the stage of drop formation, as described below and illustrated in Figure 3. The signal is at its minimum when one drop detaches from the capillary tip and the next drop begins forming. At first there is liquid only inside the capillary tip. Since there is a constant flow from the pump, the liquid is pushed to the outside of the tip where it first appears as a slight bulge. During this time the pressure signal rises steadily. The pressure maximum occurs approximately when the liquid "pops" into a hemisphere. The hemisphere becomes a sphere almost immediately and as the sphere grows in size the pressure signal decreases until the drop reaches its maximum size and detaches from the capillary tip. Drop detachment occurs when the volume is large enough that the force of gravity overcomes the force of attachment to the tip as shown in equation 1. This is the pressure minimum which is the end of one drop cycle and the beginning of another. The drop is not actually perfectly spherical but because of the excess free energy at the surface it approximates a sphere very closely.

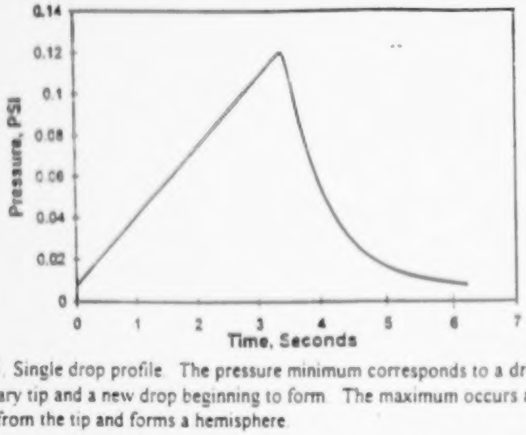

Figure 3. Single drop profile. The pressure minimum corresponds to a drop detaching from the capillary tip and a new drop beginning to form. The maximum occurs as the liquid emerges from the tip and forms a hemisphere.

In order to develop a means to compare data using the detector, the maximum and minimum pressure signal and the time from minimum to minimum for consecutive drops from the capillary tip were examined. At the pressure minimum, one drop detaches and the next begins to form; from one minimum to the next is the time of a drop. From the pressure minimum to the maximum is the total pressure. The presence of a surfactant causes both the total pressure and time to change. As predicted by equation 2, when the surface tension is lowered, the pressure due to surface tension is also lowered. At the pressure maximum the

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radius of the drop is always the same, so the pressure signal and surface tension of the solution should directly relate. According to equation 1, surface tension at the instant of drop detachment is proportional to volume, provided the other factors remain constant. Since the flow rate remains constant, the smaller volume resulting from a lower surface tension is recorded as a shorter drop time.

Changes in surface tension relative to some baseline surface tension of a flowing solvent can be determined by calculating the change in time or change in pressure. The change in pressure (ΔP) and change in time (Δt) are found by subtracting the pressure signal or time of a drop containing surfactant from the pressure signal or time of a drop containing only solvent. The solvent used is water which makes the baseline surface tension 72 dynes per centimeter. The greater the concentration of surfactant, until it forms a monolayer or reaches the critical micelle concentration, the greater the change in surface tension and therefore in pressure signal or drop time. A drop profile is the plot of pressure signal versus time for a single drop. Figure 4 shows the drop profiles for five concentrations of SDS (sodium dodecyl sulfate) in 500 ppm TBA (tetrabutyl ammonium) compared to a drop profile for pure water. The 10 ppm SDS drop pressure is slightly lower than pure water and its time is slightly shorter than pure water. The 60 ppm SDS drop pressure is much lower than that of water and the drop time is significantly shorter than water. These differences confirm that the DSTD detects the lowering of the surface tension of water by SDS/TBA.

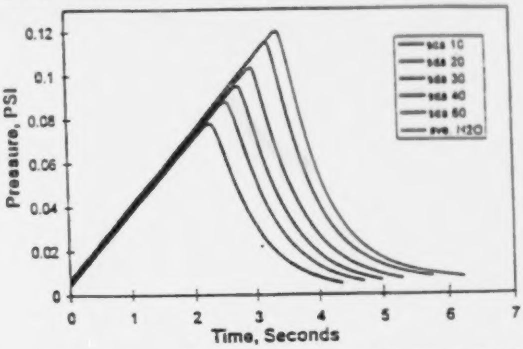

Figure 4. Overlay plot of drop profiles for water and five concentrations of SDS in 500 ppm TBA. SDS concentrations are in ppm.

Although the drop profiles in Figure 4 have different sizes, all the SDS drop profiles have the same general shape. Different surfactants can be characterized and kinetic data can be interpreted from the shape of the drop profiles. At the very least, the multidimensional data can be used to distinguish surface tension lowering effects from other phenomena such as adsorption.

Shown in Figure 5 are several drop profiles of FC-171, an industrial surfactant manufactured by 3M, overlaid on the drop profiles of SDS and water. Previous detectors relying on drop detachment rate alone would not see that FC-171 lowers the surface tension because the drop time remains the same for increasing concentrations. At the pressure maximum, however, the surface tension lowering effect is clearly manifest. The hydrophobic FC-171 adsorbs or adheres slightly to the stainless steel tip.

When a smaller sample of a higher concentration is injected and greater diffusion is allowed by increasing the length of the capillary tubing leading to the capillary tip, a gaussian signal peak is obtained. The concentration of each drop increases slightly to a maximum and then decreases until the drops consist only of water. Each drop is examined and its ΔP and Δt are found and divided by a baseline P and t. For the time t, the time of a water drop is the baseline t. For the pressure P, the total pressure of a water drop is a baseline P. $\Delta P/P$ and $\Delta t/t$ can be plotted either against one another or against the drop number. In Figure 6 as the surfactant concentration increases to a maximum, $\Delta P/P$ and $\Delta t/t$ increase. As the surfactant concentration decreases, $\Delta P/P$ and $\Delta t/t$ decrease as well. As expected from equations 1 and 2, $\Delta P/P$ and $\Delta t/t$ are at their maximum when the concentration of surfactant is at its greatest and therefore the surface tension lowering effect is greatest.

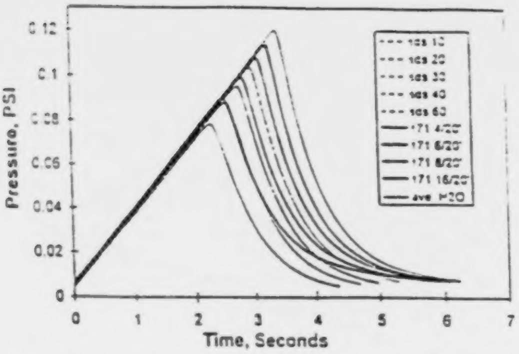

Figure 5 Overlay plot of drop profiles for water, SDS in TBA, and FC-171 SDS concentrations are in ppm and FC-171 concentrations are in µL surfactant per mL water.

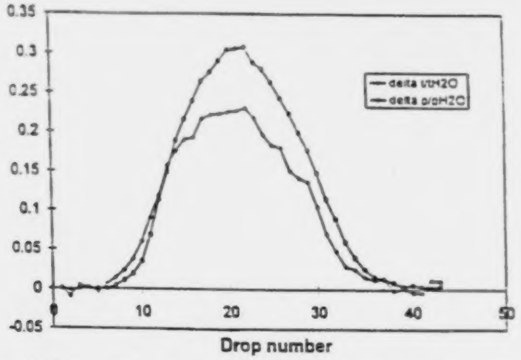

Figure 6 Plot of $\Delta P/P_{H2O}$ and $\Delta t/t_{H2O}$ versus drop number for injection of 250 ppm SDS in 500 ppm TBA. Initial and final drops shown consist of only water As varying concentrations of surfactant go through the detector $\Delta P/P_{H2O}$ and $\Delta t/t_{H2O}$ increase as a result of the lowering of the surface tension of the solution

CONCLUSIONS

The pressure-differential based dynamic surface tension detector shows great promise for surfactant detection and characterization Through the manipulation of time and pressure data, information about surface tension can be acquired Further studies will focus on applications of the detector to liquid chromatography and further test the capabilities of the detector

ACKNOWLEDGMENTS

Many thanks to Rob Synovec, Kristy Skogerboe, and Nels Olson for their help with this research and for the NSF-REU program which made this research possible

REFERENCES

(1) Enhorning, G *J. Appl. Physiol Respirat. Environ. Exercise Physiol* 1977, 43(2), 198-203
(2) Serrien, G., Geeraerts, G., Ghosh, L., Joos, P *Colloids and Surfaces* 1992, 68, 219-233
(3) Cronan, C. US Patent 4,646,562, 1987
(4) Lima III, L R., Dunphy, D R., Synovec, R E *Anal. Chem* 1994, 66, 1209-1216
(5) Lima III, L R., Synovec, R E *J. Chromatogr* 1995, 691, 195-204

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Interactions of the Domains of Myosin's Regulatory Light Chain with the Heavy Chain
A Photocross-linking Study

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The focus of the research is to determine how the regulatory light chains (LC20) of smooth muscle myosin (SMM) interact with the myosin heavy chains (HC) Regulatory light chains containing a 6xHistag marker for purification purposes were expressed from *Escherichia coli* and separated by affinity chromatography The purified LC20s were labeled at the single cysteine residue with benzophenone-4-iodoacetamide (BPIA), a photoreactive cross-linker, and the labeled LC20s were exchanged onto native SMM Investigations using SMM 10S folded form, filamentous form, and 6S monomer form provided evidence that for non-phosphorylated myosin, the 6xHistag does not affect HC-LC photocross-linking ability Analysis showed that HC-LC cross-linking ability of the BPIA attached to the C-terminal domain of the native LC20 differs from cross-linking ability of the probe when located in the N-terminal of double mutant A23C/C108A LC20 Conformation-dependent interactions of the myosin HC with the N-terminal of LC20 differ from those interactions with the C-terminal of LC20 Future studies will use phosphorylated double mutant LC20 exchanged myosin to compare the effects of phosphorylation on cross-linking ability These studies will aid in the determination of the location of HC-LC cross-link formation and give information about conformation changes that occur in myosin during contraction and regulation These studies should lead to a greater understanding of regulation in SMM

BACKGROUND

Smooth muscle lines the organs of the gastrointestinal tract and the walls of blood vessels Smooth muscle myosin (SMM) is the molecule that regulates contraction of smooth muscle SMM consists of a globular head region, a neck region, and a long coiled-coil tail SMM molecules are hexamers composed of two heavy chains and two pairs of light chains (essential and regulatory light chains) attached to the heads of the heavy chains

Regulation in SMM is phosphorylation-dependent A Ca^{2+}-calmodulin/myosin light-chain kinase complex phosphorylates SMM Upon hydrolysis of MgATP into the products ADP and P_i, the head shifts to a high-energy configuration which binds to actin filaments Catalyzed by myosin light-chain phosphatase, the release of P_i from SMM causes the head to reconfigure into a low-energy binding state This change in conformation causes tension and initiation of the power stroke, which results in the movement of actin filaments It is this "sliding" of actin and myosin filaments which causes muscle contractions The cycle is completed when ADP is released from myosin, leading to muscle relaxation[1]

In vitro, purified SMM exists in three forms In the presence of ATP, SMM exists in a soluble 10S monomer form, in which the tail forms a cross-link with its own head The 10S form has low ATPase activity In high ionic strengths, the 10S form is destabilized and exists as a soluble 6S monomer in which the tail is straightened The 6S monomer has intermediate ATPase activity and exists in equilibrium with the inhibited filament form The filaments become active (display high ATPase activity) upon phosphorylation of the regulatory light chains See Figure 1A, 1B, and 1C for SMM configurations

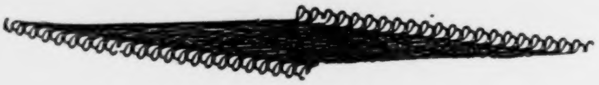


Figure 1A Filamentous SMM

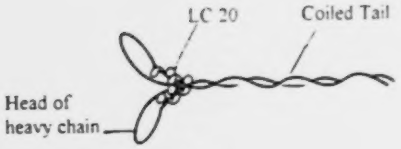


Figure 1B 6S SMM

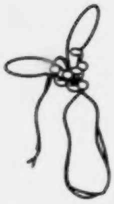


Figure 1C 10S SMM

The structure of the 20kDa regulatory light chain (LC20) is of interest because phosphorylation of the LC20 regulates myosin activity Upon phosphorylation, the LC20 and the myosin head change conformation, resulting in muscle contraction A photoreactive cross-linking probe, benzophenone-4-iodoacetamide (BPIA) Figure 2, was placed onto the single cysteine of purified unphosphorylated LC20 The labeled LC20 was exchanged for the native LC20 on purified chicken gizzard SMM The probe was irradiated, and gel analysis of the cross-links was used to discover the structural relationships involved in unphosphorylated LC20s

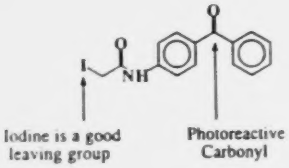


Figure 2 Structure of BPIA

An important question to be answered before continuation of the experiments was does the 6xHistag marker affect photoaffinity cross-linking ability of the labeled LC20s to the heavy chain (HC)? If so, then the 6xHistag must be cleaved before irradiation of the samples The 6xHistag to the LC20 was utilized in affinity chromatography and allowed for purification of the LC20 from *E. coli* If the Histag did not affect cross-linking ability, the Histag would be left on during irradiation, so that affinity chromatography could also be used to purify the HC-LC cross-links after irradiation of the labeled myosin

A future goal of the research is to repeat the cross-linking experiment using phosphorylated LC20 to compare the structural differences between unphosphorylated and phosphorylated LC20 in order to determine the conformational changes that occur during SMM regulation

MATERIALS AND METHODS

6xHistag LC20s were cloned and expressed from *E. coli* The cells were homogenized and the LC20s containing a 6xHistag marker were purified by affinity chromatography The 6xHistags of the LC20s chelated with the resin used for chromatography, while the remaining homogenate material was in the supernatant The LC20s were then eluted from the resin using an imidazole-based buffer solution

Two different constructs of the LC20 sequence were used a wild type (WT) construct with the native light chain sequence and a construct with a double mutant sequence (A23C, C108A) The LC20s were then labeled at the single cysteine (C108 for WT, A23C for double mutant) with BPIA, following the procedure described by Olney, et al[3]

The labeled LC20s were then exchanged onto purified chicken gizzard SMM using a 20-fold excess of labeled LC20s The SMM and labeled LC20s were placed in ATP, dithiothreitol (DTT), and EDTA at 42° C for 30 minutes to promote the exchange of native LC20s with the labeled LC20s The LC20 exchange reaction conditions and procedures were performed as described by Facemyer and Cremo[2] and Olney, et al[1]

The solution containing the labeled SMM and free LC20s was placed into a Mg^{2+} buffer to promote the formation of SMM filaments The labeled SMM were separated from the free LC20s by centrifugation The SMM were dialyzed with different buffers to promote formation of 6S, 10S, and filament conformations [6S buffer conditions 0 5 M NaCl, 15 mM imidazole pH 6 6, 1 mM EGTA, 10 mM $MgCl_2$ 10S buffer conditions 10 mM NaP, pH 7 5, 1 mM $MgCl_2$, 0 1 mM EGTA, 125 mM NaCl, 0 5 mM ATP Filament buffer conditions 15 mM imidazole pH 6 6, 10 mM $MgCl_2$, 125 mM NaCl, 1 mM EGTA] The 6S, 10S, and filament samples were then irradiated to activate the BPIA probe and initiate cross-linking 4-20% Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and 8M urea gel electrophoresis were used to analyze the cross-link formations that resulted The 6xHistag was cleaved from some of the LC20s using a thrombin buffer 15mM Tris-Cl pH 7 5, 2 5 mM $CaCl_2$, 10 mM $MgCl_2$, 150 mM KCl, 2 mM DTT, and N_3

RESULTS

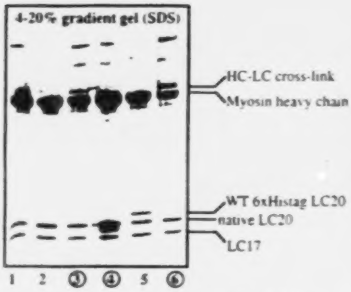
The Effect of the 6xHistag During Irradiation

To test whether the Histag affected cross-linking ability of labeled myosin, 4-20% SDS-PAGE analysis was performed on the samples in Figure 3 The samples analyzed by SDS-PAGE were unlabeled myosin control (lane 1), native LC20 C108 BPIA labeled myosin (lane 2), irradiated native LC20 C108 BPIA myosin (lane 3), myosin irradiated in a 10-fold excess of C108 BPIA free LC20 (lane 4), WT 6xHistag LC20 C108 labeled myosin (lane 5), and irradiated 6xHistag LC20 C108 labeled myosin (lane 6)

Myosin irradiated in the presence of free labeled LC20 (lane 4) did not form HC-LC cross-links, as indicated by the absence of the HC-LC cross-link band, therefore, the LC20s do not exchange during irradiation This meant that the labeled LC20s exchanged onto the native SMM during the exchange reaction would not come off during irradiation Levels of HC-LC cross-linking were similar in myosin filaments containing native labeled LC20 (lane 3) and WT Histag LC20 (lane 6) It was concluded that the Histag did not affect the cross-linking ability of the sample

A similar experiment was performed with 6xHistag LC20 A23C/C108A BPIA labeled myosin versus thrombin-cleaved LC20 A23C/C108A labeled myosin to determine whether the Histag affected photoaffinity cross-linking ability of SMM Figure 4 shows the 4-20% SDS-PAGE analysis of the experiment with the double mutant LC20 unlabeled myosin control (lane 1), 6xHistag double mutant BPIA labeled LC20 (lane 2), irradiated 6xHistag LC20 A23C/C108A BPIA labeled 10S myosin (lane 3), irradiated 6xHistag LC20 A23C/C108A BPIA labeled filamentous myosin (lane 4), irradiated 6xHistag LC20 A23C/C108A BPIA labeled 6S myosin (lane 5), LC20 double mutant labeled myosin (lane 6), irradiated LC20 double mutant labeled 10S myosin (lane 7), irradiated LC20 double mutant labeled filamentous myosin (lane 8), irradiated LC20 double mutant labeled 6S myosin (lane 9), unlabeled myosin control (lane 10)

In double mutant LC20, the levels of cross-linking formation differed with conformation The most cross-linking occurred in filamentous form (lanes 4 and 8), the least cross-linking occurred in 6S form (lanes 5 and 7) Levels of conformation-dependent cross-linking in irradiated samples were the same in myosin which contained the 6xHistag (lanes 3-5) and in myosin in which the 6xHistag was cleaved with thrombin (lanes 7-9) The 6xHistag marker did not affect the cross-linking ability of the sample


4-20% gradient gel (SDS)
HC-LC cross-link
Myosin heavy chain
WT 6xHistag LC20
native LC20
LC17
1
2
③
④
5
⑥

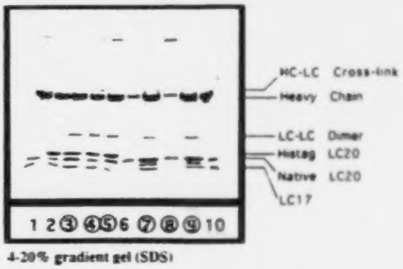

HC-LC Cross-link
Heavy Chain
LC-LC Dimer
Histag LC20
Native LC20
LC17
1 2 ③ ④⑤ 6 ⑦ ⑧ ⑨ 10
4-20% gradient gel (SDS)

Figure 3. Histag on Cross-linking

Figure 4. Histag on A23C/C108 LC20

The Effect of BPIA Location on HC-LC Cross-link Formation

The dependence of probe location on the formation of cross-links was examined by comparison of the conformation-dependent levels of cross-linking that occurred in native LC20 C108 labeled myosin versus 6xHistag LC20 double mutant labeled myosin Figure 5 shows the 4-20% SDS-PAGE analysis of the constructs unlabeled myosin control (lane 1), native LC20 BPIA myosin (lane 2), irradiated native LC20 BPIA 10S myosin (lane 3), irradiated native LC20 BPIA filamentous myosin (lane 4), irradiated native LC20 BPIA 6S myosin (lane 5), 6xHistag LC20 double mutant myosin (lane 6), irradiated 6xHistag LC20 double mutant 10S myosin (lane 7), irradiated 6xHistag LC20 double mutant filamentous myosin (lane 8), irradiated 6xHistag LC20 double mutant 6S myosin (lane 9), unlabeled myosin control (lane 10)

With placement of the probe on C108 of the native light chain in the C-terminal domain (lanes 2-5), cross-linking was very efficient in 10S myosin (lane 3), less efficient in filaments (lane 4), and did not occur in the 6S monomer (lane 5) In contrast, placement of the probe on A23C in the N-terminal domain of the LC20 (lanes 6-9) resulted in HC-LC cross-linking primarily in filaments (lane 8), less so in 6S myosin (lane 9), and in very low levels in the 10S conformation (lane 7)

The ability of BPIA to form HC-LC cross-links is dependent upon the site-specific placement of the probe on the LC20 Cross-link formation was conformation-dependent in both native and double mutant LC20 constructs, however levels of conformation-dependent cross-linking differed in the two

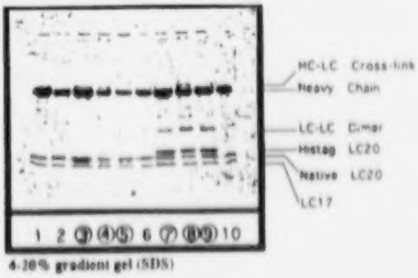

HC-LC Cross-link
Heavy Chain
LC-LC Dimer
Histag LC20
Native LC20
LC17
1 2 ③④⑤ 6 ⑦⑧⑨ 10
4-20% gradient gel (SDS)

Figure 5 Comparison of Probe Location on HC-LC Cross-link Formation

CONCLUSION

Evidence from the photoaffinity cross-linking experiments with non-phosphorylated WT 6xHistag LC20 C108 BPIA labeled myosin and with non-phosphorylated 6xHistag

LC20 A23C/C108A BPIA labeled myosin shows that the Histag does not affect cross-linking ability These experiments demonstrated that the Histag would not need to be removed before irradiation of the samples, and that thus, the Histag could be used in purification of the HC-LC cross-links However, further research (not shown here) has revealed that the Histag affinity chromatography technique cannot be used to purify the HC-LC cross-links because the HC interferes with Histag binding to the chelating resin While the Histag does not alter cross-linking ability, another method (other than using the Histag with affinity chromatography) must be found to purify the HC-LC cross-links

Cross-linking is conformation-dependent Heavy chain-light chain cross-link formation differs in myosin with native LC20 labeled at C108 from myosin with LC20 labeled at A23C Cysteine 108 is located at the C-terminal domain of the LC20, while A23C is located in the N-terminal domain Based on the data presented, HC-LC interactions change with conformation and with respect to the location of the probe on the two domains of the LC20

Investigations to study the effect of phosphorylation on cross-linking ability of A23C/C108 LC20 are in progress Goals of future studies are to determine the precise location of the HC-LC cross-linking in specific conformation, to discover why HC-LC interactions differ with conformation, and to increase overall understanding of how phosphorylation of LC20 regulates smooth muscle contraction

ACKNOWLEDGEMENTS

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REFERENCES

1 Campbell, Neil A (1993) Biology Volume 3, 1040-1041
2 Facemyer, Kevin C and Christine R Cremo (1992) Journal of Bioconjugate Chemistry Volume 3, 408-413
3 Olney, Jennifer J, James R Sellers, Christine R Cremo (1996) The Journal of Biological Chemistry Volume 271, No 34, Issue of August 23, 20375-20384
4 Sellers, James R (1995) Protein Profile Volume 2, No 12, 1323-1423

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Thermodynamic Melting Point Studies of a Native and Modified Thirteen Base Pair Oligonucleotide containing 5-Nitroindole using UV Spectrometry

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5-Nitroindole is considered a good universal base for hybridizing with other base pairs in oligodeoxynucleotides. This is due to its duplex stability and affinity for all nucleotides. To show this we determined the melting point by heating the modified oligonucleotides until they became destabilized. Then we compared this data to the original melting points of unmodified oligonucleotides. The results of this study show that the oligonucleotides containing the modified base were more stable than the the unmodified duplexes.

INTRODUCTION

The object of these experiments was to determine the feasibility of using 5-nitroindole as a universal base. We studied the stability of a series of oligonucleotides with and without incorporation of 5-nitroindole. This was done by comparing the melting temperatures of the native and modified oligonucleotides. Analysis of the resulting data was then used to show how the 5-nitroindole effects the stability of the duplex when incorporated, and more specifically how the 5-nitroindole pairs with each of the four naturally occurring bases.

A universal base is a base that pairs indiscriminately with all dNTPs (deoxyribonucleic triphosphates) with no substantial decrease in stability from that of the natural pairing partner. The stability of the oligonucleotide is dependent upon intermolecular interactions between the base pairs. One of the most important interactions stabilizing the double stranded structure of the oligonucleotide is hydrogen bonding between the base pairs in the two strands (see figure 1). Many bases have been tried as a universal base, but were not successful because of their inability to hydrogen bond with all possible 'complementary' bases. An example is hypoxanthine. It does form hydrogen bonds with all dNTPs to varying degrees. However in laboratory experiments with PCR, where it is used in the primer, it exclusively duplexes with cytosine.

5-Nitroindole is a base that is currently being looked at in this study as a universal base. It is considered a good universal base because it does duplex with all dNTPs, showing increased stability at low salt concentrations. This shows that 5-nitroindole is a good universal base because it meets both of the necessary requirements.

To accomplish the task of evaluating 5-nitroindole is as a universal base it was heated gradually until it reached its melting point. This was done by taking a UV spectrum of the solution periodically as it was being heated. The resulting data was then analyzed to determine the stability of the modified duplex relative to the oligonucleotides containing the naturally occurring base pairs.

The melting point (T_m) of the oligonucleotide is an indication of the relative stability of the molecule. By comparing the T_m's for the native and modified oligonucleotide we can determine the stability of the modified oligonucleotide with respect to the native. This information can be used in conjunction with structural studies to learn how the chemical and physical differences between the universal and naturally occurring bases effect the structure of the modified oligonucleotide complex.

HYDROGEN BONDING BETWEEN A MODIFIED BASE AND NATIVE BASES

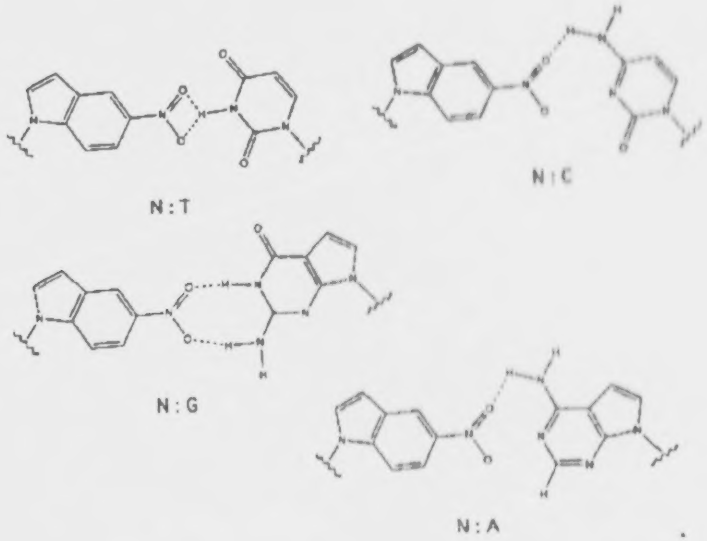

FIGURE 1

METHODS

The oligonucleotides were synthesized on an ABI DNA synthesizer using standard phosphoramidite chemistry and purified by HPLC (high performance liquid chromatography). Each DNA oligonucleotide was placed in a solution of 20mM citrate and 3mM NaCl. The solutions were then gradually heated, and changes in the structure were followed at 260nm by UV spectrometry (Gilford UV spectrometer) (See figure 2) From plots of the absorbency at 260nm vs. the temperature, the melting points of the oligonucleotides were obtained.

RESULTS AND CONCLUSIONS

The data collected from these experiments using low salt concentrations and

LOW SALT CITRATE BUFFER OLIGONUCLEOTIDE MELTING

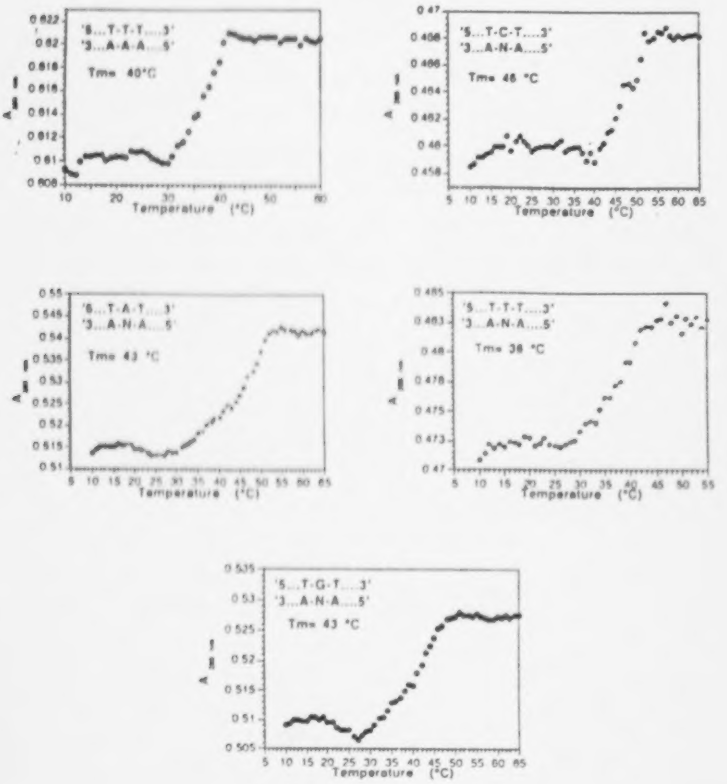

FIGURE 2

that taken from the Brown study using high salt concentrations are compared in table 1. Both studies used the normal T_m of natural oligonucleotides as 40 C. The table shows the difference between the normal and modified T_m s in degrees Celsius.

table 1 temperature differences between modified and native T_m oligonucleotide

	A	T	G	C
High conc.	-5	-7	-7	-4
Low conc.	+3	-4	+3	+6

These results show that the T_m of the 5-nitroindole actually increase the stability of the oligonucleotide at low salt concentrations especially in those oligonucleotide duplexes where the 5-nitroindole is paired to A,G or C. This can be seen by the increase in the melting temperatures of these duplexes. This indicates that 5-nitroindole acts as a good universal base. At higher salt concentrations though the 5-nitroindole was less stable than its natural counterparts. The different salt concentrations were used to show an emphasis on different contributions to the stability of the duplex. At high salt concentrations the structure of the modified DNA strand is reinforced by ionic interactions particularly in the phosphorous backbone of the DNA. At low salt concentrations the DNA strand is stabilized to a greater extent by the hydrogen bonding of the base pairs.

ACKNOWLEDGEMENTS

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REFERENCES

Brown, D.M. and D. Loakes, "5-Nitroindole as an universal base analogue", Nucleic Acids Research, Vol. 22 (1994) Oxford University Press, pp. 4039-4043

How to Calculate the Melting Temperature of Oligonucleotides, http://www.genosys.com/tech/tec_mel.html

Chitosan-Porphyrin Films for NLO Applications and Optical Devices

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Thin, transparent chitosan films have been prepared from dilute acetic acid gels. Interest is focused on the incorporation of porphyrins to prepare films that have interesting optical properties. Studies to date have involved the derivatization of porphyrins for subsequent covalent bonding to the chitosan polymer, and the synthesis of other *meso*-tetraarylporphyrins for doping the films. No reactivity between chitosan's amino or hydroxy substituents and *meso*-tetrakis(4-carboxyphenyl)porphyrin, H_2TCPP, was observed in different solvents. Consequently, the more reactive acid chloride derivative, *meso*-tetrakis(4-chlorocarbonylphenyl)porphyrin, was prepared by refluxing H_2TCPP in thionyl chloride. *meso*-Tetraphenyl-porphyrin-doped chitosan gels produced pale blue transparent films. Fluoroporphyrins such as *meso*-tetrakispentafluorophenylporphyrin, H_2TF_5PP, and its Ni(II) derivative have also been synthesized to function as potential dopants.

INTRODUCTION

Due to their potential applications in optical communications, data storage, and electro-optical signal processing, molecules with nonlinear optical (NLO) properties under vigorous investigated.[1] Many polymeric materials with functional chromophores appear to show interesting electronic properties with good processibility.[2] Chitosan is the only known amino polysaccharide and, along with several of its derivatives, forms liquid crystals, thereby providing a route to functional high temperature polymers with noncentrosymmetric structures displaying NLO properties.[3] Chitosan is the deacylated derivative of chitin, which is one of the most abundant organic resources on earth.[4] It is composed predominantly of sigma bonds, which precludes oxidation or extensive chemical reactions. This makes chitosan ideal for the fabrication of air-stable and visibly transparent thin films. These properties are also precisely those required of protective overlayers for organic light emitting devices to mitigate the degradative effects of oxidation and chemical reactions.[5] An essential process in the operation of electroluminescent organic light emitting devices is the transport of electrons, which is responsible for light emission.[6] Since chitosan can be readily functionalized,[7,8,9] the attachment of appropriate side groups to the polymer backbone should lead to efficient carrier transport. Particularly promising candidates as electron transporting functional dyes are porphyrins.[10] Additionally, porphyrins absorb visible light strongly.[11] To this end, chitosan-porphyrin films appear to be promising as components in optical devices and NLO materials.

An especially fruitful strategy involves incorporation of the dyes of interest into the polymer matrix. Therefore, in the present study, preliminary results of the formation of porphyrin-doped chitosan films are presented. The porphyrins prepared were characterized spectroscopically. A second route to interesting materials entails the direct bonding of chromophores to the polymeric backbone. To carry out this function, a reactive dye such as the porphyrin bearing acid chloride groups, was synthesized. This porphyrin may be more reactive in the proposed derivatization of the chitosan polymer than the parent acid derivative.

EXPERIMENTAL

Materials

Pyrrole was purchased from Aldrich Chemical Company and distilled under reduced pressure before use. Thionyl chloride, $SOCl_2$, was purchased from Fisher Chemicals and was freshly distilled prior to use. Practical grade chitosan and deuterated solvents were purchased from Aldrich. Thin layer chromatography plates (silica gel) were purchased from Kodak. *meso*-Tetrakis(4-carboxyphenyl)porphyrin (H_2TCPP) was purchased from Mid-Century Chemicals. All other chemicals were used without further purification.

Methods

Proton nmr experiments were conducted on a Varian YH400 MHz spectrometer at 300K and data was manipulated using Varian software in a Solaris Sparc™ environment. Absorption data was collected on a Beckman DU 7500 Series spectrophotometer at room temperature. Infrared studies were performed on a Nicolet 560Magna FTIR instrument using nujol mulls. Porphyrin isolations were achieved on neutral alumina (Eastman) via column chromatograpy (12in x 1in). Product purity was determined by TLC.

Synthesis

meso-Tetraphenylporphyrin (H_2TPP) was prepared by the Adler-Longo method of refluxing benzaldehyde and pyrrole in propionic acid for 1h under ambient conditions.[12] The resulting black solution was cooled to room temperature then further cooled on an ice bath. The insoluble product was collected by suction filtration and washed with small aliquots of propionic acid followed by diethyl ether. The shiny purple crystals were air-dried (15-17% yield). UV-vis($CHCl_3$, λ_{max}nm) 419, 516, 551, 591, 649. ^1H nmr($CDCl_3$, ppm) 8.85(8H, s), 8.25(1H, m), 7.80(4H, m), -2.65(2H, s).

meso-Tetrakis(2,3,4,5,6-pentafluorophenyl)porphyrin (H_2TF_5PP) was prepared by the Lindsey "high dilution" method.[13] In a typical experiment, 0.15 mmole (1.852mL) pentafluoro-benzaldehyde and 0.15mmol pyrrole (1.04 mL) were condensed in 1L dichloromethane in the presence of 125μL boron trifluoride etherate, BF_3:$O(CH_3CH_2)_2$, as catalyst. The flask was shielded from light by wrapping with aluminum foil. After 1h stirring, 5mL methanol was added to quench the reaction. Then 2.5g (3 equivalents) 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) was added and the slurry was stirred for an additional 15 min. The black mixture was concentrated on rotovaporization to about 50mL. The product was transferred to a 100 mL round-bottom flask and evaporated to dryness. The solid was scraped into a 50 mL fritted funnel (medium) and washed with 10 mL aliquots of methanol until the filtrate was almost colorless. The resulting purple solid was recrystallized by evaporation of a 1:1:1 chloroform:methanol:heptane mixture to give shiny purple crystals (30-40% yield). UV-vis ($CHCl_3$, λ_{max}nm(log ϵ)) 415(5.78), 463(5.44), 508(4.50), 584(4.94), 636(4.11). ^1H nmr ($CDCl_3$, ppm) 8.91 (8H, β-H, s), -2.92 (2H, N-H, s).

The Ni(II) derivative, $NiTF_5PP$, was prepared by refluxing 0.0845g (1.03 mmole) nickel chloride hexahydrate and an equal moles of sodium acetate with 0.1g (0.103 mmole) of porphyrin in 100mL acetonitrile for 24 h. The brown suspension produced a red solution and the solvent was evaporated to dryness. The resulting solid was chromatographed once on neutral alumina using 3:1 hexanes:chloroform as eluent. The purity of the fractions was determined by TLC. All similar fractions were combined and the solution was concentrated to 6 mL on rotovaporization. Equal volumes of methanol and heptane were added and the porphyrin was recrystallized to yield tinsel purple crystals (93% by integration of ^1H nmr signals). UV-vis($CHCl_3$, λ_{max} nm) 409, 524, 560. ^1H nmr ($CDCl_3$, ppm) 8.80 (8H, β-H, s).

Synthesis of the acid chloride derivative of H_2TCPP was as follows. Thionyl chloride (3mL) and 0.1g (0.0126 mmole) porphyrin in a 10mL round-bottom flask was refluxed on a water bath at 70-75°C. The condenser was equipped with a home-made gas trap. The solution turned green on warming and was stirred for 1h. The green porphyrin product was recovered by removal of the excess $SOCl_2$ under reduced pressure followed by drying under low pressure. UV-vis(DMF, λ_{max} nm) 420, 514, 547, 589, 647. ^1H nmr (DMF-d_7, ppm) 8.81(8H, β-H, s), 8.89, 8.88 (8H, m-H, d), 8.76, 8.74 (8H, o-H, d).

In the preparation of chitosan thin films, 2g of chitosan was added to 100 mL of 0.2M acetic acid in a 400 mL beaker. The white flakes dissolved slowly (overnight) on stirring to produce a viscous solution. The container was covered to prevent evaporation of the solvent. The pale-yellow gel was pipetted and cast onto a petri dish and air-dried. The chitosan plate was placed directly into a solution of 1M NaOH for 30 min to neutralize the acid and to loosen the film. This was followed immediately by two washings in deionized water using the same procedure as performed with NaOH. Another glass dish was placed directly on top of the chitosan plate to stabilize the system overnight. The film was then air-dried (12h) and the product was carefully peeled off the surface. The preparation process required about 3 days.

The fabrication of porphyrin-doped chitosan films followed the procedure above except that 100 mg of the porphyrin in acetic acid was added to 50 mL of gel prior to casting. The mixture was stirred for an additional 15 min to ensure homogeneity before pipetting.

RESULTS AND DISCUSSION

The synthesis of tetraphenylporphyrin, H_2TPP (1), proceeded via the Adler-Longo methodof refluxing starting materials in organic acid to produce modest porphyrin yields. On the other hand, the presence of the larger ortho-fluorine substituents in the target pentafluorophenylporphyrin, H_2TF_5PP (2), required dilute non-polar solutions to optimize yields (40%, equation 1). In the Adler sequence, autooxidation of the porphyrinogen formed porphyrin while the latter route required added oxidant (DDQ).

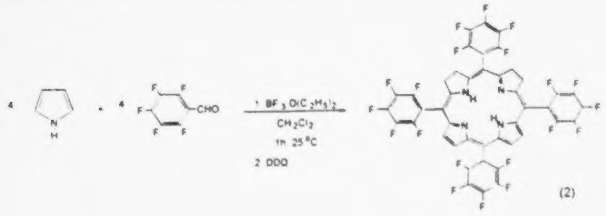

Figure 1. Synthesis of H_2TF_5PP

Insertion of nickel(II) into H_2TF_5PP required excess metal salt and added acetate as base to favor product formation (equation 2).[14] The original brown suspension produced a red solution in refluxing acetonitrile. The reaction was monitored by absorption spectroscopy and TLC. The porphyrins were all recrystallized to give shiny, purple crystals. Recrystallization of the solids from a 1:1:1 chloroform:methanol:heptane mixture was successful as a result of three factors: the differential vapor pressures of the solvents, the low solubility of porphyrin in methanol/heptane, and the high solubility of the polypyrrolic by-products in methanol.

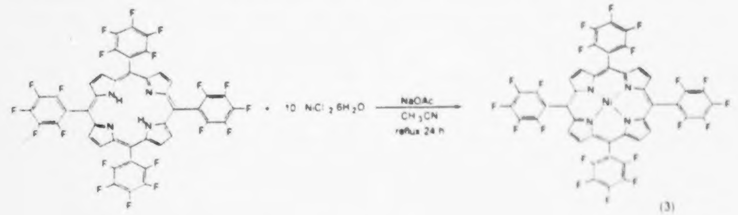

Figure 2. Preparation of $NiTF_5PP$

The free base porphyrins and $NiTF_5PP$ (3) were characterized by proton nmr and absorption spectroscopy and spectroscopic data was in agreement with published results.[15]

The initial route toward the bonding of porphyrin macrocycles to chitosan (5) used 4-carboxyphenylporphyrin, H_2TCPP (4) (equation 3). The porphyrin and chitosan was refluxed in several solvent systems such as acetone, aqueous acetone, DMF, 5wt% NaOH, and 10%

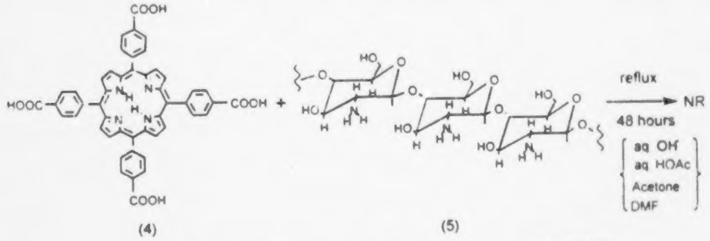

Figure 3. Attempted reactivity between Chitosan and H_2TCPP

aqueous acetic acid. The carboxyl substituent on the *meso*-phenyl rings was expected to undergo condensation with the chitosan substituents to form amide or ester linkages with the polymer. However, no reactivity occurred. Poor reactivity may have resulted from the lack of solubility of chitosan in all of the solvent systems or low reactivity of the porphyrin used. One approach to solving the solubility issue may lie in the preparation of soluble derivatives.

A better approach towards the derivatization of the chitosan backbone with H_2TCPP is proposed through reactivity with the acid chloride derivative of the porphyrin (6) (equation 4).

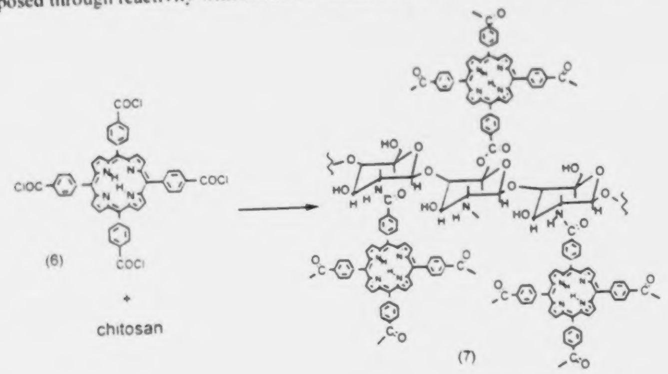

Figure 4. Proposed synthesis of porphyrin-chitosan polymer

Consequently, *meso*-tetrakis(4-chlorocarbonylphenyl)porphyrin, $H_2TClCPP$ (6) was synthesized.[16] The reaction was first conducted on microscale then the eaction was scaled up to 100 mg porphyrin. The solid was refluxed directly in excess thionyl chloride (equation 5). Initially, the porphyrin was insoluble in thionyl chloride. A green solution formed on warming, presumably due to the complexation of protons by the porphyrin pyrrolic nitrogens. Formation of the green porphyrin diacid[17] signaled that acid was liberated and indicated indirectly that the reaction was proceeding. The isolated solid was only moderate solubility in methanol. On the other hand, the starting material was highly soluble in methanol and showed slightly red-shifted Q-band absorbances relative to the product. Additionally, a downfield shift of β-pyrrole and phenyl ring protons of the product was observed, indicating a decrease in electron-density of the porphyrin, resulting from the substituted chlorine group.[18]

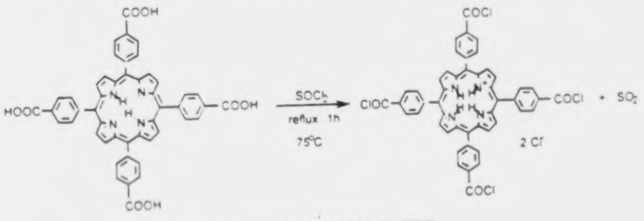

Figure 5. Synthesis of $H_2TClCPP$

Chitosan showed poor solubility in most common solvents, possibly due to the high degree of ordering through hydrogen-bonding interactions.[4] The polymer solubilized well in dilute acetic acid (10-20% v/v) via protonation of the oxygen and nitrogen centers to form a viscous gel. The structure of the gel was first investigated by ^1H nmr in a mixture of 10% CD_3COOD in D_2O. The polymeric nature of the material accounted for the broad signals (10.44, 10.25, 9.71 ppm) at 300K. A well-defined triplet at 8.58 ppm was assigned to the methylene proton at the C-5 position in the glucosamine moiety. Since the medium was acidic, peaks were shifted downfield of predicted chemical shifts. The amino protons were possibly also exchanging with solvent deteriums. These phenomena confounded further spectral analysis.

Preliminary experiments were performed in the preparation of chitosan films. First, chitosan flakes were dissolved in dilute acetic acid and produced a pale yellow, transparent gel. The gel viscosity increased as a function of time. Attempts at characterizing gels by FTIR were complicated by the strong carboxyl group vibrations of the acetic acid solvent. A petri dish served as the surface for casting and the gel was smeared on the surface with a glass rod after pipetting. After sitting overnight, the dry film was subjected towashings with dilute NaOH and water to neutralize the acetic acid solvent and to loosen the film from the surface. Non-fragile films produced on drying overnight were easily peeled from the glass surface. The materials were transparent with a pale yellow hue and were quite malleable. Films containing free base H_2TPP were pale blue in color. This method undoubtedly produces films of variable thickness. Experiments are underway to produce thin, uniform films. Future investigations involve characterization of the porphyrin-doped films by STM and AFM.

CONCLUSIONS

A new class of films has been prepared from chitosan, a cheap, abundant biomaterial. The porphyrins incorporated into the polymer matrix were synthesized by the condensation of pyrrole and aldehydes using two different synthetic routes. Spectroscopic techniques were utilized in the characterization of porphyrins and chitosan. The novel porphyrin thin films were pale blue, transparent, and relatively non-fragile. H_2TCPP was unreactive with chitosan. Therefore, the acid chloride derivative was prepared for reactivity with chitosan.

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REFERENCES

1. Garmire, E. *Physics Today*, May 1994 and references therein.
2. Drost, K. J.; Jen, A. K.-Y.; Rao, V. P. *Chemtech*, 1995, *25*, 16 and references therein.
3. Rout, D. K.; Pulpara, S. K.; Gross, R. A. *Macromolecules*, 1993, *26*, 5999.
4. Sanford, P. A. In *Chitin and Chitosan*; Skjak-Braek, G.; Anthonsen, T.; Sanford, P., Eds.; Elsevier: Amsterdam, 1989.
5. Kido, J.; Kimura, M.; Nagai, K. *Science*, 1995, *267*, 1332.
6. Strukeji, M.; Papadimitrakopolous, F.; Miller, T. M.; Rothberg, L. J. *Science*, 1995, *267*, 1969.
7. Lasko, C. L.; Pesic, B. M.; Oliver, D. J. *J. Appl. Polymer Science*, 1993, *48*, 1565.
8. Gruber, J. V.; Rutar, V.; Bandebar, J.; Konish, P. *Macromolecules*, 1995, *28*, 8865.
9. (a) Baba, Y.; Hirakawa, H.; Kawano, Y. *Chem. Lett.* 1994, 117. (b) *ibid*, 2389. (c) Chiessi, E.; Palleschi, A.; Paradossi, G.; Venanzi, M.; Pipisa, B. *J. Chem. Res., Synop.* 1991, 248. (d) Paradossi, G.; Chiessi, E.; Venanzi, M.; Pipisa, B.; Palleschi, A. *Int. J. Biol. Macromol.* 1992, 73.
10. J. Subramanian In *Porphyrins and Metalloporphyrins*; Smith, K. M., Ed. Elsevier: NY, 1975.
11. Gouterman, M. In *The Porphyrins*, Dolphin, D. Ed., Academic: New York, 1975; Vol III.
12. Adler, A.; Longo, F. R.; Fenarelli, J. D.; Goldmacher, J.; Assour, J.; Korsakoff, L. *J. Org. Chem.* 1967, *32*, 476.
13. Lindsey, J. S.; Wagner, R. W. *J. Org. Chem.* 1989, *54*, 828.
14. Kadish, K. M.; Araullo-McAdams, C.; Han, B. C. *J. Am. Chem. Soc.* 1990, *112*, 8364.
15. La, T.; Richards, R.; Miskelly, G. M. *Inorg. Chem.* 1994, *33*, 3159.
16. Wamser, C. C.; Bard, R. R.; Senthilathiphan, V. *J. Am. Chem. Soc.* 1989, *111*, 8485.
17. Hambright, P. In *Porphyrins and Metalloporphyrins*; Smith, K. M., Ed. Elsevier: New York, 1975.
18. Spectroscopic data (H_2TCPP) UV-vis(DMF, λ_{max} nm) 420, 516, 550, 592, 649; ^{1}H nmr (DMF-d_7, ppm) 8.99(8H, β-H, s), 8.53, 8.5(8H, m-H, d), 8.49, 8.47(8H, o-H, d), -2.76(2H, N-H, s).

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Biochemical Characterization of Amino Acid Uptake in Potential Vacuolar Mutants of *Neurospora crassa*

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The goal of the project is biochemical characterization of possible vacuolar mutants in *Neurospora crassa*. It was expected that mutation in any or all the vacuolar amino acid permeases and/or the vacuolar ATPase would result in a decreased level of vacuolar transport. Uptake of arginine, lysine, and ornithine was measured in these putative vacuolar mutants using a cupric ion permeabilization system. A preliminary test was done to ensure that cupric ion permeabilization system was valid in the mutant strains. Amino acid uptake was measured using radiolabelled amino acids for arginine, ornithine and lysine. Results were compared to wild type. Cupric ion permeabilization method was shown to be valid for mutants. Four mutants showed a reduced uptake for all three basic amino acids while two of them had reduced uptake for only one amino acid.

INTRODUCTION

It is easier to understand the multitude of diverse functions associated with more complex eukaryotic organisms by studying simpler eukaryotic organisms. The filamentous fungus used in this study was *Neurospora crassa*, commonly known as pink bread mold. There are many reasons *N. crassa* is commonly favored in biochemical and genetic experiments. The information derived from studying this fungus can be extrapolated to more complex organisms such as mammalian cells. The growth medium used is inexpensive, simple and easy to prepare. The generation time is relatively short. Mutation protocols are well established.

The main interest of this study is the fungal vacuole. Its functions have not been completely elucidated (Klionsky *et al.*, 1990). It has been determined that 98% of the total soluble pools of basic amino acids, ornithine, lysine, and arginine are stored in the vacuole, which only accounts for approximately 10% of the total volume of the cell. Movement of these amino acids into the vacuole goes against a concentration gradient. Hence, the process of storing these basic amino acids in the vacuole is energetically expensive (Davis, 1986). An energy source is required to facilitate the transport of these basic amino acids into the vacuole. This process is accomplished by the vacuolar ATPase by hydrolysis of ATP.

Three different amino acid vacuolar permeases have been characterized that transport ornithine, lysine and arginine into the vacuole. The arginine specific permease selectively transports arginine only (Zerez *et al.*, 1986). Lysine uptake into the vacuole is not inhibited by ornithine and ornithine uptake is not inhibited by lysine. This suggests distinct permeases for these amino acids, yet the specificity of these has not been completely characterized.

One method for characterizing vacuolar amino acid permeases is to create a mutant strain that lacks permease activity or activities. Previous experiments have isolated such mutants. It was expected that a failure to transport one (or more) of the basic amino acids into the vacuole in a strain would result in increased cytosolic concentration of the amino acid, and this would be toxic. Mutants show increased sensitivity to one or more of the basic amino acids as well as a decreased ability to accumulate the amino acids in the vacuole.

A direct way to determine if these mutants are vacuolar permease mutants is to measure the vacuolar uptake of the basic amino acids. A cupric ion permeabilization system has been developed for wild type *Neurospora crassa* that selectively permeabilizes the plasma membrane but leaves the vacuole intact. Cupric ion permeabilized mycelia are used for measuring vacuolar basic amino acid permease activity. To ensure that the permeabilization of the cupric ion on the mutants is similar to that of wild type, preliminary tests were performed by assaying for the intracellular enzyme, ornithine transcarbamylase (OTC), by means of the OTC assay.

There is evidence that the addition of cupric ion causes a selective change in the permeability of the plasma membrane but leaves the vacuolar membrane intact (Ohsumi *et al.*, 1988). This observation provides an effective method of separating the cytosolic and vacuolar constituents. The vacuolar permease activity can therefore be effectively measured.

The effects of cupric ion permeabilization on the potential mutants and the wild type were studied and compared to determine the effectiveness of the procedure. Basic amino acid uptake into vacuole was measured in putative mutant strains using cupric ion-permeabilized mycelia. Uptake was compared to wild type to identify those with deficient permease activity.

METHODOLOGY

Cupric Ion Permeabilization

Putative vacuolar mutants were grown and inoculated in Vogel's minimal media with 1.5% sucrose. They were allowed to grow overnight at 16°C and then for 4-6 hours at 30°C in a shaking water bath. Mycelia were collected by centrifugation and washed with distilled water. Unless stated otherwise, all centrifugations were done in a table top centrifuge at maximum speed (1,000xg) for 3 minutes. The pellets were suspended in a uptake buffer (UB = 0.6 M sorbitol, 20 mM morphinolinoethane sulfonic acid/Tris, pH 6.0), and divided into two aliquots. To one portion, 4mM Cu^{+2} was added from 100 mM $CuCl_2$ while other was untreated. Both aliquots were placed in a shaking water bath for 20 minutes, collected by centrifugation, and washed twice with UB. Each portion was re-suspended in buffer and further divided in half. A volume of 1.0 ml was removed to assay for protein using the Lowry assay. To one portion the detergent Triton X-100 was added to a concentration of 1%. There were four samples: cupric treated with and without Triton X-100 as well as untreated with and without Triton X-100. Each fraction was assayed for ornithine transcarbamylase activity (Keenan).

Vacuolar Amino Acid Uptake

Mycelia were grown, collected, washed, and suspended as described. For cupric ion permeabilization, cupric ion was added to 4mM concentration from 100 mM $CuCl_2$ solution and mycelia were shaken on a water bath for 20 minutes at 30°C. Permeabilized mycelia were collected by centrifugation, washed twice with UB and re-suspended in UB. A portion is removed for protein analysis by Lowry procedure. To initiate the uptake assay, ^{14}C-Arginine, ^{3}H-Lysine or ^{3}H-Ornithine were added and mycelia were shaken at 30°C. At 0, 5, 10, 15, 20, and 40 minutes, samples were removed, filtered through Whatman GF/A filters, washed with ice cold UB and suspended in distilled water. A boiling water extraction was done followed by a centrifugation. A portion of the supernatant was removed, mixed with scintillation fluid and level of radioactive material is measured in a liquid scintillation counter.

DATA AND RESULTS

In order to determine if cupric ion permeabilizes membranes of mutant strains, OTC activity was measured in mycelia treated and untreated with cupric ion.

Table 1: Ornithine Transcarbamylase (OTC) specific activity

STRAIN	Specific Activity			
	w/ Cu+2 & 1% Triton (nmole/mg min)	Cu+2 treated only (nmole/mg min)	1% Triton treated only (nmole/mg min)	in AUB only (nmole/mg min)
74A	0.11	0.10	0.11	0.02
RSC-41	0.09	0.12	0.11	0.00
RSC-53	0.02	0.16	0.32	0.35
RSC-57	0.09	0.07	0.09	0.02
RSC-66	0.06	0.06	0.05	0.01
RSC-85	0.05	0.01	0.03	0.00

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Since Triton X-100 is a detergent, it completely solubilizes all membranes. In mycelia treated only with Triton X-100, the specific activity of the ornithine transcarbamylase enzyme is 0.11 nmol/mg min for wild type as shown in Table 1. The activities of the extracts treated with cupric ion alone and with Triton X-100 are similar, 0.11 and 0.10 nmol/mg min, respectively. Table 1 also shows that in the presence of buffer only, the OTC specific activity was 0.02 nmol/mg min. The membrane in this extract remained intact. These results suggest that cupric ion has the same effect as Triton X-100. Furthermore, data for the mutants RSC-41, RSC-57, and RSC-66 exhibit the same pattern of OTC activity as the wild type. This suggests that cupric ion selectively permeabilizes the plasma membrane of both the mutants and the wild type similarly.

Since it was shown that cupric ion permeabilizes the plasma membrane in mycelia, vacuolar amino acid uptake was measured. Uptake was measured over time as shown in Figure 1. Uptake increased linearly until 15 minutes and initial velocity was calculated based on the first three points.

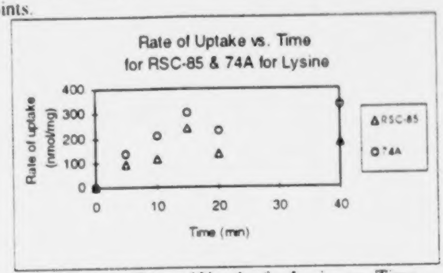

Figure 1: Rate of Uptake for Lysine vs. Time

In order to determine if the strains had a reduced level of vacuolar uptake from the wild type, a range for wild type was calculated using average +/- standard deviation. A strain is considered to have reduced vacuolar uptake if the value falls below the range of the wild type. The results for the vacuolar uptake of all three amino acids is shown in Table 2.

Table 2: Rate of Basic Amino Acid Uptake in Putative Vacuolar Mutants

Strains	Rate of Uptake		
	Lys (nmol/mgxmin)	Arg (nmol/mgxmin)	Orn (nmol/mgxmin)
74A Mean	4.34 *(+/-) 1.73*	5.80 *(+/-) 3.20*	14.04 *(+/-) 5.19*
RSC-57	2.76	3.09	1.30
RSC-41	0.67	1.68	0.79
RSC-66	0.24	1.24	1.23
RSC-53	0.56	0.74	N/A
RSC-85	3.02	6.10	0.98
RSC-87	[illegible]60	0.14	1.22

RSC-57 and RSC-85 appear to have a lower rate of uptake of ornithine as compared to wild type yet arginine and lysine uptake values are within range of wild type. RSC-57 and RSC-85 have a reduced level of ornithine uptake while lysine and arginine uptake are normal. RSC-41, RSC-53, RSC-66, and RSC-87 have lower rates of uptake of arginine, lysine, and ornithine.

DISCUSSION

The putative vacuolar permease mutants of *Neurospora crassa* were biochemically characterized. RSC-85 and RSC-57 are possible ornithine vacuolar permease mutants. The other mutants, RSC-41, RSC-53, RSC-66, and RSC-87, have a decreased ability in transporting all three basic amino acids, arginine, lysine, and ornithine, into the vacuole. They are potential vacuolar ATPase mutants.

The treatment of mycelia with cupric ion was successful in selectively permeabilizing the plasma membrane of both the mutants and the wild type. This allowed for the selective analysis of the rate of uptake of vacuolar permeases.

Future studies include the measurement of vacuolar ATPase activity for strains that appear to be vacuolar ATPase mutants as well as genetic characterization using complementation analyses.

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REFERENCES

Basabe, J.R., Lee, C.A., and Weiss, R.L. (1979). Enzyme Assays using Permeabilized Cells of *Neurospora*. Analytical Biochemistry, 92, 356-360.

Davis, R.H. (1986). Arginine Pathways of *N. crassa* and *S. cerevisiae*. Microbiological Reviews, 50, 280-318.

Davis, R.H., and DeSerres, F.J. (1970). Genetic and Microbiological Research Techniques for *N. Crassa*. Methods in Enzymology, 17A, 79-143.

Keenan, K.A., and Weiss, R.L. Characterization of Arginine Uptake and Efflux in Vacuoles of *Neurospora crassa* using Cupric Ion to Selectively Permeabilize the Plasma Membrane. Fungal Genetics and Biology, in press.

Klionsky, D.J., Herman, P.K., and Emr, S.D. (1990). The Fungal Vacuole: Composition, Function, and Biogenesis. Microbiological Reviews, 54, 266-292.

Ohsumi, Y., Kitamoto, K., and Anraku, Y. (1988). Changes Induced in the Permeability Barrier of the Yeast Plasma Membrane by Cupric Ion. Journal of Bacteriolgy, 170, 2676-2682.

Zerez, C.R., Weiss, R.L., Franklin, C., and Bowman, B.J. (1986). The Properties of Arginine Transport in Vacuolar Membrane Vesicles of *Neurospora crassa*. Journal of Biological Chemistry, 261, 8877-8882.

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Preparation of Co(PYAN)$^{+3}$ and Progress Toward the Separation of its Optical Isomers

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[Co(en)$_3$]$^{+3}$ is a classical complex having D$_3$ symmetry for which the optical isomers have been separated and much is known about the electronic and circular dichromism spectra. This research involves the preparation of [Co(PYAN)]$^{+3}$, a complex somewhat similar to [Co(en)$_3$]$^{+3}$ but having D$_2$ symmetry. In [Co(PYAN)]$^{+3}$ the hexaaza macrocycle, pyo$_2$[18]dieneN$_6$, or PYAN, is complexed with Co(III). The complex is prepared from sodium tris (carbanato)- cobaltate(III) trihydrate reacted with PYAN•4HBr and is precipitated out of absolute ethanol as a bromide salt, [Co(PYAN)]Br$_3$.

INTRODUCTION

Co(II) and Co (III) both form stable coordination complexes. Once in complex form, Co(II) is commonly oxidized to Co(III) to produce a more stable and less labile Co(III) complex. This research involves complexing Co(III) directly to form a stable complex by ligating with 3,6,14,17,23,24-hexaazatricyclo[17.3.1.1]tetracosa-1(23),8,10,12(24),19,21-haxaene, or PYAN (Figure 1, below.)

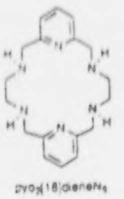


Figure 1. PYAN

PYAN is an 18-membered ring having D$_2$ symmetry, with one two-fold axis through the pyridine rings, two C$_2$ axes perpendicular, and no horizontal or vertical planes of symmetry. When PYAN is complexed with a metal ion, the molecule, due to rigidity and planarity imposed on it by the pyridine rings, wraps only in the meridional mode and retains D_2 symmetry. Of the five possible isomers[1] of PYAN shown in Figure 2 only one is known to occur in coordinated form.

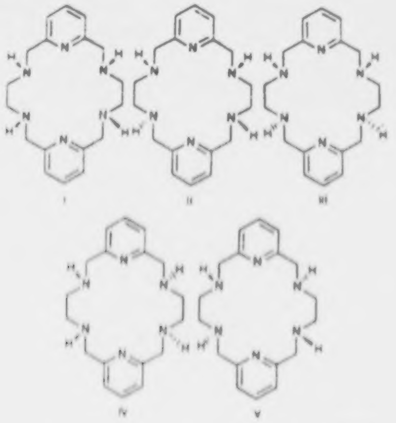


Figure 2. Five possible isomers of PYAN

The isomer (V) forms optically active stereoisomers with the RR,RR isomer twisting left, producing the Δ enantiomer, and the SS,SS isomer twisting right, producing the Λ enantiomer as shown in Figure 3.

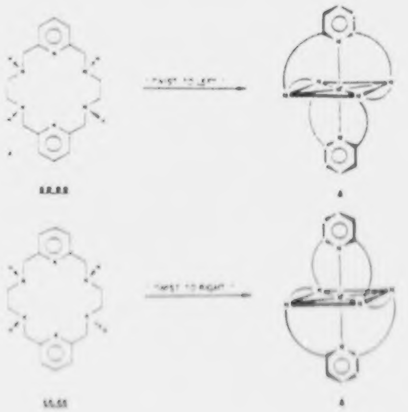
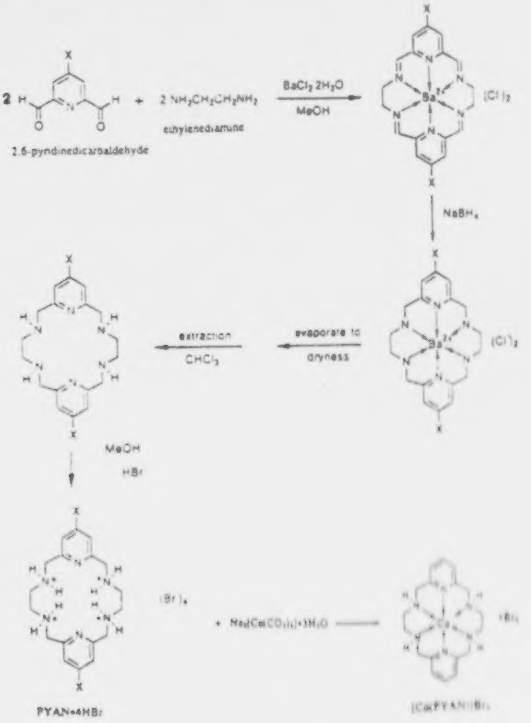


Figure 3. Enantiomeric twist of coordinated PYAN

Previous separation attempts[2] of these optical isomers yielded inconclusive results. The racemic mixture was treated with the optically active compound potassium antimonyl-*d*-tartrate which theoretically reacts with these enantiomers to form diastereomeric salts. No separation was evident from these results and it is thought that all of the Co(PYAN) was precipitated out under the conditions tried. This research will attempt separation of the racemic mixture by eluting through an ion exchange column with an optically active eluent, sodium-*d*-tartrate This technique was successfully applied by Yoshikawa et al[3] to $[Co(en)_3]^{+3}$ and resulted in complete resolution

EXPERIMENTAL PROCEDURE

PYAN was synthesized starting with 2,6-pyridinedicarboxylic acid purchased from Aldrich Chemical Co The procedure involved first esterification of the white powder, then reduction to 2,6-pyridinedimethanol, and finally oxidation to 2,6-pyridinedicarbaldehyde, by previously published methods[4] The 2,6-pyridinedicarbaldehyde was then combined with ethylenediamine to produce the Schiff base cyclized tetraimine intermediate (shown below) which was further reduced with $NaBH_4$ to give PYAN The free base was converted to the bromide salt by protonating with HBr in methanol The complex with Co(III) was prepared by reacting PYAN•4HBr with $Na_3[Co(CO_3)_3]\bullet 3H_2O$ as shown in Figure 4 below



2
X
2,6-pyridinedicarbaldehyde
2 NH2CH2CH2NH2
ethylenediamine
BaCl2 2H2O
MeOH
(Cl)2
NaBH4
evaporate to dryness
extraction CHCl3
(Cl)2
MeOH
HBr
(Br)4
+ Na3[Co(CO3)3]•3H2O
(Br)3
PYAN•4HBr
[Co(PYAN)]Br3

Figure 4 Synthesis of PYAN and [Co(PYAN)]Br

RESULTS

Elemental analysis, infrared spectra and magnetic susceptibility tests were all used to confirm the product The results of the elemental analysis are summarized in Table 1

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Table 1 Elemental analysis results for [Co(PYAN)]Br_3

Element	Calculated %	Experimental %
Carbon	34.59	34.76
Hydrogen	4.19	4.40
Nitrogen	13.50	13.67
Cobalt	9.43	9.82

IR spectra of a previously synthesized [Co(PYAN)]Br_3 complex were available for comparison. The peaks indicative of the product are readily seen in the spectra of the newly prepared compound and are summarized in Table 2 below.

Table 2 Infrared spectra results

IR Peak (cm^{-1})	Assignment
3132.8	N-H stretch
2996.4	C-H aromatic
1608.2	C=N stretch (pyridine)
1482.1	aromatic ring
1459.2	aromatic ring

Magnetic susceptibility tests run on the product confirmed the presence of Co^{3+}. The results indicated that the compound is diamagnetic, and that the metal is in the +3 oxidation state and low spin state. In this case, the electron configuration for Co^{3+} will correspond to t_{2g}^6 (octahedral). Had the metal been reduced to Co^{2+} the product would have been paramagnetic.

Optical resolution of the stereoisomers is being attempted by ion exchange column chromatography. Sephadex C25 was obtained from Aldrich and the ion exchange column has been set up for the separation process according to the procedure by Yoshikawa *et al*.[4] The column was packed with Sephadex C25 and a 0.2 M solution of sodium-*d*-tartrate was prepared for use as eluent. The ion exchange process has run for a total elapsed time of 15 hours, with no apparent results to date, although the yellow band containing the sample has slowly moved down the column. As the sample elutes it will be collected for further testing.

A small amount of [Co(PYAN)]Br_3 (0.001g) was dissolved in 2 mL water and its absorbance recorded using a Hewlett-Packard Photo Diode Array. The following table shows the wavelengths and corresponding absorbance bands.

Table 3 Absorbance spectra for [Co(PYAN)]Br_3

Wavelength (nm)	Absorbance
244	2.9437
254	2.8115
448	0.19821

The spectra will be used to determine which fractions collected from the column contain the appropriate material for further testing. If two separated bands are observed, each will be pooled and concentrated. A second ion exchange column will remove the optically active sodium-*d*-

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tartrate and replace it with bromide. The resultant bromide salt is non-optically active and will not affect the optical rotatory ability of the Co(III) complex. Polarimetry will ultimately ascertain if the separation was successful.

ACKNOWLEDGMENTS

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REFERENCES

1. Bryant, L. H. et al. *Inorg. Chem.*, 1994, 33, 2219-2226
2. Horton, A. unpublished, 1995
3. Rothermel, G. L. et al. *Inorg. Chem.*, 1992, 31, 4854-4859
4. Yoshikawa, Y. et al. *Inorg. Nucl. Chem. Lett.*, 1970, 6, 523-526

1567

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Attempted Synthesis of a Precursor of an Anti-tumor Marine Alkaloid: Shermilamine B

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In recent years many marine pyridoacridine alkaloids have been isolated from tunicates, sponges and a type of anemone. These compounds have drawn special attention due to their pharmaco-biological activity. After studying their chemical structure and biological properties, we have proposed that the identification and synthesis of biological active precursors of some marine alkaloids could be possible. In this study we report our attempts at the synthesis of 6-Methylthiazin-3-one-(5,6-b)-acridine-5,12-dione(Fig. 3) which is a precursor and probable pharmacophore of shermilamine B (Fig. 2).

INTRODUCTION

There is current interest in marine pyridoacridine alkaloids because of their significant properties. Amphimedine was the first marine alkaloid described in 1983 by two research groups led by Schmitz and Shoolery.[1] Today, we find a considerable number of descriptions of these types of compounds in the literature. These novel compounds have in common a fused tetracyclic pyrido (2,3,4-mn) acridine ring system (Fig. 1).[2] They have been isolated from diverse marine organisms including sponges, tunicates, and a type of anemone.[1] Therefore, it is very interesting that pyridoacridine alkaloids present an unprecedented distribution among several phyla of marine invertebrates.[1]

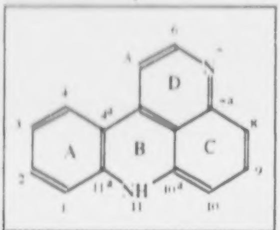

Figure 1: Structure of the fused tetracyclic pyrido (2.3.4-mn) acridine ring system

Reports indicate that most pyridoacridine alkaloids are cytotoxic to a variety of cancer cell lines[3,4], and they also show antineoplasic activity in whole animal experiments.[1] The mechanism by which they act is not yet clear, and it is unknown whether they act via the same mechanism.[2] It is also unknown if these compounds are only cytotoxic agents or if they are growth regulators as well.[2] Even though there is still a lot to learn about the marine alkaloids, some specific biological properties have been reported for different compounds. For example, inhibition of topoisomerase II catalytic activity,[5] anti-HIV activity,[6] Calcium release activity, intercalation of DNA,[8] DNA single-strand cleavage,[1] and alteration of cAMP-mediated processes and/or other second messenger systems.[2]

Among the biologically active marine alkaloids are shermilamine A, shermilamine B, amphimedine, ascidemine, kuanoniamine, bromoleptoclinidinone, dercitin, nordercitin, cystoditin A and cystoditin B.[1,3] We proposed that the identification and synthesis of biologically active precursors of some marine alkaloids would be possible. In this study we attempted the synthesis of 6-Methylthiazin-3-one-(5,6-b)-acridine-5,12-dione (fig. 3), a precursor and probable pharmacophore of shermilamine B (fig. 2) following a scheme that contains a series of well known reactions.[9,11]

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Pentacyclic pyridoacridine alkaloids are classified into two groups: those having a linear ring fusion at C 8, 9 of ring C, and those having one extra angular fused ring at C 9,10 of the acridine system at ring C. Shermilamine B (Fig. 2) is a naturally occurring pentacyclic pyridoacridine that belongs to the former group, and has been found in the colonial tunicate *Trididemnum*. Its molecular formula is $C_{21}H_{18}N_4OS$ and it has been reported to have a mp. of 234 °C.[12,13] 6-Methylthiazin-3-one-(5,6-b)-acridine-5,12-dione (fig. 3) is a tetracyclic compound that has not been previously isolated or synthesized. Therefore, there is no information available on its biological activity and physical properties.

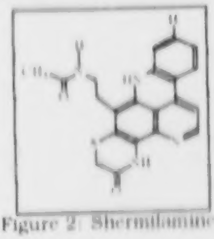

Figure 2: Shermilamine B

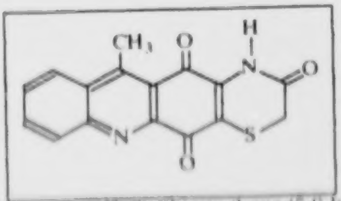

Figure 3: 6-Methylthiazin-3-one-(5,6-b)-acridine-5,12-dione

METHODS/RESULTS

The synthesis of 6-Methylthiazin-3-one-(5,6-b)-acridine-5,12-dione (fig. 2) was attempted by the following scheme, statrting with readily available 2,5-Dimethoxyaniline (fig. 4). The ^1H-NMR data was obtained on a 200 MHz Bruker instrument and the IR data on a Perkin Elmer Infrared Spectrophotometer 735B. In order to obtain compound (4), 2,5 dimethoxyacetanilide, three different sets of reactions (a), (a'), and (a'') were performed.

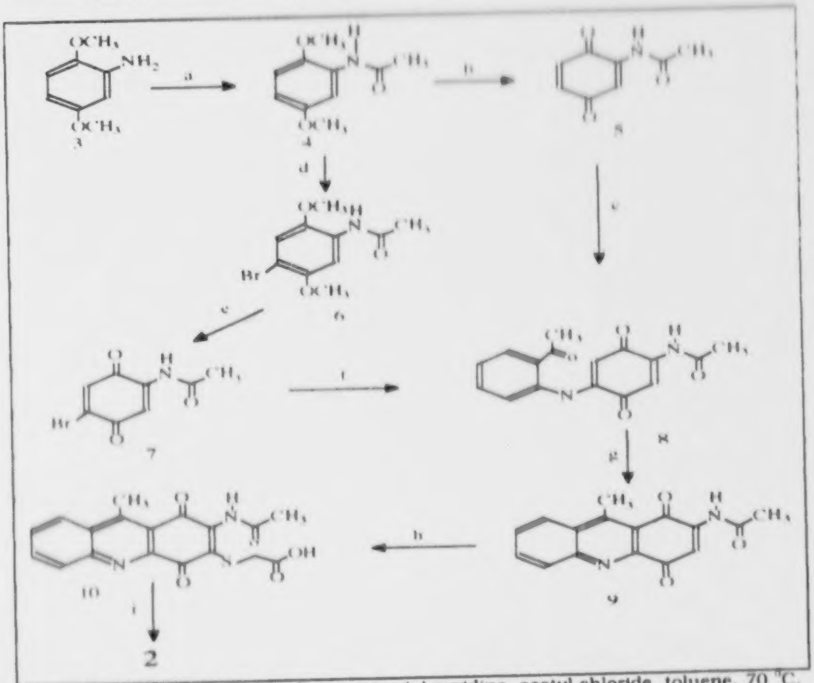

Figure 4: Synthetic Scheme. Reagents: (a) pyridine, acetyl chloride, toluene, 70 °C, 1 hr. (a') conc. HCl, Sodium acetate, acetic anhydride, 50 °C, 1 hr. approx. (a'') pyridine, acetic anhydride, 1M HCl, rt, 24 hr. (b) CAN, CH_3CN-H_2O, 2M H_2SO_4 0-5 °C. (c) 2-aminoacetophenone, cerric chloride heptahydrate, rt, 24 hrs. (d) bromine, acetic acid, rt, 24 hrs.

(a). 2,5-Dimethoxyacetanilide (4). Dry pyridine (5 mL) and acetyl chloride (1.28 g,1.16 mL,16.4 mmol) were added to a solution of 2,5 dimethoxyaniline (3) (1.0 g,6.6 mmol) in 20 mL of dry toluene. The solution was heated (70 °C, 1 hr.). The mixture was cooled to room temperature and then poured into water (600 mL). The aqueous layer was extracted with toluene (3X35 mL). The combined toluene solution was dried with anhydrous sodium sulfate, filtered, and the toluene was removed on the rotary evaporator. Ethyl acetate (80 mL) was added to the residue. The solution was then washed with 1M HCl (3x25 mL) and later dried over anhydrous sodium sulfate. The resulting material was compared with the starting material by TLC. The product was purified by flash chromatography on SiO_2 with the eluant being dichloromethane. NMR studies confirmed the presence of the compound 4. 0.96 g (75.5%) of purified product was obtained.

(a') 2,5-Dimethoxyacetanilide (4). Concentrated HCl (30 mL) was added with stirring to water (60 mL). Compound 3 (3.0g,19.6 mmol) was added to this solution. The solution was decolorized with decolorizing charcoal and then filtered off. Sodium acetate (4.5 g) was dissolved in water (12 mL). The anilinum solution was warmed to 50 °C on a water bath. Acetic anhydride (4 mL) was added with stirring. The aqueous sodium acetate was added on dissolution of the acetic anhydride. The mixture was stirred and cooled in an ice bath. No crystals of amide were obtained. The aqueous solution was extracted with dichloromethane (3X25 mL) and dried over anhydrous calcium chloride. The solvent was removed and a purple-brownish oil was obtained. The product was purified by flash chromatography on SiO_2 using a 15% ethyl acetate/dichloromethane mixture as the eluant. A sample of the purified material was submitted for IR-spectra studies which showed the presence of the carbonyl functionality indicative of compound 4. The yield of the reaction was 2.0 grams (52.3 %)of compound 4.

(a'') 2,5-Dimethoxyacetanilide (4). Compound 3 (3.5 g, 23 mmol) was dissolved in dry pyridine (10 mL), and dry acetic anhydride (5.4 mL, 5.9 g, 58 mmol) was added to this solution. The solution was stirred for 24 hrs. Water (50 mL) was added to the mixture, and the whole extracted with ethyl acetate (4X50 mL) in a separatory funnel. The aqueous solution was extracted. The ethyl acetate layer was washed with 1M HCl (3X40 mL) and with brine (3X40 mL). The solution was then dried with anhydrous sodium sulfate. The reaction mixture was filtered and the solvent removed. The final product was a brown crystallized material. NMR studies confirmed its presence in a pure form. Finally, 4.40 g.(95.2%) of material were obtained.

(b). 2-Acetamido-1,4-benzoquinone (5). Compound 4 (2.0 g, 10.2 mmol) was stirred in acetonitrile (10 mL). Ceric ammonium nitrate (CAN)(8.43 g, 15.38 mmol) at 0-5 °C dissolved in 2M H_2SO_4 (25 mL) was added portionwise with stirring. The reaction was monitored by TLC at 2 and 4 hr. At 4 hr. the reaction was complete. The TLC showed presence of some by-products. The products were separated by flash chromatography on SiO_2 using 50% ethyl acetate/chloroform as the eluant. 0.76 g (45.8%) of the compound 5 in the form of a black powder was obtained. The NMR results confirmed the presence of the compound.

c. 2-Acetamido-5-acetilanilino-1,4-benzoquinone (8). A solution of compound 5 (92 mg, 0.56 mmol) in ethanol (15 mL) was added to a solution of 2-aminoacetophenone (83 mg, 0.616 mmol) and cerric chloride heptahydrate (230 mg) in ethanol (15 mL). The reaction was stirred overnight. The products of the reaction were purified by flash chromatography on SiO_2 using a 50% ethyl acetate:chloroform mixture as the eluant. The yield of the reaction was 70.9% and the NMR data confirmed the presence of compound 8.

d. 4-Bromo- 2,5-dimethoxyacetanilide (6). Bromination of (4) to (6) was tried using bromine in acetic acid. To a solution of compound 4 (3.0 g, 15.4 mmol) in acetic acid (50 mL) , a solution of bromine (1.0 mL, 2.6 g, 16 mmol) in acetic acid was added at 5 °C. The resulting mixture was stirred at room temperature overnight. The solution was poured in cold water (200 mL) and stirred for 5 more min. Sodium bisulfate solution (50%) was added dropwise until the bromine color was discharged. The mixture was cooled in an ice-bath for 30 min. and the product was collected by vacuum filtration. This reaction proved to be very slow, and after more than 24 hr., starting material was present along with a mixture of products. No attempt to characterize the products of this reaction was made.

DISCUSSION

We performed three reaction procedures in an effort to obtain compound 4 from compound 3. This was done so that we could compare methods and identify the most efficient in terms of yield and purity of the products. In reaction (a), we acylated the 2,5-dimethoxyaniline (3) in dry toluene in the presence of dry pyridine and by addition of acetyl chloride. The pyridine reacted with the liberated HCl converting it into a pyridinium chloride salt. We obtained a % yield of 75.5 of the acylated amine.

In reaction (a'), we obtained compound 4 by reaction of compound 3 with sodium acetate and acetic anhydride in presence of HCl. This reaction presented the lowest percentage yield of the three methods.

Reaction (a''), where compound 3 is stirred in dry pyridine with acetic anhydride, proved to be a very simple and efficient method to carry out the transformation of compound 3 to compound 4. The reaction had a 95.2% yield after purification of the final product (4).

Reaction (b) was the oxidation of compound 4 to obtain the respective benzoquinone (5). In the review of the literature, we found that ceric ammonium nitrate [Ce $(NH_4)_2(NO_3)_6$, CAN] in aqueous acetonitrile oxidizes a variety of 2,5-disubstituded 1,4-dimethoxy benzene derivatives yielding the p-benzoquinones.[14] So, we performed the reaction following this method The yield was 45.8% after purification. A review of the literature led us to believe that this reaction may have been complicated by competitive dimerization. We believe that the yield of this reaction can be improved by using pyridine-2,6-dicarboxylic acid-N-oxide reducing the polymerization of the benzene compounds.

Reaction (d), in which the bromination of compound 4 was attempted to obtain 4-bromo-2,5-dimithoxyacetanilide (6), was inconclusive. This reaction proved to be very slow, and after more than 24 hr. starting material was present along with a mixture of products. No attempt to characterize the products of this reaction was made.

In reaction (c), compound 8 was synthesized by reacting compound 5 in ethanol with a solution of 2-aminoacetophenone and cerrous chloride heptahydrate. The reaction was efficient (70.9% yield) and the compound was successfully isolated with high purity.

CONCLUSIONS

Marine pyridoacridine alkaloids are a novel class of compounds that present an interesting chemical configuration and have come to occupy a primary position in the biomedical field as powerful antitumor agents or lead compounds. There is still much to learn about their chemical, physical, and biological properties. Therefore, if in the near future we are successful in designing efficient synthetic strategies for the pyridoacridine alkaloids, it would be of crucial importance for the understanding of their chemical characteristics and biological actions. To date, we have not been able to carry out our proposed synthetic scheme to completion. However, the results obtained so far indicate that the synthesis of 6-methylthyazin-3-one-(5,6-b)-acridine-5,12-dione(2) could be achieved following our proposed scheme. The results of the final part of this synthesis are pending.

ACKNOWLEDGMENTS

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REFERENCES

(1) Molinski, T.F. Chem. Rev. 1993, 93, 1825-1838.

(2) Shoshet, N.R.; Rudi, A.; Kashman. Y.; Hod, Y.; El-maghrabi, M.R.; Spector, I. J. Cell. Physio. 1993, 157, 481-492.

(3) Schmitz, F.J.; DeGuzman, F.S.; Choi, Y.; Hossain, M.B.; Rizvi, S.K.; Van der Helm, D. Pure & Appl. Chem. 1990, 62, 1393-1396.

(4) Bishop, M.J.; Ciufolini, M A. J. Am. Chem. Soc. 1992, 114, 10081-10082.

(5) McDonald, L.A.; Eldredge, G.S., Barrows, L.R., Ireland, C. M. J. Med. Chem 1994, 37, 3819-3827.

(6) Taraporewala , L. B.; Ceasac, J. W. ; Delgado, A.V.; Schinazi, R.F. J. Med. Chem. 1992, 35, 2744-2752.

(7) Kobayashi, J.; Cheng, J.; Walchli, M. R.; Sasaki, T.; Ohisumi, Y. J. Org. Chem 1988, 57, 1523-1526.

(8) Gunawardana, J. P.; Koehn, F. P.; Lee. Y.; Clardy, J.; He, H. J.; Faulkener, D.J. J. Org. Chem. 1992, 57, 1523-1526.

(9) Fieser, L.F.; Turner, R.B. J. Am.Chem. Soc. 1947, 69, 2335-2338.

(10) Fieser, L.F.; Brown, R.H. J. Am.Chem. Soc. 1949, 71, 3609-3614.

(11) Little, J.E.; Sproston, T.J.; Foote, M.W. J. Am. Chem. Soc. 1949, 71, 1124(12)

(12) Parkanyi, L.; Clardy, J. J. Org. Chem. 1988, 53, 4619-4620

(13) Carroll, R.; Cooray, N. M.; Poiner, A., Scheuer, P. J. Org. Chem. 1989, 54, 4231-4232.

(14) Jacob, A.; Callery, P. S.; Shulgin, A. T.; Castagnoli, N. J. Org.Chem. 1976, 41,3629-3629.

DETERMINATION OF THE VANADATE-MEDIATED NAD(P)H OR NADH OXIDATION MECHANISM IN BIOLOGICAL SYSTEMS

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Vanadium (V) compounds, such as $NaVO_3$, exert potent toxic effects on a wide variety of biological systems and some mechanism proposed that vanadate-mediated hydroxyl radical generation is a possible step in these toxic reactions. Also, V(V) is responsible for the stimulation of NAD(P)H and NADH oxidation in biological membranes and the mechanism is controversial. Some reports favor a key role of superoxide ($O_2^{\cdot -}$), while others suggest enzymatic pathways, independent of $O_2^{\cdot -}$, where vanadium (IV) accumulates in a buffered V(V), cofactor and enzyme solution. The V(IV) species depend critically on the simultaneous presence of enzyme and cofactor. The controversial mechanism has two opposite viewpoints and the purpose of this research is to determine the most reasonable mechanism according to the observations of V(IV) accumulation by ESR, NAD(P)H and NADH oxidation kinetics and oxygen consumption determinations.

INTRODUCTION

Vanadium (V) species, such as $NaVO_3$, exhibit potent toxicity on a wide variety of biological systems. The biochemical mechanism which explains V(V) toxicity is still not well understood. Vanadate-mediated hydroxyl radical ($HO^\cdot$) generation is assumed to be a possible step in these toxic reactions. Also, V(V) has repeatedly been responsible of the stimulation of the reduced forms of Nicotinamide Adenine Dinucleotide Phosphate (NAD(P)H) and Nicotinamide Adenine Dinucleotide (NADH) oxidation in biological membranes and the biochemical mechanism is very controversial.

Liochev and Fridovich (Liochev, S. & I. Fridovich, 1990) favor that superoxide radical ($O_2^{\cdot -}$) plays a key role in the mechanism, where a radical chain reaction in which the peroxovanadyl V^{+4}-O-O$^\cdot$ is formed has been proposed. They reported molecular oxygen (O_2) consumption and the accumulation of hydrogen peroxide (H_2O_2). Also, superoxide dismutase (SOD) completely inhibited the V(V) effect, whereas catalase exerted no inhibition in phosphate as well as in 4-(2-hydroxyethyl)-1-piperazineethanesulfonic acid (Hepes) buffered solutions.

On the other hand, Shi and Dalal (Shi, X. & N. Dalal, 1991) suggest enzymatic pathways, independent of $O_2^{\cdot -}$ but dependent on molecular oxygen (O_2), where V(IV) accumulates in a buffered V(V), cofactor and enzyme solution. According to this, the V(IV) accumulation was found to take place in the presence of enzyme and cofactor simultaneously. In 1991, they encountered no SOD inhibition on the NAD(P)H or NADH oxidation, concluding that $O_2^{\cdot -}$ had no role in the enzyme-catalyzed NAD(P)H or NADH oxidation by V(V). Also, Shi and Dalal presented that the H_2O_2 generated in the enzymatic mechanism reacts with V(IV) to produce $HO^\cdot$ in a Fenton-like reaction ($Fe^{+2} + H_2O_2 - Fe^{+3} + HO^\cdot + HO^-$), not in a Haber-Weiss-like reaction ($O_2^{\cdot -} - H_2O_2 \rightarrow O_2 + HO^\cdot + HO^-$).

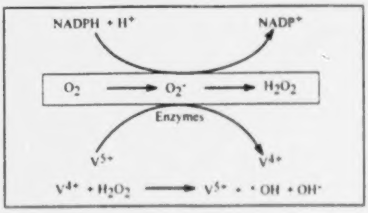
Furthermore, in 1993 they proposed a mechanism based on a free radical chain reaction instead of an enzymatic pathway (Shi, X. & N. Dalal, 1993). It was because of the observations involving a non-linear increase with time of the V(IV) concentration, as it was supposed to be in an enzyme-mediated mechanism. Both mechanisms could be summarized in the following equations:

Mechanism proposed by Liochev and Fridovich:

$$V^{+5} + O_2^{\cdot-} \rightarrow V^{+4}\text{-O-O}^{\cdot}\ (1)$$
$$V^{+4}\text{-O-O}^{\cdot} + \text{NAD(P)H} \rightarrow V^{+4}\text{-O-OH} + \text{NADP}^{\cdot}\ (2)$$
$$V^{+4}\text{-O-OH} + H^{+} \rightarrow V^{+5} + H_2O_2\ (3)$$
$$\text{NADP}^{\cdot} + O_2 \rightarrow \text{NADP}^{+} + O_2^{\cdot-}\ (4)$$

Net reaction: $\text{NAD(P)H} + O_2 + H^{+} \rightarrow \text{NADP}^{+} + H_2O_2$ (5)

Mechanism proposed by Shi and Dalal:



V(IV) accumulation may be monitored by Electron Spin Resonance spectrometry and oxygen consumption determinations are done using Clarke electrode polarography in order to determine $O_2^{\cdot-}$ role in the mechanism. Also, it is essential to follow NAD(P)H or NADH oxidation by observing the decrease in absorbance as a function of time at λ=340nm.

OBJECTIVE

Establish if the mechanism responsible for the NAD(P)H or NADH stimulated oxidation by Vanadium (V) is either:

1. a radical chain reaction
2. an enzymatic pathway
3. a Fenton-like or a Haber-Weiss-like reaction

The effect of SOD and Catalase upon this reactions will be monitored to identify the most adequate mechanism.

INSTRUMENTATION

Bruker Electron Spin Resonance spectrometer model ER200D
Beckman UV-Vis spectrophotometer model DU7400
Clarke Electrode Polarograph

TABLE I: Table of Reagents

Reagents		ESR experiments		UV-Vis experiments	
		Stock Concentration	Assay Concentration	Stock Concentration	Assay Concentration
Vanadate (Sigma)	Sodium Metavanadate ($NaVO_3$)	50 mM	4.8mM- XO 2.5mM- GSSG-R	50 mM	0.2 mM
Cofactors (Sigma)	NADH	10 mM	2.0 mM	50 mM	0.2 mM
	NAD(P)H	10 mM	2.5 mM	50 mM	0.2 mM
	Xanthine (X)	2.0mM	0.3 mM	2.0 mM	0.14 mM
Enzymes (Boehringer Mannheim)	Xanthine Oxidase (XO) (Sigma)	31 u/mL	0.1 u/mL	26041 µg/mL	50 µg/mL
	Glutathione Reductase (GSSG-R)	600 u/mL	15 u/mL	5000 µg/mL	50 µg/mL
	Superoxide Dismutase (SOD)	5000 u/mg	100 u/mL	1000 µg/mL	1 µg/mL
	Catalase	65000 u/mg	5000 u/mL	20000 µg/mL	10 µg/mL

METHODOLOGY

A phosphate buffer monobasic (pH 7.4, from Fisher) is treated first with Chelex 100, using the dialysis method, in order to avoid any metal contamination. All solutions are freshly prepared using this buffer. Then they are mixed in the buffer, to a final volume of 1.5 mL to reach the target assay concentrations. ESR spectra are recorded, following this catalytic scheme:

Xanthine/Xanthine Oxidase System:

a. V + NADH + X + XO
b. V + X + XO
c. V + NADH + X
d. V + NADH + XO
e. a. + XO (boiled)
f. a. + SOD
g. a. + Catalase
h. V + X
I. V + NADH
j. V + XO

Glutathione Reductase System:

a. V + GSSG-R + NAD(P)H
b. V + GSSG-R
c. V + NAD(P)H
d. a. + GSSG-R (boiled)
e. a. + SOD
f. a. + Catalase

In the UV-Vis spectrophotometric experiments, the catalytic scheme described above is followed, but with the specific concentrations (see Table of Reagents). The measurement is done in a 1.000 cm cuvette and the reaction mixture is monitored each 15 seconds for 30 minutes at A_{340nm}. A kinetic plot is obtained and the reaction rate (dA/dt) is analyzed.

RESULTS AND DISCUSSION (data not shown)

ESR experiments

When all the components (xanthine oxidase, NADH, xanthine and vanadate) are added to the reaction mixture in the case of xanthine oxidase, we observed vanadyl accumulation. That is, the reaction proceeds in the presence of enzyme, cofactors and vanadate. If xanthine is not added, a weak signal is obtained suggesting that xanthine is not extremely necessary over NADH for the reduction of vanadate in the presence of xanthine oxidase. If the enzyme is not added, a poor signal to noise ratio is obtained also and it is even weaker than when xanthine is not present (previous sample). This implies the possibility of direct reaction between NADH and vanadate instead of the enzymatic process or pathway. Furthermore, when NADH is not in the reaction mixture, no vanadyl accumulation is observed, suggesting that the cofactor is important for the process to take place. The assay with boiled xanthine oxidase presents the same results that without the enzyme (weak vanadyl signal). The effect of SOD is clearly observed; since the process is completely inhibited in its presence implying that $O_2^{\cdot-}$ is playing an important role in the mechanism studied. Also, the effect of catalase confirms that as it reacts with H_2O_2, vanadyl accumulates with very high yield in the reaction mixture.

In the case of glutathione reductase we observed the same results, but in this system, the enzyme is essential. When GSSG-R is not added, the reaction does not take place, suggesting that in this system, the enzyme presence is extremely necessary. Again, SOD and catalase exert the same effect as in the xanthine oxidase system.

Oxygen consumption determinations

The reaction mixture of vanadate, NADH, xanthine and xanthine oxidase consumes oxygen in high proportion, however, if we mix the components except the enzyme, the assay does not consume oxygen until xanthine oxidase is added. The same happened with GSSG-R. A relatively high consumption is observed in the assay of NADH and vanadate (but not as sharp as in the presence of xanthine oxidase), suggesting that the reaction proceeds through a direct reaction between the metal and the cofactor. The oxygen consumption ratio of NADPH and vanadate is not as high as NADH but the direct reaction is still observed. The addition of SOD exhibits inhibition of the oxygen consumption process. SOD essentially stops the reaction (SOD assay in underway for the XO/X/NADH/V system). These results suggest that $O_2^{\cdot-}$ is essential for the reaction mechanism to proceed. Determinations with catalase have not been done for the moment.

Kinetic analysis

Kinetics of the oxidation of NADH and NADPH were measured at $\lambda = 340$nm. A plot of $-\Delta$ Absorbance vs time (in seconds) shows that the mixture of NADH, vanadate, xanthine and xanthine oxidase has a high rate, in contrast to both, the assay with NADH and vanadate and the assay with NADH, xanthine and vanadate. This suggest that the oxidation of NADH or NADPH proceeds rapidly in the presence of enzyme, and metal. The reaction among NADH, vanadate and xanthine oxidase in the absence of xanthine, has a considerable rate but not so high as the assay with xanthine. The same results are observed with the GSSG-R system. It may represent a synergistic effect of both cofactors in this system: xanthine vs NADH. So, the rates of reaction could be summarized as follow: $R_{mixture} > R_{\text{[illegible]}} > R_{\text{[illegible]}} > R_{\text{[illegible]}} > R_{\text{[illegible]}}$. Up to now, rate analysis of the effect of SOD has been performed from the xanthine oxidase system. The rate of reaction decreased by 3.69% but this has to be corroborated. It is important to point out that the enzyme is essential to observe any oxidation of the NADH or NADPH.

1576

CONCLUSION

The results observed may suggest an enzymatic pathway in which $O_2^{\cdot -}$ plays a significant role. The GSSG-R reacts with NADPH, reducing it to NADP•. NADP• reacts with O_2 to produce $O_2^{\cdot -}$. Then, the $O_2^{\cdot -}$ reduces vanadate to produce vanadyl and the $O_2^{\cdot -}$ is oxidized to H_2O_2. This component is known to react with vanadyl, reoxidazing it to vanadate and generating OH^- and OH• (Shi & Dalal, 1991). The presence of SOD in the system shows that it dismutases $O_2^{\cdot -}$ to O_2 and H_2O_2, inhibiting the reduction of vanadate to vanadyl, the oxygen consumption ($O_2 - O_2^{\cdot -}$) and slightly affecting the NADH oxidation rate. Furthermore, catalase reacts with the H_2O_2 produced by the $O_2^{\cdot -}$ oxidation preventing the reoxidation of vanadyl and allowing it to accumulate in the assay. Nevertheless, both systems may be different because GSSG-R is definitely essential for the process, whereas the xanthine/xanthine oxidase system the enzyme is not the most important factor to produce vanadyl or to consume oxygen. It is only in the absence of NADH that no vanadyl spectrum is obtained, implying the possibility of an oxidation-reduction reaction directly between the cofactor and the metal or between the cofactor and molecular oxygen. In the case of GSSG-R, if the enzyme or the cofactor are not added, no vanadyl ESR spectra is observed, ruling out a direct oxidation-reduction reaction between the cofactor and either the metal or oxygen.

More experimentations must be done in order to clarify which mechanism explains each system and to assure if each one has its unique pathway.

FUTURE PLANS

a. Changes in buffers
b. Kinetic control (Time control)
c. pH control
d. Aerobic versus anaerobic conditions

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Möbius Kekulenes:
Semiempirical and *ab initio* Hartree-Fock Calculations of Their Structures and Properties

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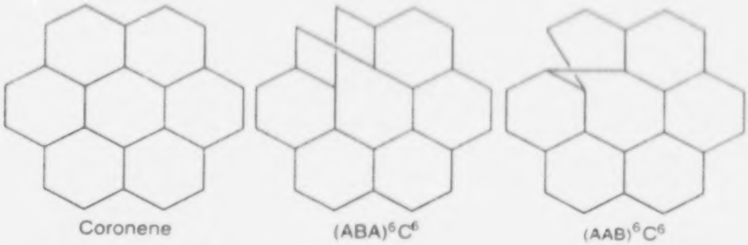
ABSTRACT

The structures and properties of the two possible coronene isomers, four possible Möbius-[12]kekulenes, and six possible Möbius-[18]kekulenes have been computationally investigated using the semiempirical PM3 method as well as by the *ab initio* Hartree Fock $3\text{-}23G^{(*)}$ method. These isomers each contain the half-twist which makes them one-sided and one-edged Möbius systems. In addition to discussions of their structures and electronic properties, information is presented regarding their potential for fluxional behavior as well as indications from vibrational analysis calculations concerning their possible structural interconversions.

INTRODUCTION

The methods by which coronene and coronoid molecules can be twisted into the topological equivalent of a Möbius band have been reported, and a descriptor system was presented which uniquely identifies the specific Möbius analogs of simple coronoids.[2] The two possible Möbius isomers of coronene were computationally investigated using the MNDO (modified neglect of diatomic overlap) semiempirical method. (See Figure 1).



Coronene

$(ABA)^6C^6$

$(AAB)^6C^6$

Figure 1. Coronene and its two Möbius isomers, $(ABA)^6C^6$ and $(AAB)^6C^6$. Double bonds and hydrogen atoms have been removed for clarity.

In continuing studies of the Möbius isomers of coronoid systems, semiempirical AM1 (Austin model 1) and PM3 (perturbational model 3) methods and the $3\text{-}23G^{(*)}$ *ab initio* method have been used to re-investigate the structures and properties of the Möbius isomers of coronene. Further, the work has been extended to include studies of the four Möbius isomers of [12]kekulene (Figure 2) and the six Möbius isomers of [18]kekulene (Figure 3) using the PM3 method. Computational results for each of the molecules are reported herein. Each Möbius isomer is identified by its individual character string as previously described.[1]

METHODS

All computations were carried out using the SPARTAN suite of programs[3] running on Silicon Graphics Indigo2 workstations. The initial geometries were constructed with the BUILDER module in SPARTAN, using the expert mode.

RESULTS

The tables below list the calculation results. In the tables, the following symbols and abbreviations are used: ΔH_f, the heat of formation in kcal/mol; E_{HOMO} and E_{LUMO}, the highest occupied and lowest unoccupied molecular orbital energies, respectively,

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in eV; Dipole, the dipole moment in debye; H_{trans}, H_{rot}, and H_{vib}, the translational, rotational, and vibrational enthalpies at 298K and 1 atm, respectively, in kcal/mol; S_{trans}, S_{rot}, and S_{vib}, the translational, rotational, and vibrational entropies at 298K and 1 atm, respectively, in cal/(K mol); and $E_{ZP(vib)}$, the zero-point vibrational energy in kcal/mol. All calculated vibrational frequencies were real.

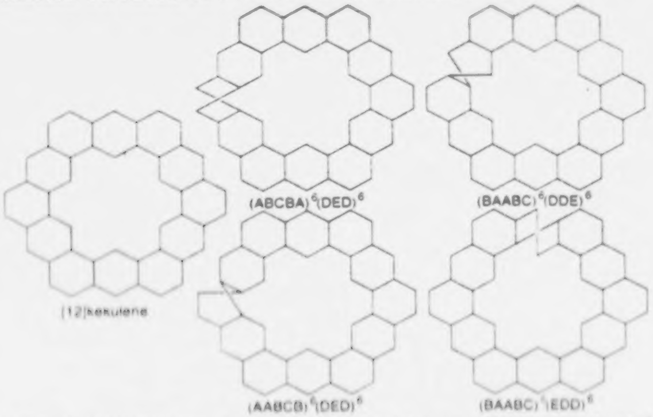
[12]kekulene
(ABCBA)⁶(DED)⁶
(BAABC)⁶(DDE)⁶
(AABCB)⁶(DED)⁶
(BAABC)⁶(EDD)⁶

Figure 2. [12]Kekulene and its four Möbius isomers. Double bonds and hydrogen atoms have been removed for clarity.

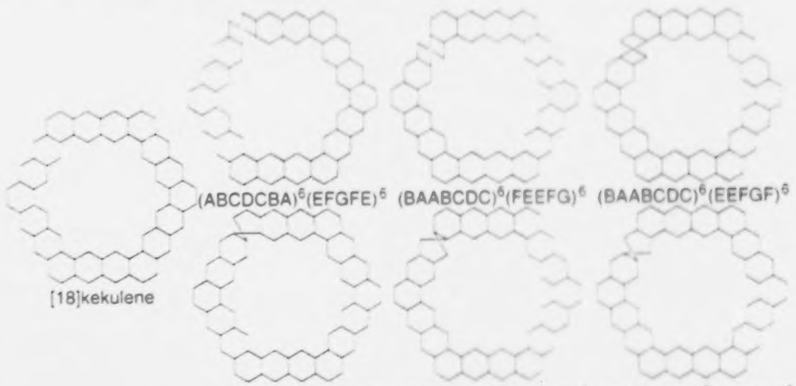
[18]kekulene
(ABCDCBA)⁶(EFGFE)⁶
(BAABCDC)⁶(FEEFG)⁶
(BAABCDC)⁶(EEFGF)⁶
(AABCDCB)⁶(EFGFE)⁶
(BAABCDC)⁶(EEFGF)⁶
(CBAABCD)⁶(FEEFG)⁶

Figure 3. [18]Kekulene and its six Möbius isomers. Double bonds and hydrogen atoms have been removed for clarity.

Table 1: Calculated ground state results for coronene

	MNDO	AM1	PM3	3-23G(*)
ΔH_f	83.063	96.229	87.486	-904.8227
E_{HOMO}	-8.07734	-8.19067	-8.28991	0.17519
E_{LUMO}	-1.01259	-0.97728	-1.06257	-0.20098
Dipole	0.00000	0.00000	0.00000	0.00000
H_{trans}	0.889	0.889	0.889	0.889
H_{rot}	0.889	0.889	0.889	0.889
H_{vib}	192.207	190.646	185.319	208.686
S_{trans}	42.994	42.994	42.994	42.994
S_{rot}	30.610	30.545	30.533	30.545
S_{vib}	39.161	37.683	39.611	31.475
$E_{ZP(vib)}$	185.199	183.836	178.171	202.847

Table 2: Calculated ground state results for the Möbius isomers of coronene

(ABA)^{6}C^6	MNDO	AM1	PM3	3-23G$^{(*)}$
ΔH_f	215.169	282.331	232.976	-904.5452
E_{HOMO}	-8.08628	-7.80320	-8.26478	-0.20293
E_{LUMO}	-1.01259	-1.21216	-0.97810	0.17767
Dipole	0.106837	0.51000	0.057180	0.191548
H_{trans}	0.889	0.889	0.889	0.889
H_{rot}	0.889	0.889	0.889	0.889
H_{vib}	191.467	187.970	184.010	207.751
S_{trans}	42.994	42.994	42.994	42.994
S_{rot}	32.491	33.783	32.424	32.949
S_{vib}	36.979	37.268	38.234	31.173
$E_{ZP(vib)}$	184.618	181.102	176.922	201.877

(AAB)^{6}C^6	MNDO	AM1	PM3
ΔH_f	266.443	294.268	256.511
E_{HOMO}	-6.95177	-7.09355	-8.02384
E_{LUMO}	-2.22589	-2.116699	-1.66725
Dipole	1.308808	1.453340	0.287000
H_{trans}	0.889	0.889	0.889
H_{rot}	0.889	0.889	0.889
H_{vib}	189.343	187.530	182.992
S_{trans}	42.994	42.994	42.994
S_{rot}	33.874	33.810	33.763
S_{vib}	39.198	37.802	38.826
$E_{ZP(vib)}$	182.183	180.576	175.822

Table 3: Calculated PM3 ground state results for [12]kekulene and [18]kekulene

	[12]kekulene	[18]kekulene
ΔH_f	197.827	317.790
E_{HOMO}	-8.23795	-8.08809
E_{LUMO}	-1.20720	-1.34438
Dipole	0.000194	0.0000
H_{trans}	0.889	0.889
H_{rot}	0.889	0.889
H_{vib}	375.717	564.266
S_{trans}	45.060	46.268
S_{rot}	38.906	37.237
S_{vib}	102.704	173.988
$E_{ZP(vib)}$	358.695	536.894

Table 4: Calculated PM3 ground state results for the Möbius analogs of [12]kekulene

	(ABCBA)^6(DED)^6	(AABCB)^6(DED)^6	(BAABC)^6(DDE)^6	
ΔH_f	367.159	253.594	251.465	(BAABC)^6(EDD)^6
E_{HOMO}	-7.8538	-8.09932	-8.09931	is
E_{LUMO}	-1.50237	-1.21639	-1.21641	identical
Dipole	1.064407	0.798956	0.798920	to
H_{trans}	0.889	0.889	0.889	(BAABC)^6(DDE)^6
H_{rot}	0.889	0.889	0.889	
H_{vib}	372.135	372.765	372.770	
S_{trans}	45.060	45.060	45.060	
S_{rot}	38.786	38.718	38.718	
S_{vib}	102.536	100.563	100.555	
$E_{ZP(vib)}$	354.882	355.724	355.730	

Table 5: Calculated PM3 ground state results for the Möbius analogs of [18]kekulene

	$(ABCDCBA)^6(EFGFE)^6$	$(AABCDCB)^6(EFGFE)^6$	$(BAABCDC)^6(FEEFG)^6$
ΔH_f	369.949	349.404	350.704
E_{HOMO}	-7.54450	-7.92725	-8.01488
E_{LUMO}	-1.81706	-1.41865	-1.35255
Dipole	1.189715	0.923869	0.863294
H_{trans}	0.889	0.889	0.889
H_{rot}	0.889	0.889	0.889
H_{vib}	561.762	562.077	562.048
S_{trans}	46.268	46.268	46.268
S_{rot}	42.126	42.000	42.046
S_{vib}	170.922	170.602	170.338
$E_{ZP(vib)}$	534.366	534.730	534.722

	$(BAABCDC)^6(EEFGF)^6$
ΔH_f	346.888
E_{HOMO}	-8.01488
E_{LUMO}	-1.35255
Dipole	0.813294
H_{trans}	0.889
H_{rot}	0.889
H_{vib}	562.048
S_{trans}	46.268
S_{rot}	42.046
S_{vib}	170.338
$E_{ZP(vib)}$	534.722

$(CBAABCD)^6(EEFGF)^6$
is
identical
to
$(BAABCDC)^6(FEEFG)^6$
and
$(CBAABCD)^6(FEEFG)^6$

DISCUSSION

Figure 4 illustrates the final geometries of all of the PM3-calculated Möbius coronenes and kekulenes. The results, based especially upon vibrational analyses and heats of formation calculations, suggest that each of the Möbius isomers of coronene, [12]kekulene, and [18]kekulene are real minima on their respective potential energy surfaces. The lowest energy Möbius isomer of coronene, $(ABA)^6C^6$-Möbius coronene, is about 150 kcal/mol less stable than coronene itself, while similar computations of the lowest energy Möbius isomers of [12]kekulene and [18]kekulene yield values of about 53 kcal/mol and 29 kcal/mol, less stable, respectively, indicating that the larger rings can accommodate the strain of the Möbius half twist. These isomers may be better targets for synthetic studies.

An additional isomer of $(ABA)^6C^6$-Möbius-coronene has arisen in the PM3 calculations, and is also illustrated in figure 4. This isomer has apparently relieved some of the twisting strain by forming four-membered rings reminiscent of "Dewar benzene".

The previously reported descriptor system adequately describes the different possible Möbius isomers of these coroniods. However, the values obtained for the [12]kekulene isomers $(BAABC)^6(DDE)^6$ and $(BAABC)^6(EDD)^6$ are computationally identical. Adjacent cuts and twists appear to produce identical isomers. The [18]kekulene isomers $(BAABCDC)^6(EEFGF)^6$, $(CBAABCD)^6(EEFGF)^6$ and $(CBAABCD)^6(FEEFG)^6$ are also computationally identical.

REFERENCES

1. Zoellner, R.W.; Krebs, J.F.; Browne, D.M.; *J. Chem Inf. Comp. Sci.* **1994**, *34*, 252.

2. Coronoids are molecules composed of fused benzenoid hexagons which are missing at least two fused (or adjacent) hexagons in the interior of the molecule. In simple coronoids, each hexagon is fused to two and only two other hexagons.

3. SPARTAN v. 4.0; Wavefunction, nc.; 18401 Von Karmen; Irvine, CA 92715.

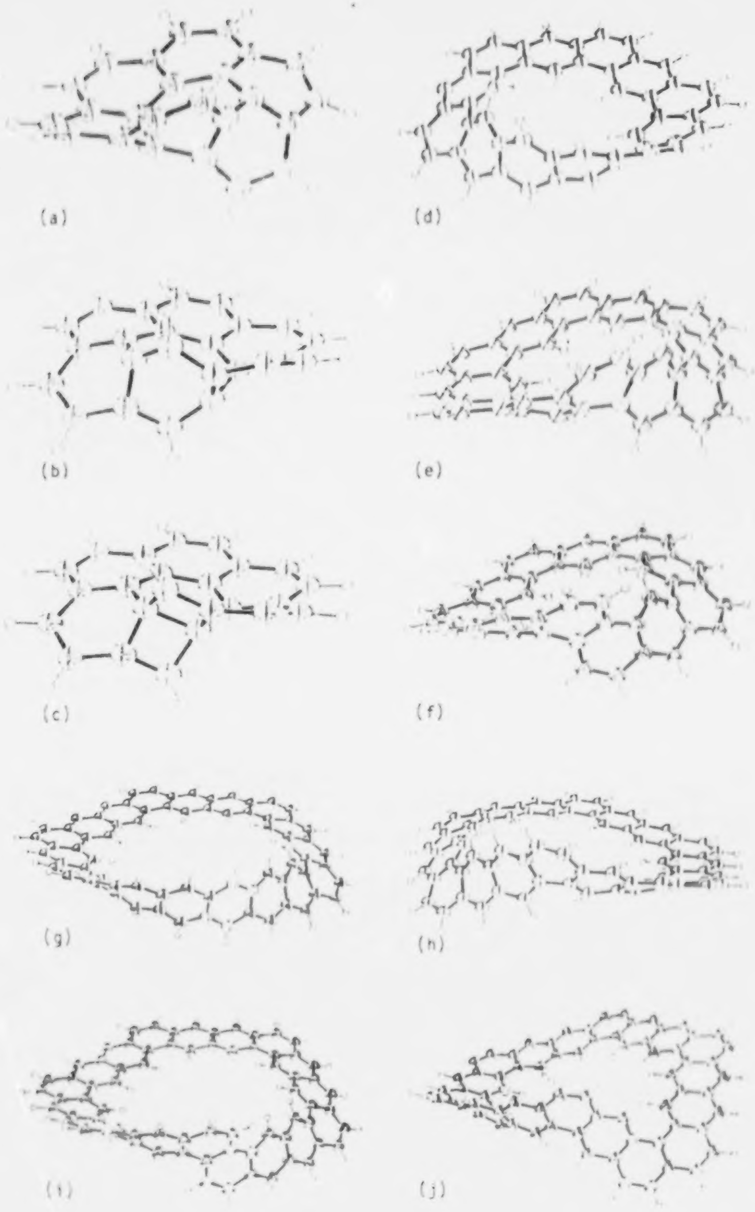

Figure 4. Mobius-coronenes: (a) $(ABA)^6C^6$. (b) $(ABA)^6C^6$ using AM1. (c) $(ABA)^6C^6$ using PM3. Mobius-[12]kekulenes: (d) $(ABCBA)^6(DED)^6$. (e) $(AABCB)^6(DED)^6$. (f) $(BAABC)^6(EDE)^6$. Mobius [18]kekulenes: (g) $(ABCDCBA)^6(EFGFE)^6$. (h) $(AABCDCB)^6(EFGFE)^6$. (i) $(BAABCDC)^6(FEEFG)^6$. (j) $(BAABCD)^6(EEFGF)^6$. All were calculated using PM3 unless otherwise indicated.

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Synthesis of (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d Diisopropyl 4b,8b,8c,8d-tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate: A Project on Absolute Asymmetric Induction

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Faculty Advisor: Moses Lee

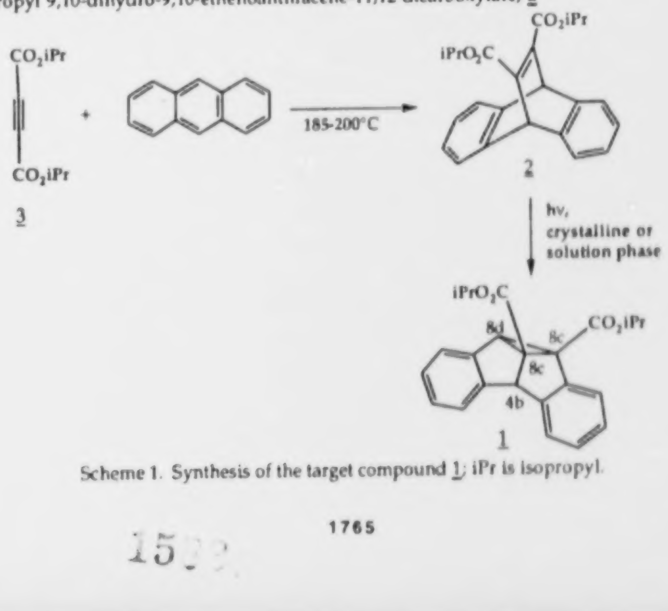
A laboratory project on the absolute asymmetric induction of the titled compound 1 from a solid phase photochemical rearrangement of the achiral compound 2 is described. Compound 1 generated in this way was found to be optically active and had an enantiomeric excess of 20% favoring the (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d enantiomer. In comparison, a similar solution phase photochemical reaction gave product 1 as a racemic mixture.

BACKGROUND

One of the areas in organic chemistry that is receiving a lot of attention is asymmetric synthesis, i.e. preparation of optically active compounds from achiral substrates (Crosby, 1991). Examples of methods of asymmetric induction involve the use of chiral auxiliaries and chiral catalysts, including the use of enzymes and catalytic antibodies (Trost, 1994). It is our plan to develop laboratory exercises that demonstrate these concepts of asymmetric induction in our organic chemistry curriculum. While a series of laboratory projects that demonstrate the use of chiral auxiliaries (Lee, et al., 1995) and enzymes (Lee, et al., 1994) to achieve asymmetric induction have been published, there has been no reports of a laboratory project that illustrates the concept of absolute asymmetric induction.

Absolute asymmetric induction is a process to prepare optically active compounds directly from achiral reactants without external intervention of pre-existing optically active groups, and it is unique to the crystalline phase. A number of examples of absolute asymmetric syntheses have been reported (Penzien and Schmidt, 1969; Evans, et al., 1986; Garcia-Gaibay, et al., 1986; Chen, et al., 1992; Caswell, et al., 1993; Scheffer, 1994). In these reactions, either enantiomer could be preferentially formed depending on which crystalline enantiomorph was formed predominantly. Therefore the probability of producing mainly one enantiomer is high in one reaction, but over an infinite number of experiments, exactly equal amount of both enantiomers will be produced. The enantiomeric preference can also be influenced by impurities present in either the sample or by "self seeding" of an enantiomer. As part of a plan to design a project to demonstrate the phenomenon of absolute asymmetric induction, the synthesis of the titled compound was developed. This project also demonstrates the use of various laboratory techniques (extraction, thin layer and column chromatography, vacuum distillation, photochemistry) and spectroscopic (^{1}H-NMR, IR, polarimetry, and circular dichroism) methods that are commonly used in contemporary organic chemistry.

Scheme 1 depicts the synthesis of (-)-4(S)-diisopropyl 4b,8b,8c,8d-tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate, 1, from the achiral diisopropyl 9,10-dihydro-9,10-ethenoanthracene-11,12-dicarboxylate, 2



Scheme 1. Synthesis of the target compound 1; iPr is isopropyl.

(Evans, et al., 1986; Garcia-Gaibay, et al., 1986; Chen, et al., 1992; Caswell, et al., 1993; Scheffer, 1994). Compound 2 has been previously demonstrated to either crystallize from cyclohexane or solidify from its molten form to give visually indistinquishable crystals in two dimorphic space groups, Pbca and $P2_12_12_1$. These crystals have identical metling points but different solid state infrared spectra. X-ray analyses have shown that both dimorphs crystallize in asymmetric conformations, but only the $P2_12_12_1$ crystals are chiral; the Pbca crystals are racemic . Studies published by Scheffer's group have shown that laser-induced photochemical rearrangement of a single $P2_12_12_1$ crystal of compound 2 produced an optically active (-)-compound 1 which has the (S)-4b, (S)-8b, (S)-8c, (S)-8d absolute configuration as the predominant enantiomer .

In this project, photochemical rearrangement reactions were run both in the crystalline and solution phases, and the products were analyzed for optical activity, enantiomeric excess, and the absolute configuration of the predominant enantiomer. The starting material, compound 2 was produced directly from a Diels-Alder reaction of diisopropyl acetylenedicarboxylate 3, which can be readily prepared from esterification of acetylenedicarboxylic acid and isopropyl alcohol.

RESULTS AND DISCUSSION

The crystalline phase photochemical rearrangement of compound 2 was conducted in three separate shortened (3 cm) 5mm quartz NMR tubes. The crystals of 2 that were used in this experiment were obtained from solidifying molten samples in the NMR tubes. The samples were kept under an atmosphere of nitrogen, capped and irradiated at 350 nm and room temperature using medium powered lamps in a Hanovia photoreactor for nine days. The crude product was purified by recrystallization from ethyl acetate and hexanes to remove the unreacted compound 2. Analysis of the concentrated mother liquor by ^{1}H-NMR spectrometry revealed a mixture of the desired adduct 1 (55.8%, i.e. an overall yield of 13%) and some unreacted 2 (44.2%) (see Figure 1).

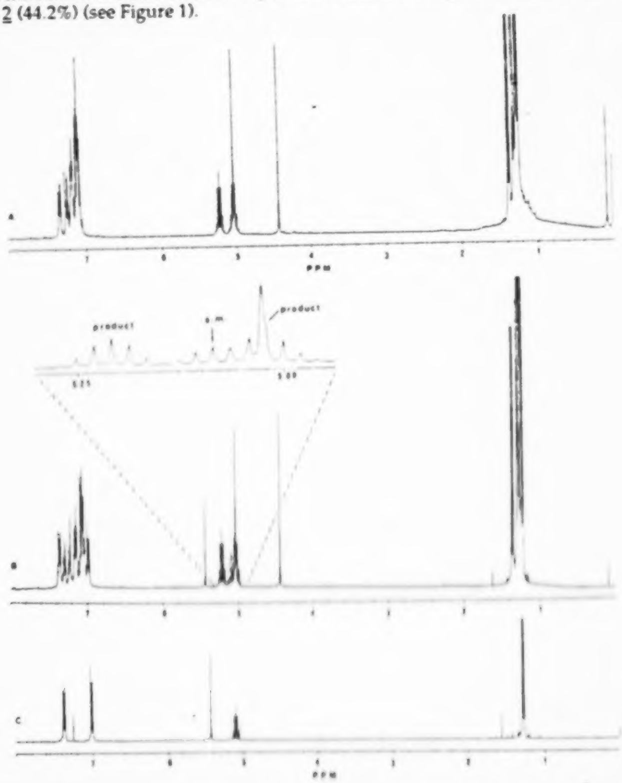


Figure 1. 300 MHz ^{1}H-NMR spectra of compounds 1 and 2. A, compound 1. B, mixture of compounds 1 and 2 that was obtained from the crystalline phase photochemical reaction. An insert of an expansion from 4.90 to 5.30 ppm is given; s.m. denotes starting material. C, compound 2.

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This mixture was not purified by silica gel column chromatography because the two compounds co-eluted in all the solvents tested. A chloroform solution of this mixture was found to be optically active, $[\alpha]_{578}$ at 22°C of -7.4° [c = 0.0065g of $\underline{1}$/mL], and since the contaminating compound $\underline{2}$ is optically inactive, it was excluded in the calculation of the value of "c" in the polarimetric analysis. The *minus* optical rotation indicated that the major enantiomer had the (S)-4b, (S)-8b, (S)-8c , (S)-8d absolute configuration (5-9). Additionally, the same chloroform solution of the mixture of $\underline{1}$ and $\underline{2}$ also produced an intrinsic CD band at 246 nm, $[\theta]$ at 22°C = -1.26×10^5 mdeg M^{-1} cm^{-1} (see Figure 2).

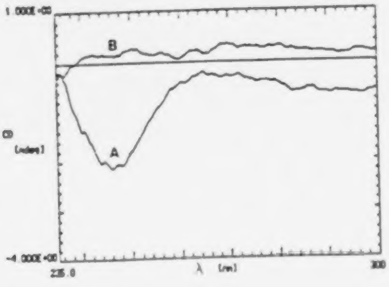

Figure 2. CD spectra of photoproducts. Part A is the spectrum of the mixture of compounds $\underline{1}$ and $\underline{2}$ that was obtained from the crystalline phase photochemical reaction. Part B is for compound $\underline{1}$ obtained from the solution reaction.

As indicated in Figure 3, further analysis of the product mixture by ^{1}H-NMR in the presence of 0.25 molar equivalents of a chiral lanthanide shift reagent [Eu(hfc)3, tris(3-heptafluoropropylhydroxymethylene)-(+)-camphorato] europium (III) showed that the enantiomeric excess (e.e.) of the (-)-(S)-4b, (S)-8b, (S)-8c , (S)-8d enantiomer of compound $\underline{1}$ was 20 ± 4%, i.e. it was present in 60% and the antipode was present in 40%.

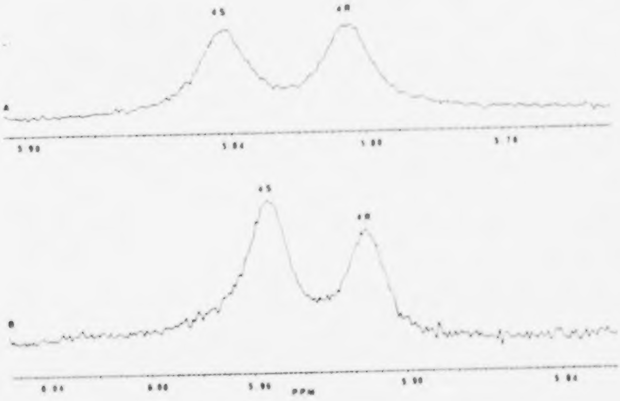

Figure 3. 300 MHz ^{1}H-NMR analyses of the racemic and optically active photoproducts in the presence of 0.25 molar equivalents of Eu(hfc)$_3$. The 4b-(S) [lower field] and 4b-(R) [higher field] signals are indicated. Parts A and B are for compound $\underline{1}$ obtained from the solution and solid reactions, respectively.

As a control experiment, two nitrogen purged solutions of compound $\underline{2}$ in acetone were irradiated at 350 nm for nine days to produce compound $\underline{1}$. Since the starting material $\underline{2}$ was absent in the crude product, it was purified by silica gel column chormatography to give product 1 (see Figure 1) in a combined yield of 38%. Since these reactions were done in a solution phase, it was not surprising that a chloroform solution of the product showed no optical activity at 578 nm [c = 0.0074g/mL], and no intrinsic CD band was seen in the CD spectrum (see Figure 2). ^{1}H-NMR analysis of this product in the presence of 0.25 molar equivalents of $Eu(hfc)_3$ revealed an enantiomeric excess of 0 ± 4%, i.e. a racemic mixture (see Figure 3).

CONCLUSION

This project demonstrates an example of absolute asymmetric induction in the solid phase photochemical rearrangement of the achiral reactant 2 to give an optically active sample of compound 1. The results will contribute to a more complete coverage in the pedagogy of asymmetric induction in organic reactions. Participation in the project will provide students with experience in contemporary laboratory techniques and spectroscopic methods of organic chemistry.

EXPERIMENTAL

Synthesis of disopropyl acetylene aicarboxylate 3

A solution of 5.0 g (0.044 mol) of acetylenedicarboxylic acid in 250 mL of isopropanol and 20 mL of concentrated sulfuric acid was heated to reflux for 2 hrs and 45 min. Upon cooling the reaction mixture to roon temperature 50 mL of water was added, and the solution was then extracted three times (150 mL each) with chloroform. The chloroform extracts were combined, washed with 50 mL of saturated sodium bicarbonate, and dried with anhydrous sodium sulfate. Concentration of the filtrate gave an oil which was distilled using a Kugelrohr apparatus at 75°-80°C and 2.5 mm Hg to yield the desired product 3 as a clear oil (4.25 g, 0.021 mol, 49%). TLC (2.5% $CH_3OH/CHCl_3$) Rf = 0.59. ^{1}H-NMR (300 MHz, $CDCl_3$): δ 1.30 (d, 6.6, 12H), 5.15 (hept, 6.0, 2H). IR (neat): ν 2971, 2356, 1720, 1466, 1374, 1261, 1180, 1099, 1018, 894, 819, 743, 688 cm^{-1}.

Synthesis of diisopropyl 9,10-dihydro-9,10-ethenoanthracene-11,12-dicarboxylate 2

A mixture of 5.0 g (0.28 mol) of anthracene and 6.12 g (0.031 mol) of alkyne 3 was heated at 185-200°C in an oil bath for 1 hour. Upon cooling the reaction mixture to room temperature the contents were dissolved in 75 mL of ethyl acetate, and then 125 mL of hexanes was added to precipitate the remaining anthracene. Concentration of the filtrate gave an solid residue which was purified by silica gel column chromatography using a solvent of 5% ethyl acetate: 95% hexanes to give the desired compound as a white solid. The solid was recrystallized from cyclohexane, and the crystals were collected and dried in a vacuum oven at 40°C, about 1 mm Hg, to yield product 2 (5.67 g, 0.015, mol, 44%). TLC (10% ethyl acetate/hexanes) Rf = 0.36. Mp 145°C [Lit. 145 -146 °C (5-9)]. IR (KBr-pellet): ν 2966, 1713, 1631, 1455, 1267, 1220, 1149, 1096, 1044, 908, 838, 750, 673, 609 cm^{-1}. ^{1}H-NMR ($CDCl_3$): δ 1.28 (d, 6.9, 12H), 5.09 (hept, 6.3, 2H), 5.42 (s, 2H), 6.98 - 7.38 (m, 8H).

Solution Phase Phtochemical Rearrangement of Compound 2 Synthesis of Diisopropyl 4b,8b,8c,8d-tretahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate 1

Two separate samples of 45.3 mg (0.120 mmol) and 45.9 mg (0.122 mmol) of compound 2 were placed into two separate 10 mm quartz NMR tubes were dissolved in 10 mL of acetone. After the solutions were degassed with a gentle stream of nitrogen they were sealed and the caps were wrapped with parafilm. The reaction tubes were placed in a photoreactor at 350 nm at room temperature for 9 days. The samples were combined, concentrated, and purified by silica gel column chromatography using an initial solvent of 2% ethyl acetate: 98% hexanes. The percantage of ethyl acetate of the solvent was raised consecutively to 4, 6, 8 and finally 10% after every 50 mL of solvent. The desired fractions were combined and concentrated to an oily product 1 (35.2 mg, 0.094 mmol, 38%). TLC (10% EtOAc/ hexane) Rf = 0.43. IR (neat): ν 2966, 1719, 1461, 1378 1284, 1243, 1102, 1031, 1044, 908, 826, 732, 614 cm^{-1}. ^{1}H-NMR ($CDCl_3$): δ 1.21 (d, 6.5, CH_3), 1.25 (d, 6.5, CH_3), 1.27 (d, 6.6, CH_3), 1.35 (d, 6.6, CH_3), 4.43 (s, 8d-H), 5.02 (s, 4b-H), 5.03 (hept, 6.5, CH-isopropyl), 5.22 (hept, 6.8, CH-isopropyl), 7.04 - 7.31 (m, 8H). $[\alpha]_{578}$ 22°C = 0 (c = 0.0074 g/mL). No CD band present. ^{1}H-NMR studies with 0.25 molar equivalent $Eu(hfc)_3$: 5.842 ppm for the (S)-4b, (S)-8b, (S)-8c, (S)-8d enantiomer (50.2%), and 5.805 ppm for corresponding R,R,R,R-enantiomer (49.8%), hence e.e = 0.4 ± 4%.

Crystalline Phase Phtotochemical Rearrangement of Compound 2

Three separate samples of adduct 2 (2 x 200 mg, 0.532 mmol; 210 mg, 0.558 mmol) were introduced into three shortened (3 cm) 5-mm quartz NMR tubes. The tubes were selaed under nitrogen, and wrapped with parafilm. The samples were heated in a hot mineral oil bath at 145-160°C for 20 minutes, until the samples had melted. After the smples had solidified at room temperature over a 5 day period they were placed in the photoreactor at 350 nm and room temperature for 9 days. The contents of each of the tubes were dissolved in 15 mL of

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The Polymerization of Dicyclopentadiene for use in the Undergraduate Organic Laboratory Utilizing Computational Methods

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A catalyst system consisting of a tungsten oxyphenolate complex [$WOCl_3(OC_6H_3$-2,6-$Cl_2)$] and tributyltin hydride (Bu_3SnH) was used in the olefin metathesis polymerization of dicyclopentadiene. An industrial process for this polymerization was modified using a 50% dilution of the reactants with methylcyclohexane and quenching the reaction with methanol at the gel stage to produce some soluble polydicyclopentadiene for HNMR. Computational methods were used to predict the monomeric subunit formed in the polymerization.

INTRODUCTION

The polymerization of dicyclopentadiene, is an olefin metathesis reaction. Olefin metathesis (1) is a general reaction of unfunctionalized and, in select cases, functionalized alkenes.[1]

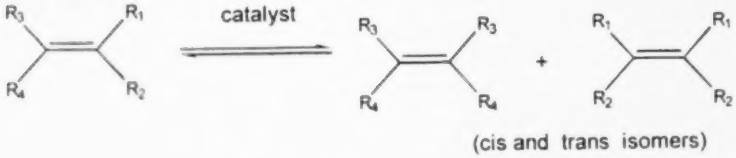

Figure 1: Olefin Metathesis

The most common metathesis catalysts involve a transition metal halide and main group alkylmetal co-catalyst. The generally accepted reaction mechanism involves the reversible addition of a transition metal alkylidene to an alkene to form a metalocyclobutane.[1]

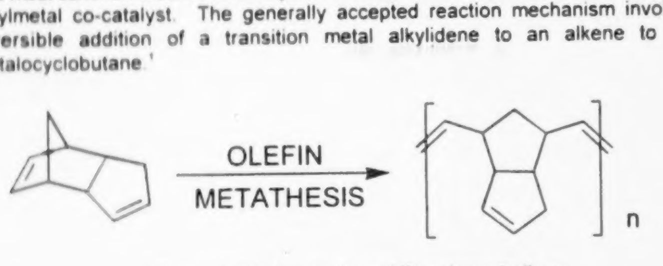

Figure 2: Polymerization of Dicyclopentadiene

The metathesis of dicyclopentadiene catalyzed by a tungsten oxyphenolate complex/tributyltin hydride catalyst system (2) is an equilibrium controlled process.[2] The product, polydicyclopentadiene, is a polymer in which the double bond of the bicyclo[2.2.1] ring system is metathesized.[1]

The purpose of this research was to propose a suitable method to form soluble polydicyclopentadiene in an undergraduate organic laboratory setting. An industrial procedure[2] was used as the basis for the polymerization. This procedure was then modified to produce soluble polydicyclopentadiene and to use conventional organic laboratory equipment in the process.

EXPERIMENTAL

general methods

All reactions were performed under inert atmosphere. Flushing with an inert gas (N_2 or Ar) was performed by bubbling N_2 or Ar through a septum and DCPD with a needle. An air exit needle was put in the septum to allow air to escape as the test tube filled with inert gas. This bubbling was allowed to take place until one was sure the tube was full of inert gas (1-2 minutes). All additions of reagents were performed by syringe.

tungsten catalyst ($WOCl_3(HOC_6H_3\text{-}2,6\text{-}Cl_2)$) preparation

Modifications of a published procedure[3] were employed. $WOCL_4$ (1.14 g) was stirred (not dissolved) in methylcyclohexane (15 mL). 2,6-dichlorophenol ($HOC_6H_3\text{-}2,6\text{-}Cl_2$) (0.54 g) was added to methylcyclohexane (7.5 mL) and stirred until the 2,6-dichlorophenol was dissolved. The phenolic solution was added dropwise over 30 minutes to the methylcycloexane/$WOCl_4$ solution. The reaction mixture was stirred at room temperature with a magnetic stir bar for two hours. The catalyst was used as a solution (0.1 mL).

polydicyclopentadiene preparation

Modifications of a published procedure[4] were employed. Solution 1 of dicyclopentadiene (DCPD) (2.00 mL), Bu_3SnH (0.0156 mL), $P(OBu)_3$ (0.0240 mL), and methylcyclohexane (2.00 mL) was made in a test tube flushed with N_2. Solution 2 of dicyclopentadiene (2.00 mL), $WOCl_3(OC_6H_3\text{-}2,6\text{-}Cl_2)$ (0.00688 g), 2-methoxyethyl ether (diglyme) (0.0044 mL), and methylcyclohexane (2.00 mL) was made in a flask flushed with N_2. Solution 2 was added to Solution 1 via syringe. The product solution was mixed and placed in a hot tap water bath. When the polymer entered the gel stage, it was dumped into methanol (~30 mL) and stirred to collect the polymer in one piece.

polydicyclopentadiene workup

The polymer was filtered through a Buchner funnel. The precipitate was dried under a vacuum pump. The precipitate was dissolved in chloroform (~30 mL). The solution was filtered, and the clear solution was rotary evaporated. The film on the flask (dissolved polydicyclopentadiene) was scraped with a spatula and placed in an NMR tube with deuterated chloroform. The HNMR (200 MHz) was performed.

computational methods

Macrmodel 3.5 was used on an "Indy" silicon graphics workstation to predict the subunit of polydiciyclopentadiene formed in the metathesis: endo-5 or endo-6, by comparing the relative energies of the subunits.

RESULTS AND DISCUSSION

The computational results from MacroModel gave a 216.49 kJ/mol energy for the reaction pathway to endo-5 and a 157.43 kJ/mol energy for the pathway resulting in endo-6. Due to thermodynamic control for the polymerization, the endo-6 product is formed due to the lower energy of the conformer. The literature NMR of polydicyclopentadiene used to compare with experimental NMRs was for the endo-6 conformer. The experimental NMRs compared favorably to the endo-6 literature NMR.

The experimental modification from the literature method used in industry proved to be somewhat successful. Enough soluble polydicyclopentadiene was produced to run an NMR, but not a large amount. There are many complications with these modifications. One of these is the determination of the gel stage. There is a very small window in which soluble polydicyclopentadiene can be obtained. If one quenches the reaction prematurely no product is formed, but if one waits too long no soluble polydicyclopentadiene is formed. The oxyphenolate catalyst system is very unstable, its reactivity changes (i.e. different amounts of catalyst are needed on different days) and it lasts for a maximum of two weeks. The amount of dissolved polymer is very small (around 0.1g). The experimental NMRs of this dissolved polymer have some impurities

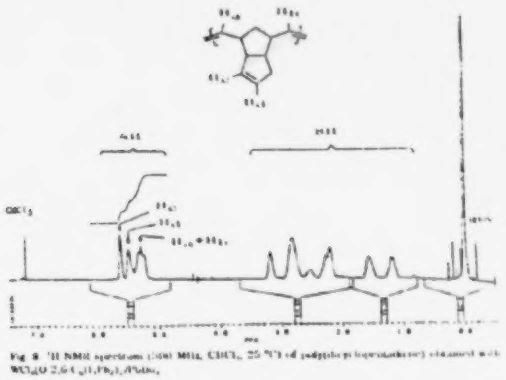

Figure 3: Literature HNMR Spectrum of PDCPD

in them (i.e. monomer) compared to the literature spectrum above.[2]

More work is currently being done at Miami University on this research project. different catalyst systems are being used to attempt to form a linear soluble polymer rather than a mostly insoluble, cross-linked polymer as was formed using the oxyphenolate catalyst system.

In the experimental spectrum below, there are peaks at 5.9 ppm and 3.9 ppm thatare not in the literature spectrum of polydicyclopentadiene. The peak at 5.9 ppm is due to dicyclopentadiene (monomer) that could not be gotten out of the polymer. The peak at 3.9 ppm is unknown as to what it may be due.

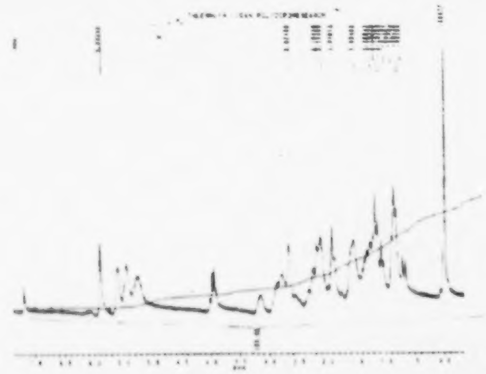

Figure 4: Experimental HNMR Spectrum of Dicyclopentadiene

CONCLUSION

Soluble polydicyclopentadiene can be formed using an oxyphenolate complex to catalyze the polymerization of dicyclopentadiene and following the experimental method described previously. The amount of soluble polymer produced by this method is not large, but an HNMR can be performed on the dissolved polydicyclopentadiene. These experimental HNMRs compare favorably to the literature HNMR for polydicyclopentadiene. Computational methods can be used to predict the subunit formed in the polymerization, endo-6.

ACKNOWLEDGEMENTS

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REFERENCES

1. Collman, J.P.; Hegedus, L.S.; Norton, J.R.; Finke, R.G. *Principles and Application of Organotransition Metal Chemistry*, University Science Books: Mill Valley, CA; **1987**, pp 475-485.
2. Boutarfa, D.; Paillet, C.; Leconte, M.; Basset, J. *J. Mol. Catal.* **1991**, *69*, 157.
3. Bell, A. *J. Mol. Catal.*, *76* (**1992**) 165.
4. Bell, A. *U.S. Pat.* 5082909 A to A. Bell

EXAMINATION OF THE DECARBOXYLATION OF KETOISOVALERATE USING PYRUVATE DECARBOXYLASE FROM *Saccharomyces cerevisiae*

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Pyruvate decarboxylase from *Saccharomyces cerevisiae* (SCPDC) is a hysteretically regulated enzyme that catalyzes the decarboxylation of α-keto acids to the corresponding aldehyde and CO_2. The kinetics of the decarboxylation of ketoisovalerate (KIV), an analog of pyruvate, the normal substrate of SCPDC, were examined. The sigmoidal characteristics of substrate activation were observed for both pyruvate and KIV. However, the mechanisms of regulation and catalysis for these substrates are different.

INTRODUCTION

Pyruvate decarboxylase catalyzes the decarboxylation of pyruvate to acetaldehyde and carbon dioxide in the anaerobic alcoholic fermentation pathway following glycolysis. This enzyme not only catalyzes the decarboxylation of pyruvate, but also a number of α-keto acids including aromatic β-substituted α-keto acids. (Sun, 1995) This enzyme also requires a coenzyme, thiamin diphosphate and a cofactor, magnesium sulfate, and is usually purified as a holo-enzyme with thiamin diphosphate (ThDP) and magnesium tightly bound at neutral pH. (Ullrich, 1970)

Pyruvate decarboxylase from *Saccharomyces cerevisiae* (SCPDC) is a tetramer with a molecular weight of 242 kDa, with one ThDP and magnesium binding site per monomer. (Lindqvist and Schneider, 1993) SCPDC is hysteretically regulated by its substrate, and a plot of reaction rate as a function of substrate concentration gives a sigmoidal curve at low substrate concentrations, which indicates substrate activation (Boiteux and Hess, 1970) Recently, a mechanistic model for regulation and catalysis was developed by Alvarez et al. based on isotope effects and proton inventories. Alvarez et al. suggested that sulfhydryl addition to the regulatory molecule occurs within each catalytic cycle, acting as a switch to open the active site to permit substrate in or allow the product out. (Alvarez, 1995)

Because SPDC decarboxylates a number of α-keto acids, the mechanism of action is fully understood. The model suggested by Alvarez et. al. is based on pyruvate as the α -keto acid. This study examined the catalysis of ketoisovalerate (KIV), an analog of pyruvate containing an isopropyl group, to test the Alvarez et. al. model. Steady-state kinetic experiments and proton inventory experiments were performed to study the detailed mechanism of action of SCPDC. The proton inventory experiment contributed to the understanding of regulation and catalysis of SCPDC by pyruvate and the larger substrate, KIV.

EXPERIMENTAL

Several enzymes and cofactors including the SCPDC, cocarboxylase (ThDP), nicotinamide adenine dinucleotide (NADH, reduced form) and ketoisovalerate were purchased from Sigma Chemical Co. The liver alcohol dehydrogenase (LADH) was purchased from Fluka and the sodium citrate, citric acid and magnesium sulfate were purchased from Fisher Scientific. A 0.10 M sodium citrate buffer was used in both the water form (pH=6.2) and deuterated form (pH=6.3). A 0.10 M solution of the magnesium sulfate and thiamin diphosphate were also prepared for use in the SCPDC solution. A typical SCPDC solution contained 9.2 nM SCPDC, 0.3 U/mL LADH, 5 mM magnesium and ThDP, 0.265 mM NADH and varying concentrations of KIV (0 - 50 mM). For the full saturation kinetic runs, a typical assay vessel would consist of a set volume of SCPDC solution followed by a varying amount of citrate buffer and substrate to a total volume of 1 mL. (Sun, 1995) The assay was measured at 360 nm and was allowed to run for 200 seconds with the absorbance being recorded every two seconds. The kinetics of the decarboxylation reaction were measured indirectly by a secondary coupled reaction that used liver alcohol dehydrogenase (LADH). In this reaction, NADH is oxidized to NAD^+ as LADH reduces the acetaldehyde to ethanol. NAD^+ does not absorb at 360 nm, as does NADH, thus, a negative absorbance is recorded.

A proton inventory is a solvent isotope experiment that leads to a definition of the number of exchangeable protons in the structure of an enzyme's catalytically active site. The reaction kinetics, or rate velocities, are determined in a series of isotopic water solvents. It begins with pure protium oxide and works up through mixtures of increasing atom fraction of deuterium to nearly pure deuterium oxide. The result is a compilation of rates as a function of the atom fraction of deuterium present in the solvent. This yields a list of kinetic isotope effects at each of the contributing sites, thus a proton inventory. The velocity was determined using the different atom fractions of deuterium based on a rate calculated from the full saturation kinetics. The interpretation lends itself to the shape of the curve. (Venkatasubban and Schowen, 1984)

RESULTS AND DISCUSSION

We examined the mechanisms of regulation and catalysis by SCPDC with KIV. Steady state saturation kinetic assays of SCPDC with KIV are shown in Figure 1.

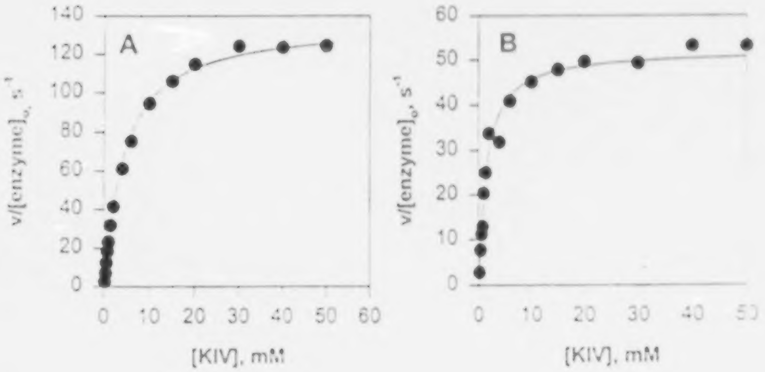

Figure 1. Steady-state saturation curves for the decarboxylation of KIV with catalysis by SCPDC at different atom fraction of deuterium, n.
(A) n = 0.0, (B) n = 0.99

A specific rate constant, k, was calculated for each assay using a modified version of the Michaelis-Menten equation. (Alvarez, 1995) The rate constant, k, is zero order with respect to substrate. It describes the events from reactant state to transition state for both decarboxylation and product release. (Sun, 1995)

Figure 2 shows the proton inventory of SCPDC with pyruvate and KIV.

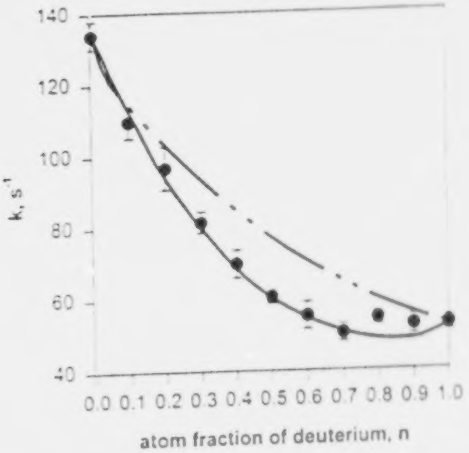

Figure 2. Proton inventory of SCPDC with Pyruvate and KIV Dashed line represents pyruvate data and solid line re[resemts KIV data

Pyruvate forms a "hypercurve" that suggests multiple protons being exchanged in the active site. In the mechanistic model of hysteretic regulation and catalysis by SCPDC with pyruvate proposed by Alvarez et al., the substrate enters the regulatory domain of the enzyme and binds to the sulfhydryl group of a cysteine residue. Sulfhydryl addition activates the enzyme through a conformational change, which opens the enzyme's active site. Sulfhydryl elimination in the regulatory domain closes the active site and the catalytic cycle begins. Entry of the pyruvate into the active site is the rate-determining step. SCPDC decarboxylates pyruvate, releasing CO_2 and aceta'dehyde Sulfhydryl addition in the regulatory domain opens the active site and acetaldehyde is released. Decarboxylation and product release are equally rate-limiting. Sulfhydryl elimination then closes the active site and prepares for another catalytic cycle

KIV forms a "super hypercurve" that suggests multiple protons are being exchanged in the active site also. Figure 3 presents a model for regulation and catalysis by SCPDC with KIV

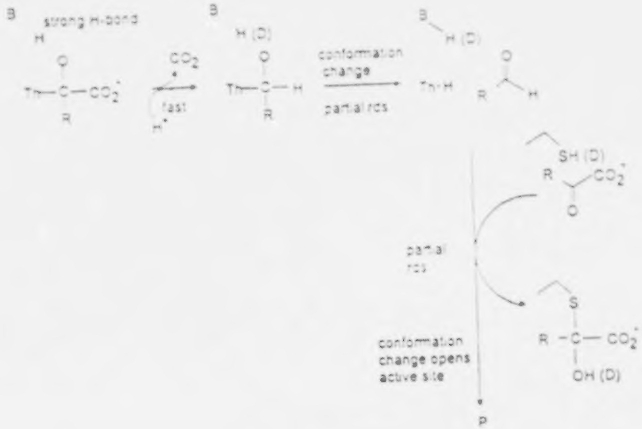
B
strong H-bond
H
O
Th—C—CO$_2^-$
R
CO$_2$
fast
H$^+$
B
H (D)
O
Th—C—H
R
conformation change
partial rcs
B
H (D)
Th·H
O
R
H
SH (D)
R
CO$_2^-$
O
partial rcs
S
R —C— CO$_2^-$
OH (D)
conformation change opens active site
P

Figure 3. Possible model for regulation and catalysis by SCPDC with KIV

For KIV, the rate determining step is removal of the proton from ThDP by a base, accompanied by a conformational change in SCPDC. This rate determining step using KIV is relatively fast and unobserved using pyruvate as substrate. Both generation of acetaldehyde and product release are rate-determining.

Although the shapes of the proton inventory curves for pyruvate and KIV are similar, the mechanisms of regulation and catalysis are different. KIV, which has a bulky isopropyl R-group, slows the rate of catalysis due to increased steric strain placed on the enzyme in both the regulatory and active sites. In addition, increased electronic effects of KIV are involved with the isotope effects.

REFERENCES

Alvarez, F J., Ermer, J. Hubner, G. Schellenberger, A. Schowen, R L. *J Am Chem Soc* **1995**, 117, 1678-1683
Boiteux, A. and Hess, B. *FEBS Lett* **1970**, 9, 293-296
Lindqvist, Y. and Schneider, G. *Curr Opin Struc Biol* **1993**, 3, 896-901
Sun, S. *University of Kansas PhD Dissertation* **1995**
Ullrich, J. *Methods Enzymol* **1970**, 18A, 109-115
Venkatasubban, K. and Schowen, R L. *CRC Critical Reviews in Biochem* **1984**, 17, 1

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Synthesis, Purification, and Activity of Glutaryl-CoA Analogs

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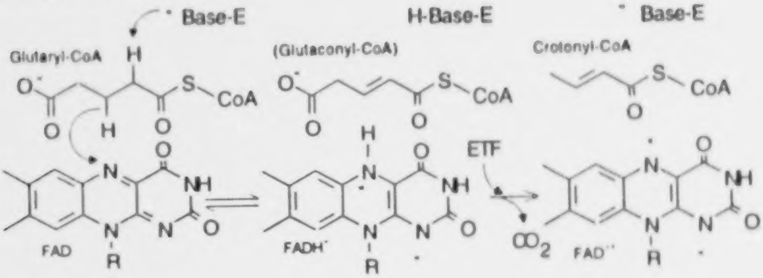
INTRODUCTION

The acyl-coenzyme A (CoA) dehydrogenases are a class of enzymes responsible for the oxidative breakdown of fatty acids and amino acids as well as the transfer of electrons to electron transfer flavoprotein (ETF). ETF works to shuttle electrons between the acyl-CoA dehydrogenases and the electron transport chain for the production of ATP for the cell.

Glutaryl-CoA dehydrogenase (GCD), an acyl-CoA dehydrogenase, plays a role in the breakdown of the amino acids lysine, hydroxylysine, and tryptophan. It also catalyzes the oxidation and subsequent decarboxylation of the substrate, glutaryl-CoA, to crotonyl-CoA according to Equation 1 (Gomes, et. al., 1991).



Equation 1: Mechanism of GCD

Individuals born with specific mutations in this enzyme develop certain metabolic illnesses, such as Glutaric Aciduria Type I, that lead to death within the first decade of life. The mutations in the enzyme are thought to interfere with the electron transfer that occurs between the enzyme and its substrate. Therefore, it is important to study the electrochemical relationship between GCD and its substrate, glutaryl-CoA, so that better ways to understand these metabolic illnesses may be elucidated.

Because the reaction occurring between GCD and its substrate results in the elimination of CO_2, it is an irreversible reaction. This irreversibility complicates electrochemical study of the enzyme:substrate complex and thus it becomes necessary to look at analogs of the substrate. The purpose of this study was to evaluate commercially available and synthetic analogs of glutaryl-CoA to determine the extent of their activity (if any) with GCD.

The analogs chosen for this study include hexanoyl-CoA, succinyl-CoA, adipoyl-CoA, 4-nitrobutyryl-CoA, and glutaramidyl-CoA. Their structures are shown below. It can be seen, for example, that hexanoyl-CoA is similar in chain length to glutaryl-CoA but lacks a carboxyl group. Succinyl-CoA has

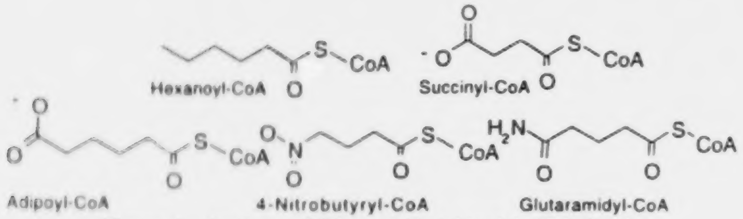
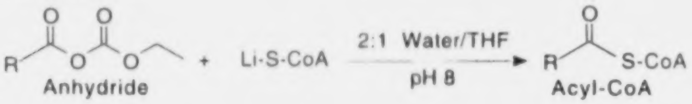

Hexanoyl-CoA
Succinyl-CoA
Adipoyl-CoA
4-Nitrobutyryl-CoA
Glutaramidyl-CoA

Figure 1. Analogs of Glutaryl-CoA Used in This Study

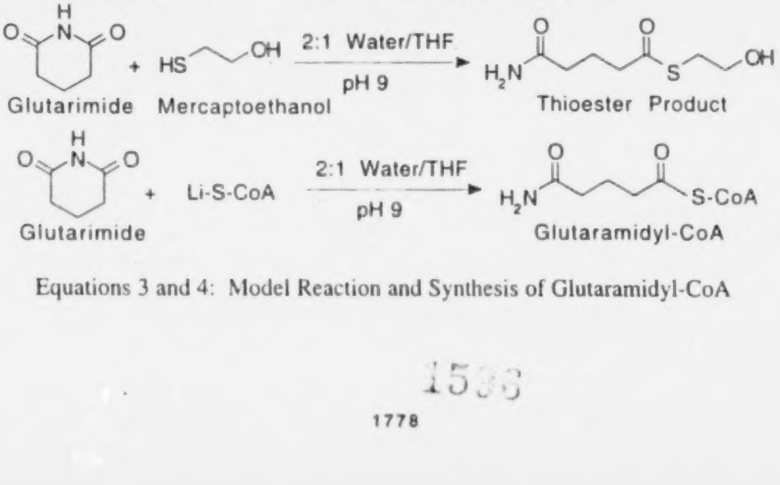
one less methylene group than glutaryl-CoA while adipoyl-CoA has one more methylene group. These features should prevent decarboxylation. 4-Nitrobutyryl-CoA contains a nitro, rather than a carboxylic acid group. The nitro group of this analog is isoelectronic with the carboxylic acid group of glutaryl-CoA and thus should mimic the binding properties of the carboxyl group of glutaryl-CoA. Finally, glutaramidyl-CoA contains an amide in place of the carboxylic acid group found on glutaryl-CoA. This amide is also believed to mimic the carboxylic acid group present in glutaryl-CoA. For these reasons, it is feasible that these analogs may show activity with GCD.

Hexanoyl-CoA and succinyl-CoA are commercially available. The syntheses of adipoyl-CoA and 4-nitrobutyryl-CoA are based on the following general reaction scheme (Bernert and Sprecher, 1977). First, the acid derivative is reacted with ethyl chloroformate to produce the anhydride. This product is next reacted with a lithium CoA (LiCoA) salt, yielding the acyl-CoA derivative.


Anhydride
Li-S-CoA
2:1 Water/THF
pH 8
Acyl-CoA

Equation 2: Synthesis of Adipoyl-CoA and 4-Nitrobutyryl-CoA

Since glutaramidyl-CoA has not been previously synthesized, a model reaction between glutarimide and a small sulfhydryl compound was developed as a basis for the CoA reaction. This model reaction is shown below. In this reaction, glutarimide is subject to a nucleophilic attack by mercaptoethanol. This attack breaks open the ring to yield the resulting amide and thioester. The success of the reaction would provide grounds for the plausibility of the synthetic scheme for glutaramidyl-CoA formation. Similarly to the model reaction using mercaptoethanol, glutarimide should also be subject to a nucleophilic attack by LiCoA, thereby yielding the desired product.


Glutarimide
Mercaptoethanol
2:1 Water/THF
pH 9
Thioester Product
Glutarimide
Li-S-CoA
2:1 Water/THF
pH 9
Glutaramidyl-CoA

Equations 3 and 4: Model Reaction and Synthesis of Glutaramidyl-CoA

EXPERIMENTAL

Unless otherwise stated, all reagents used in these studies were purchased commercially (Aldrich, Milwaukee, WI and Sigma, St. Louis, MO) and were used without further purification. Absorbance measurements were obtained using a Hewlett-Packard 8452A uv/vis diode array spectrophotometer. Nuclear magnetic resonance spectra were obtained using a Varian Model EM360L spectrometer. Enzymatic assays were performed using human GCD expressed in and purified from *E. coli* using methods described by Husain and Steenkamp (1985) and by Frank E. Frerman (personal communication).

Preparation of Substrate Analogs

Adipoyl-CoA synthesis followed Equation 2. Adipic anhydride was synthesized according to the method of Hill (1930), and coupled to CoA via the method of Bernert and Sprecher (1977) as modified by Lenn (1989). Nitroprusside tests (Stadtman, 1957) confirmed the coupling and product purification was performed using the method of Corkey (1985) as modified by Lenn (1989). The product was stored in a concentrated aqueous solution at -20 ^{o}C.

4-Nitrobutyryl-CoA was synthesized according to Kultgen, et. al. (1997). Nitroprusside tests confirmed CoA coupling and product purification was performed as above. The product was stored in a concentrated aqueous solution at -20 ^{o}C.

For the reaction described in Equation 3, 0.0136 g of glutarimide were dissolved in 3 mL of 2:1 H_2O/THF solution. This solution was transferred to a 5 mL conical vial and refluxed with 25.3 µL of mercaptoethanol and 19 µL of NaOH (pH 9) for 4 hr. Next, the pH of the solution was adjusted to 3 using 6 M HCl, and the resulting mixture was washed 3 times with ether. The aqueous layers were collected and lyophilized. The resulting precipitate was dissolved in a minimum amount of D_2O for NMR analysis.

The synthesis of glutaramidyl-CoA was carried out in accordance with the reaction described in Equation 4, using a 2:1 molar ratio of LiCoA and glutarimide. Glutarimide (2.5 µg) and 31.6 µg of LiCoA salt were dissolved in 3 mL of a 2:1 solution of H_2O/THF. This solution was transferred to a 5 mL conical vial fitted with a reflux condenser, stir vane, and boiling chips. The pH of the solution was adjusted to 9 using concentrated NaOH. The solution was refluxed for 2 hours. Next, 2 drops of 6 M HCl were added, and the resulting mixture was washed 3 times with ether. The aqueous layers were collected and lyophilized. The resulting precipitate was dissolved in a minimum amount of deionized H_2O for purification according to the method described by Williamson (1983). The dissolved precipitate was applied to a DEAE Sephadex A-25 column (1.5 X 22 cm). A linear gradient of 0.2 M NaCl/0.1 mM HCl (80 mL) to 0.6 M NaCl/0.1 mM HCl (100 mL) was used for elution. The A_{260} and A_{232} of the collected fractions were monitored. A plot was constructed of A_{260} versus fraction number. Two peaks appeared on the graph indicating two sets of fractions with a higher concentration of CoA. The fractions corresponding to each peak were consolidated and lyophilized. The resulting precipitate of each sample was dissolved in a minimum of deionized H_2O. An absorbance spectrum was recorded for each sample from 200 nm to 310 nm. These spectra were compared to spectra of a known coupled CoA analog and a free CoA sample of the same wavelength range to determine which fractions contained excess CoA and which contained coupled CoA. Pooled fractions were stored at -20 ^{o}C.

Assays for Analog Activity with GCD

GCD assays were performed similarly to that described by Husain and Steenkamp (1985). Assay stock solutions were prepared containing 100 mL of 0.1 M KPi buffer (pH = 7.5, RT) and 1.7 mg of 2,6-dichlorophenolindophenol. For glutaryl-CoA, hexanoyl-CoA, and succinyl-CoA assays, separate 1 mL stock solutions containing 0.00111 g of an individual CoA derivative were first prepared. An individual 250 µL aliquot of a CoA derivative stock solution was then added to a 25 mL aliquot of the assay stock solution. Three milliliters of this stock + CoA derivative solution was added to a standard cuvette, followed by 30 µL of a 0.13 M aqueous phenazine methosulfate solution, and 50 µL of GCD. The decrease in absorbance of this mixture with time was monitored at 600 nm to determine GCD activity. For adipoyl-CoA, 4-nitrobutyryl-CoA, and impure glutaramidyl-CoA, assay quantities were determined by measuring the A_{260} of stored aqueous analog and comparing this value to the A_{260} of glutaryl-CoA at the concentration at which glutaryl-CoA is used for GCD assays. Appropriate dilution factors were calculated to ensure that when small (µL) aliquots of each analog solution were added to 2.9 mL of the assay stock solution and 30 µL of the 0.13 M phenazine methosulfate solution, that the final assay mixture was consistent in analog concentration with glutaryl-CoA final assay mixtures. Ten microliters of GCD were added to the final assay mixture and the A_{600} was monitored as before to determine activity. An assay using glutaryl-CoA was repeated at this time using 10 µL of GCD.

RESULTS AND DISCUSSION

Successful modeling of the glutaramidyl-CoA reaction using mercaptoethanol is shown by the NMR spectrum presented in Figure 2.

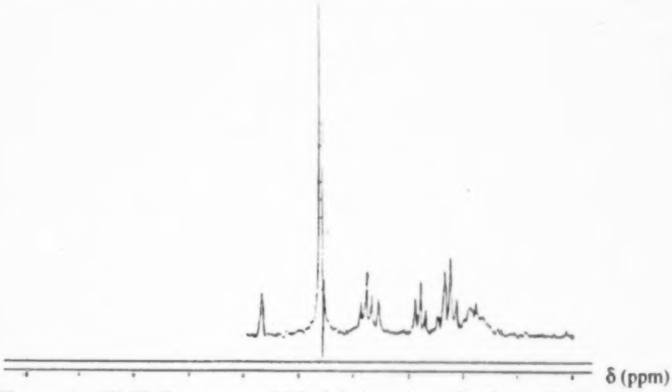


Figure 2. NMR Spectrum of Model Reaction. Scale reads from 0 - 10 ppm.

This spectrum shows peaks characteristic of the thioester product. The broad multiplet at 1.6 ppm corresponds to the two hydrogens of the carbon β to the thioester. The two overlapping triplets at 2.2 ppm coincide with the four hydrogens on the carbons α to the two carbonyl groups. The triplet at 2.7 ppm is indicative of the methylene hydrogens next to the sulfur atom and the triplet at 3.8 ppm corresponds to the methylene hydrogens next to the alcohol group. Spinning side bands of the large H_2O peak are found at 3.5 ppm and 5.7 ppm. This H_2O peak at 4.1 ppm is a result of the exchangeable hydrogens of the amide and alcohol groups. This successful model synthesis supports the assertion that the glutarimide ring could be broken open through nucleophilic attack to yield the formation of a thioester. The synthesis of glutaramidyl-CoA, however, is still in the process of being confirmed. Evaluation of the fractions collected following the A-25 column for their A_{232}:A_{260} absorbance ratios did not yield values near 0.5, the ratio indicative of a clean CoA derivatization (Lenn, et. al., 1990). However, GCD assays performed with impure product mixtures, discussed below, suggest synthesis of the desired product.

The percent activities in Table 1 were calculated by dividing the GCD activity with the analog by the GCD activity with its native substrate, glutaryl-CoA. All five analogs show evidence of activity with GCD and thus appear viable for future GCD electrochemical studies.

Table 1. Table of Analog Activities

Analog	*Percent Activity*
Hexanoyl-CoA	44.4
Succinyl-CoA	13.4
Adipoyl-CoA	3.4
4-Nitrobutyryl-CoA	4.7
Glutaramidyl-CoA (impure)	14.1

As of yet, this study remains incomplete. More work is needed on the characterization and purification of the analog, glutaramidyl-CoA. However, this study was successful in that the synthesis of three substrate analogs and the elucidation of their activity with GCD were able to be evaluated. This data, by shedding some light on the interaction of GCD with its substrate, will be helpful to the ensuing electrochemical studies of GCD:substrate analog complexes as well as be helpful to others wishing to synthesize similar acyl-CoA derivatives.

ACKNOWLEDGMENTS

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REFERENCES

Bernert, J., Sprecher, H. (1977) *J. Biol. Chem. 252*, 6736.
Byron, C. M., Husain, M., Stankovich, M. (1990) *Biochemistry 29*, 3691.
Corkey, B. (1985) *J. Biol. Chem. 257*, 9668.
Gomes, B., Fendrich, G., Abeles, R. H. (1981) *Biochemistry 20*, 1481.
Hill, J. W. (1930) *J. Am. Chem. Soc. 52*, 4110.
Husain, M., Steenkamp, D. J. (1985) *J. Bacteriol. 163*, 709.
Kultgen, P., Edwards, Jr., L., Byron C. M. (1997) *Microchem. J.* , in press.
Lenn, N. D., (1990) M.S. Dissertation, University of Minnesota
Lenn, N. D., Hiu, H-W, Stankovich, M. T. (1990) *Biochemistry 29*, 3709.
Stadtman, E. R. (1957) *Meth. Enzym. 231*, 931.
Williamson, G. (1983) Ph. D. Thesis, University of Sheffield.

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The Synthesis of Rigidin — A Tetrasubstituted Pyrrole

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A main emphasis of this research group in past years has been to develop new approaches for the synthesis of interesting and important pyrroles. It has been demonstrated that the pyrrole is a central structure in many naturally occurring, bioactive compounds. One such molecule is Rigidin. It has been shown to be important in the regulation of Calmodulin activated phosphodiesterase and a potential chemotheraputic agent. This effort towards the synthesis of Rigidin has focused on a "pyrrole-first" approach. This work details the synthesis of a trisubstituted pyrrole intermediate and outlines the planned approach to the target molecule.

INTRODUCTION

An active area for organic chemistry research continues to be the discovery and synthesis of new chemotherapeutic agents for the treatment of various forms of cancer. One specific target of recent efforts has been Calmodulin.[1] It is a protein that binds up to four calcium ions at a time, and has been shown to be an activator of a particular molecular form of phosphodiesterase. It is also a major contributor to calcium signaling in the cells of all eucaryotic organisms. The regulation of Calmodulin activated phosphodiesterase by a variety of pharmaceutical agents, has been the emphasis of researchers attempting to synthesize antitumor compounds. One such compound, Rigidin (1), has recently been isolated from the Okinawan marine truncate Eudistoma cf. rigida by Kobayashi and coworkers.[2]

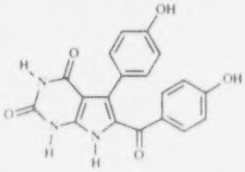

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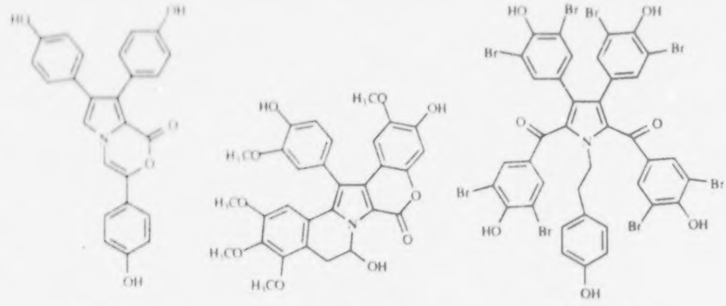
Figure-1. Rigidin.

Rigidin (1) has at its core, a fundamental cyclic structure called a pyrrole. This moiety is comprised of four carbon atoms and one nitrogen connected in a ring and doubly bound in such a way as to create a conjugated system of pi electrons (an energetically favorable situation). Although the specific mechanism of activity is not completely understood, the pyrrole ring, in addition to its substituents, appears to be important in that it is present in a number of potential chemotherapeutic agents (for examples, see Figure-2).[3]



Lukianol A Lamellarin A Polycitone A

Figure-2. Pyrrole Containing Potential Chemotherapeutic Agents.

Unlike previously reported syntheses[4] that have employed a uracil/pyrimidine first approach, we have elected to utilize a "pyrrole first strategy" to the synthesis of Rigidin (see Figure-3). The key intermediate in this strategy is the trisubstituted pyrrole 3 that results from the condensation of vinylogous amide 4 with aminoketone 5. The western portion of Rigidin (1) can be constructed by introducing an amine in the 5-position of the pyrrole and using it and the ester as a foundation for the uracil ring.[5] With the skeleton complete, the only item remaing in the synthesis is the demethylation of the ethers.

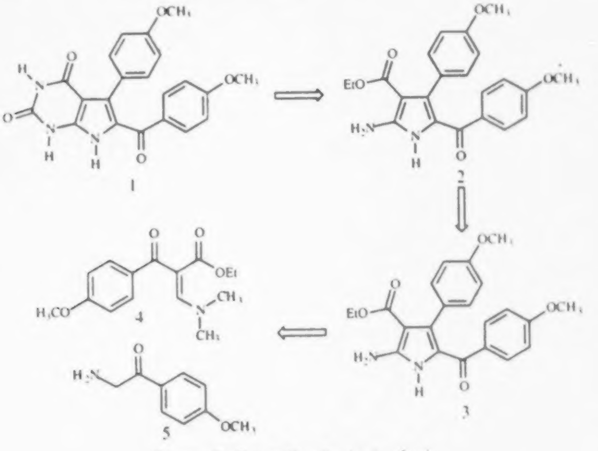


Figure-3. Retro-Synthetic Analysis

This approach to pyrroles can be viewed generally as the coupling of a three-atom unit with a two-atom, nitrogen containing unit (Figure-4). We have found that it allows for the controlled production of a variety of substitution patterns, including: 2,3-disubstituted[6], 2,4-disubstituted[7], 2,5-disubstituted[6,8] and 2,3,4-trisubstituted[9] pyrroles. A number of three carbon synthons are available and can be reacted under different conditions depending upon the nature of the nitrogen-containing unit.

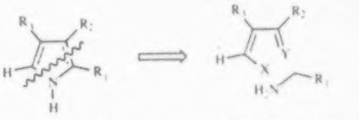


Figure 4. Vinylogous Imine Derivatives — A 3 + 2 Approach to Pyrroles

RESULTS AND DISCUSSION

Trisubstituted pyrrole 3 is the product of a convergent synthesis that utilized two commercially available 4'-methoxyacetophenones (6 and 7) as the initial starting materials (see Figure-5). Claisen condensation[10] of 4'-methoxyacetophenone (6) with diethyl carbonate produced β-ketoester 7 in 85% yield. Without purification, 7 was transformed into vinylogous amide 4 in high yield (78%) by refluxing it with N,N-dimethylformamide dimethyl acetal (DMFA) in dimethylformamide (DMF). This approach to the synthesis of vinylogous amides[11] has been used extensively in our laboratory and provides us with the requisite three-atom units in excellent yields.

The two-atom unit, aminoketone 5, was obtained by first converting 2-bromo-4'-methoxyacetophenone (8) to azide 9 and then reducing it to aminoketone 5a (Figure-5). The azide was obtained in 87% yield by reacting the bromide with an ethanolic solution of sodium azide for 24 hours.[12] Unfortunately the reduction of the azide group to the amine was not as straight forward as was anticipated. Reactions utilizing traditional conditions[13] for the production of amines from azides either resulted in no discernable reaction or produced significant quantities of pyrazine 11 (Figure-6) when reduction did occur . However, it was found that the treatment of the azide with one equivalent of triphenylphosphine[14] and three equivalents of *p*-toluene sulfonic acid (*p*TSA) monohydrate in THF produced analytically pure 5a in 90% isolated yield. The water from the *p*TSA serves to decompose the intermediate phosphorimine (11) while the acid itself traps the aminoketone 5 before dimerization to pyrazine 12 can occur.

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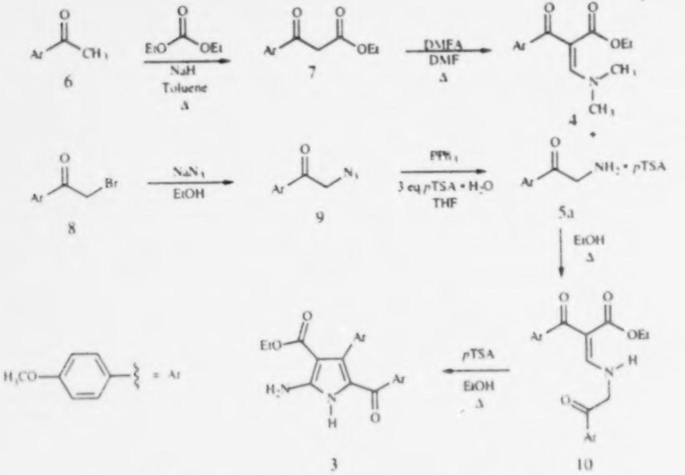

Figure-5. Synthesis of Trisubstituted Pyrrole 3.

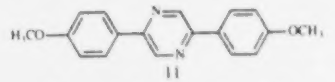

Figure-6. Pyrazine Byproduct

With the two necessary componets in hand, the synthesis of pyrrole 3 was initiated (Figure-5). The first step in the sequence involved the exchange reaction between vinylogous amide 4 and α-aminoacetophenone 5a. This process produced a new vinylogous amide (10) in a crude yield of greater than 95%. Based upon previous studies in our laboratory,[15] it was not surprising that this exchange occurred smoothly. Cyclization of the pyrrole was effected in 30% yield by dissolving vinylogous amide 10 and an additional equivalent of *p*TSA in ethanol and refluxing the solution overnight. It is believed that the protic solvent facilitates enolization of the isolated ketone which undergoes an Aldol condensation with the β-ketoester. The dihyropyrrole (13) that is produced readily eliminates water to produce the energetically favorable aromatic pyrrole 3 (Figure-7).

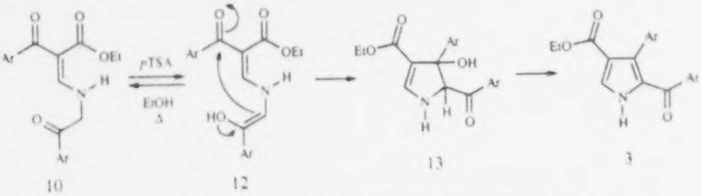

Figure-7. Proposed Mechanism for Pyrrole Formation

CONCLUSION

Although pyrrole 3 has been successfully synthesized, the yield for the cyclization remains less than ideal. Previous work in our group with similar reactions indicates that the reaction is very much substrate dependent. In other words, ideal reaction conditions are very much dependent upon the nature of both the two- and three-atom units that are used. Therefore, we have begun a systematic investigation of this reaction in an effort to maximize its yield. While this study is in progress, trisubstituted pyrrole 3 will be collected so that further progress towards Rigidin can be made. The approach that will be taken is outlined in Figure-8.

ACKNOWLEDGEMENTS

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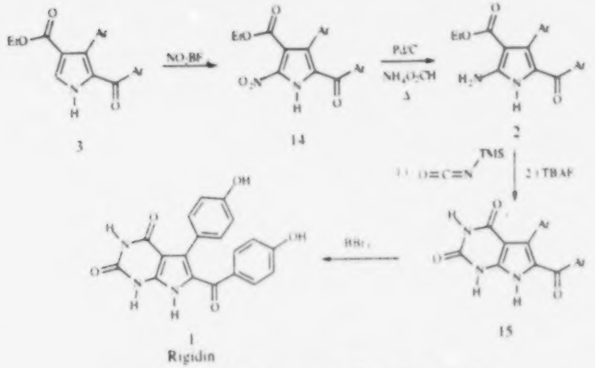

Figure-8 Steps Remaining to Complete Rigidin

EXPERIMENTAL PROCEDURES

Synthesis of 2-Carbethoxy-3-dimethylamino-1-(4'-methoxyphenyl)-2-propenone (4)

4.01 g (0.167 mol) of 60% sodium hydride and 47.06 g (0.398 mol, 48.27 ml) diethyl carbonate were suspended in approximately 150 ml of toluene, and this solution was heated to 60° C. 10.0 g (0.067 mol) of 4'-methoxyacetophenone (6) was dissolved in approximately 150 ml of toluene and added dropwise to the above solution over three hours. The reaction stirred and changed from gray to dark orange-brown with an increase in temperature to approximately 70° C within the first 30 min. The reaction was allowed to stir for an additional 48 hrs and monitored by thin layer chromatography. After completion, the solution was cooled to 0° C and 25 ml of glacial acetic acid was added. This mixture was then poured into a mixture of 40 ml of ice and 10 ml of concentrated hydrochloric acid. After being separated, the aqueous layer was extracted with ethyl acetate (3 x 50 ml). The combined organic layers were washed sequentially with saturated sodium bicarbonate solution (2 x 50 ml) and brine (2 x 50 ml), and dried over anhydrous magnesium sulfate. Concentration of solution under reduced pressure afforded 12.6 g (85.1%) of a yellow oil that was identified as ethyl 4'-methoxybenzoylacetate (7) on the basis of the following physical properties: IR (neat) 2918, 2820, 1740, 1675, 1600, 1030, and 840 cm^{-1}; NMR ($CDCl_3$, 200 MHz) δ 1.23 (t, 3H, J=7.1 Hz), 3.84 (s, 3H), 3.92 (s, 2H), 4.18 (q, 2H, J=7.1 Hz), 6.92 (d, 2H J=8.8 Hz), 7.90 (d, 2H, J=8.8 Hz).

2.22 g (10.00 mmol) of the above β-ketoester (7) and 4.77 g (40.00 mmol) dimethyl formamide acetal (DMFA) were added to 100 ml DMF and allowed to reflux and stir overnight. The methanol byproduct was removed on the rotoevaporator under reduced pressure. Concentration by Kughelrohr distillation under reduced pressure afforded 2.18 g (78.5%) of a dark red oil that was idendified as 2-carbethoxy-3-dimethylamino-1-(4'-methoxyphenyl)-2-propenone (4) on the basis of the following spectral properties: IR (neat) 2860-3000, 1675, 1585, 1430, 1375, 1075, 960, 845, 775, 200-600 cm^{-1}; NMR ($CDCl_3$, 200 MHz) δ 0.955 (t, 3H, J=7.0 Hz), 2.77-3.06 (m, 6H), 3.83 (s, 3H), 3.98 (q, 2H, J=7.0 Hz), 6.88 (d, 2H, J=7.4 Hz), 7.66 (s, 1H), 7.80 (d, 2H, J=7.4 Hz).

Synthesis of α-Amino-4'-methoxyacetophenone *p*-toluenesulfonic acid salt (5a).

To a solution containing 3.13 g (40.81 mmol) of sodium azide in 300 ml of ethanol was added a solution of 10.0 g (43.65 mmol) of 2-bromo-4'-methoxyacetophenone (8) in 150 ml of ethanol. After stirring at room temperature for 20 hrs, the solution was concentrated to 1/2 its volume under reduced pressure. The remaining solution was diluted with 250 ml of diethyl ether and washed with 300 ml of water. The organic layer was separated and washed with brine (2 x 50 ml). The original water layer was back extracted twice with ether (2 x 50 ml) and the resulting organic layers were washed again with brine. All organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated. Recrystallization of the resulting yellow crystals from dichloromethane and hexane afforded 7.30 g (87.3%) of pale yellow crystals that were identified as 2-azido-4'-methoxyacetophenone (9) on the basis of the following spectral properties: mp 69.5-71.0°C; IR (neat) 2905, 2105, 2100, 1680, 1590, 1175, and 825 cm^{-1}; NMR ($CDCl_3$, 200 MHz) δ 3.88 (s, 3H), 4.50 (s 2H), 6.96 (d, 2H, J=9.2 Hz), 7.89 (d 2H, J=9.2 Hz).

2.00 g (10.46 mmol) of the above azide (9), 2.74 g (10.46 mmol) of triphenyl phosphine and 5.97 g (31.38 mmol) of *p*TSA were combined in THF (100 ml) and allowed to stir overnight at room temperature. The resulting white crystalline solid was filtered and dried under reduced pressure. The yield of solid product was 1.80 g (90.0%) and it was identified as 2-amino-4'-methoxyacetophenone on the basis of the following spectral properties: mp 187.6-188.9°C; IR (KBr) 2800-3300, 1690, 1600, 1160, 1020, 820, 675, and 560 cm^{-1}; NMR

(DMSO, 200 MHz) δ 2.27 (s, 3H), 3.85 (s, 3H), 4.52 (s, 2H), 7.10 (d, 4H, J-7.8 Hz), 7.46 (d, 2H, J=8.4 Hz), 7.98 (d, 2H, J=9.2 Hz), 8.08-8.22 (s, 3H).

Synthesis of 4-Carbethoxy-2-(4'-methoxyphenacyl)-3-(4'-methoxyphenyl)pyrrole (3).

0.50 g (1.89 mmol) of vinylogous amide (4) and 0.64 g (1.89 mmol) of amino ketone *p*TSA salt (5a) were dissolved in 50 ml of ethanol and allowed to stir and reflux under an inert atmosphere for 48 hours. The reaction was cooled to room temperature and the solvent was removed under reduced pressure. The resulting light brown solid product was redissolved in chloroform and washed with saturated sodium bicarbonate solution (2 x 100 ml). The organic layer was separated and dried over anhydrous magnesium sulfate. Concentration of the solution under reduced pressure yielded 0.42 g (55.9%) of an oily solid which was identified by TLC as not being either of the starting materials and by crude NMR as vinylogous amide (10). Without purification, the solid was redissolved in 100 ml of ethanol, 0.253 g (1.33 mmol) of *p*TSA was added, and the solution stirred at reflux for 10 hrs. After cooling, the reaction was concentrated under reduced pressure, dissolved in 100 ml of chloroform, and washed saturated sodium bicarbonate solution (2 x 50 ml). The organic layer was dried over anhydrous magnesium sulfate and concentrated under reduced pressure. Chromatography of the crude product with 25% ethyl acetate-75% hexane afforded 0.11 g (14.5%) of a yellow solid that was identified as 4-carbethoxy-2-(4'-methoxyphenacyl)-3-(4'-methoxyphenyl)pyrrole (3) on the basis of the following spectral properties: mp 124.0-127.2°C; IR (KBr) 3280, 1680, 1600, 1250, 900, 830, 600 cm^{-1}; NMR (CDCl$_3$, 200 MHz) δ 1.22 (t, 3H, J=7.0 Hz), 3.71 (s, 3H), 3.73 (s, 3H), 4.19 (q, 2H, J=7.0 Hz), 6.53 (d, 2H, J=8.8 Hz), 6.61 (d, 2H, J=9.2 Hz), 7.03 (d, 2H, J=8.8 Hz), 7.36 (d, 2H, J=9.2 Hz), 7.72 (d, 1H, J=3.2 Hz), and 10.0-10.2 (bs, 1H).

REFERENCES AND CITED LITERATURE

1) For recent reviews regarding the importance of Calmodulin in biological processes see: a) Motohashi, N., "Phenothiazines and Calmodulin", *Anticancer Res.*, 1991, *11*, 1125; b) Ovadi, J., "Effects of drugs on Calmodulin Mediated Enzymatic Actions", *Prog. Drug Res.*, 1989, *33*, 353; c) Veigl, M.; Klevit, R.; Sedwick, W., "The Uses and Limitations of Calmodulin Antagonists", *Pharmcol. Ther.*, 1989, *44*, 181.

2) Kobayashi, J.; Cheng, J.; Kikuchi, Y.; Ishibashi, Y.; Yamamura, S.; Ohizumi, Y.; Ohta, T. and Nozoe, S., "Rigidin, A Novel Alkaloid with Calmodulin Antagonistic Activity from the Okinawan Marine Truncate Eudistoma cf. Rigida", *Tetrahedron Lett.*, 1990, *31*, 4617.

3) a) Furstner, A.; Weintritt, H. and Hupperts, A., "A New, Titanium-Mediated Approach to Pyrroles: First Synthesis of Lukianol A and Lamellarin *O* Dimethyl Ether", *J. Org. Chem.*, 1995, 60, 6637-6641 b) Yoshida, W. Y.; Lee, K. K.; Carrol, A. R.; Scheuer, P. J., *Helv. Chim. Acta*, 1992, 75, 1721-1725. c) Rudi, A. Golberg, I., Stein, Z., Frolow, F., Benayahu, Y., Schleyer, M. and Kashman, Y., "Polycitone A and Policytrins A and B: New Alkaloids from the Marine Ascidian Polycitor sp.", *J. Org. Chem.*, 1994, 59, 999.

4) a) Edstrom, E. and Wei, Y., "Synthesis of a Novel Pyrrolo[2,3-d]pyrimidine Alkaloid, Rigidin", *J. Org. Chem.*, 1993, 59, 403; b) Sakamoto, T.; Kondo, Y; Sato, S.; and Yamanaka, H., "Total Synthesis of the Marine Alkaloid Rigidin", *Tetrahedron Lett.*, 1994, 35, 2919 and references therein.

5.) Wamhoff, H. and Wehling, B., "Pyrrolo[2,3-d]- and Pyrrolo[1,2-a]pyrimidines from Heterocyclic Enaminoesters", *Chem. Ber.*, 1976, 109, 2983.

6.) Gupton, J.; Petrich, S.; Smith, L.; Bruce, M.; Vu, P.; Du, K.; Dueno, E.; Jones, C.; and Sikorski, J., "The Application of Vinylogous Iminium Salts and Related Synthons to the Regiocontrolled Preparations of 2,3- and 2,5-Disubstituted Pyrroles", *Tetrahedron*, 52, 6879, 1996.

7.) Gupton, J.; Krolikowski, D.; Yu, R.; Sikorski, J.; Vu, P.; and Jones, C., "The Application of 2-Substituted Vinamidinium Salts to the Synthesis of 2,4-Disubstituted Pyrroles", *J. Org. Chem.*, 1990, 55, 4735.

8.) Gupton, J.; Krolikowski, D.; Yu, R.; Vu, P.; Sikorski, J.; Dahl, M.; and Jones, C., " An Efficient Regiocontrolled Synthesis of 5- Aryl-2-carboethoxypyrroles from 3-Aryl-3-chloropropeniminium Salts", *J. Org. Chem.*, 1990, 57, 5480.

9.) Gupton, J.; Krumpe, K.; Burnham, B., Sikorski, J.; Jones, C.; Bowers, B.; Webb, T.; Shuford, J.; Dwornik, K.; Petrich, S.; Du, K., unpublished results.

10.) a) March, J. in *Advanced Organic Chemistry*, Third edition, p. 437, Wiley, New York, 1988. b) House, H. O. and Hudson, C. B., "Perhydroindan Derivatives. XII. 6-Methoxyindanone and its Derivatives", *J. Org. Chem.*, 1970, 35, 647.

11.) For a review see Liebscher, J. and Hartman, H., " 3-Chloro-2-propeninminium Salts as Building Blocks in Organic Chemistry", *Synthesis*, 1979, 241.

12.) For a review see Biffin, Miller, and Paul, in Patai, "The Chemistry of the Azo Group", pp 57-119, Interscience, New York, 1971.

13.) For a review see a) Larock, R. C., *A Guide To Functional Group Preparations*, pp.409-410, VCH Publishers, New York, 1989. b) Ref. 10a, p. 1106.

14.) Ganem, B. and Nagarajan, S; "Chemistry of Naturally Occurring Polyamines. 11. Unsaturated Spermidine and Spermine Derivatives", *J. Org. Chem.*, 1987, 52, 5044.

15.) a) Smith, L. M.S. Thesis, "Preparation and Functionalization of Regioselectively Substituted Pyrroles", University of Central Florida, August, 1993. b) Abdulla, R. and Brinkmeyer, R., "The Chemistry of Formamide Acetals", *Tetrahedron*, 1979, *35*, 1675.

Molecular Modeling of Vanadium-Oxo Complexes

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The design of more effective insulin mimetic agents remains a goal of diabetes research. Vanadyl complexes show promise as effective anitdiabetic drugs, but at present predicting the compounds which will be most effective insulin mimetics by experiment is costly and inefficient. The object of this research was to develop computational methods to accurately and efficiently predict the structure of vanadyl complexes. Once established, the computational method enabled structure-function studies to be done on vanadium drugs. Overlays of theory versus experiment structures affirm that modeling vanadium insulin mimetics may be carried out with reasonable accuracy. Analysis revealed maximum activity of vanadium drugs with a volume of 500 A^3.

BACKGROUND

The design of more effective insulin mimetic agents remains a goal of diabetes research.[1] One group of compounds that show promise as effective insulin-mimicking compounds contain the metal vanadium.[2] Specifically, vanadyl (VO^{+2}) compounds stimulate glucose oxidation in rat adipocytes and lower blood glucose levels in diabetic rats.[3] The advantages of such drugs include oral administration and a minimization of long-term health problems common to diabetic patients such as cardiac and circulatory problems, visual difficulties, and premature death.

The efficacy of vanadium drugs is sensitive to the vanadium metal and its attached ligands.[4] However, no rational basis for selection of optimal ligands exists at present. Drug companies that presently test over 10,000 compounds a year would be able to study the complexes most likely to be the best insulin-mimetic compounds first. This eliminates costly and inefficient experimental work by prioritizing compounds that will be studied. It is highly desirable, therefore, to use computers to model chemical interactions, predict shape, and determine pharmacological properties of drugs before synthesizing the compound in the lab. In addition, once one understands what chemical properties contribute to the drug's effectiveness, the efficacy of drugs may be increased by changing the various components of the chemical. Altering the drug to increase water solubility is an example of a method to make drugs more effective with less side effects.

Past research has been done by the Cundari group on modeling related vanadium compounds called pervanadates.[5] These complexes include a central vanadium molecule in the (+5) oxidation state and two attached peroxy ligands; a typical example is shown in Figure 1. The vanadium metal, in addition to the attached ligands which surround it, in pervanadates is responsible for a large portion of their activity.[4] The objects of the present study are vanadyl complexes which are characterized by the vanadium in the (+4) oxidation state and an oxide ligand; a typical vanadyl complex is shown in Figure 2. Both pervanadates and vanadyl complexes have been shown to be potent insulin mimetics by increasing glucose oxidation, reducing blood glucose levels, and inhibiting protein tyrosine phosphatase (PTP).[4]

16

Finally, computational studies at the University of Memphis complement experimental studies of vanadium compounds being performed at Mississippi State University. It is the goal of this combined effort to develop greater insight into the design of more effective vanadium-based anti-diabetic drugs. Computer-aided design of many drugs is now a reality, however this has not yet been achieved for metal-containing drugs due to the difficulties in computer modeling of metal chemistry.

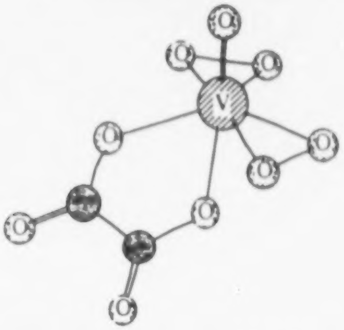


Figure 1: Pervanadate Complex with Oxalate Ancillary Ligand.

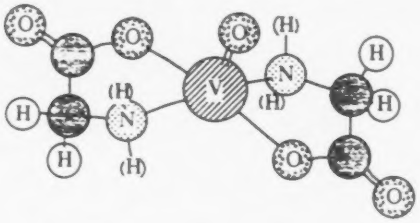


Figure 2: Vanadyl Complex with Glycine Ancillary Ligands.

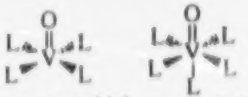
HYPOTHESIS

The objective of this research is to develop computational methods to accurately predict the structure of vanadyl complexes in an efficient manner. Once the computational model is validated by comparison with existing experimental data, the information obtained by computation will be used to identify new antidiabetics. By establishing a computational method, one is able to perform structure-function studies on vanadium drugs. The primary focus of this research will be on compounds with coordinated amino acids and related ligands because of their steric bulk, hydrophilicity, and chirality, properties which have been shown to determine insulin mimic ability. Furthermore, since amino acids are naturally occurring compounds, there is reduced possibility of toxic side effects if they are incorporated into antidiabetic drugs.

METHODOLOGY

Vanadium, a transition metal, gives vanadyl complexes a chemical diversity that is very challenging for computer modeling.[2] However, the accuracy of the computer models of vanadyl compounds can be checked by comparing calculated geometric data to that of published experimental results.[6] This allows one to develop a thoroughly validated computational model with which to study the properties of new compounds.

Vanadyl compounds to be studied are of the form L_nVO with vanadium in the +4 formal oxidation state; L_n signifies the ligand(s) which are attached to the vanadyl species. Complexes with four ancillary ligands (n = 4) are square pyramidal, while complexes with five ancillary ligands ($n = 5$) are octahedral, Figure 3. Biologically significant ligands to be studied are amino acids and other nitrogen and oxygen-based ligands since these form stable compounds with vanadyl.



square pyramidal   octahedral

Figure 3: Prototypical Vanadyl Structural Types.

Standard molecular mechanics programs (MM) which have been modified in our lab for vanadyl complexes are used to draw the preliminary sketch of the target complex and optimize its geometry.[7] A basic MM force field is given by equation 1.

$$U_{steric} = U_r + U_q + U_t + U_{vdw} \qquad (1)$$

Molecular mechanics is a simple ball-and-spring model of chemical systems, where the balls represent the atoms and the bonds are represented by springs. U_r describes the amount of energy needed to compress and stretch the bond between two atoms. U_Θ is the energy required to increase and decrease a bond angle formed by three atoms. U_τ is the amount of energy required to rotate about an individual bond or spring. Lastly, U_{vdw} describes the strength of the interaction between atoms which are not directly chemically bonded to each other. The optimum geometry of a drug is the combination of bond lengths, bond angles, etc. with the lowest steric energy (U).

There is no guarantee that the first structure sketched in is the lowest energy structure. Therefore, molecular dynamics (MD) is used to search for different low energy geometries by simulated annealing of a compound by heating it up to high temperatures (500 - 1000 K), and then cooling the drug back down to 0 K. The MD procedure begins with a rough sketch of the drug's conformation. The preliminary geometry is heated up allowing the atoms to freely move about. The drug is then allowed to cool. As a result of the continual heating up and then cooling down of the drug, one should be able to obtain the lowest energy (i. e., naturally occurring) geometry. Approximately fifty simulated annealing cycles (heating up followed by cooling down) are run to search for the lowest energy geometry. We have found this approach allows us to consistently determine the structure of metal-containing drugs. The simulated annealing process is depicted graphically in Figure 4.

RESULTS AND DISCUSSION

Based on preliminary theory-experiment data, we conclude that quantum mechanical calculation of molecular mechanical parameters for vanadium insulin mimics may be carried out with reasonable accuracy. To provide graphical proof that molecular mechanics can be used to accurately calculate geometries of vanadium insulin mimetics, computer generated models can be overlaid with experimental geometries. These overlays affirm that computational methods for prediction of vanadium complexes are accurate. Vanadium dioxo dioxalate and vanadium dioxo s-peida are just two examples of nearly twenty vanadyl drugs whose theory-experimental overlay shows good agreement. These examples are shown in Figure 5 and Figure 6.

16

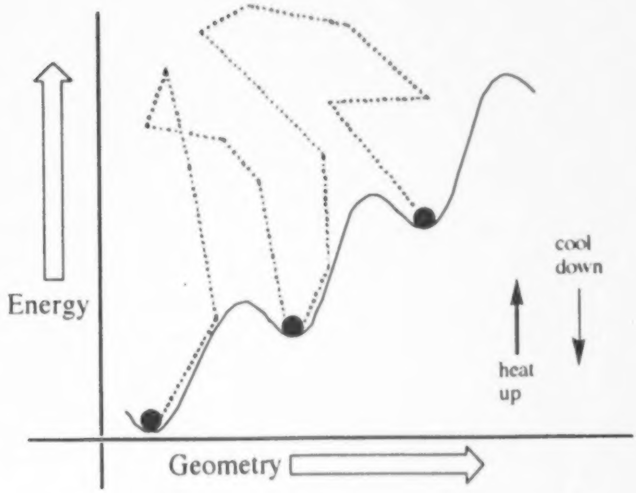

Energy
Geometry
cool
down
heat
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Figure 4: Graphical Depiction of the Simulated Annealing Process.

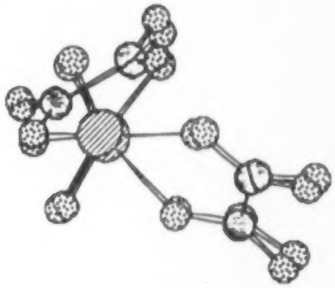

Figure 5: Overlap of Experimental and Predicted Geometries of V^{+5} Dioxo Dioxalate

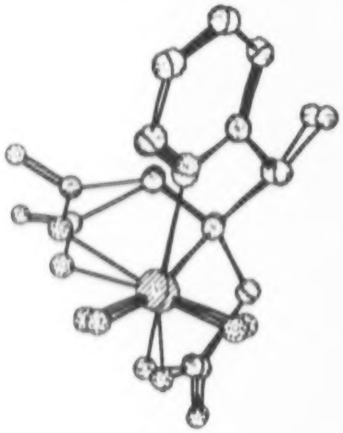

Figure 6: Overlap of Experimental and Predicted Geometries of V^{+5} Dioxo S-peida

Furthermore, the speed with which molecular mechanics may be applied to metal complexes is very fast. What takes many days to generate on a high performance computer using previously developed methods now takes only six seconds with comparable accuracy on a Macintosh personal computer using the MM methods developed in our lab. In addition the MM-predicted structures are as accurate, if not more accurate, than previous methods.

Now that the accuracy of the MM method has been demonstrated by comparison with known experimental systems, it is now possible to employ this computational model with good confidence for the study of novel vanadyl antidiabetics. In previous research from our group,[5] a quantitative structure activity relationship was developed by plotting the inhibition of PTP (a measure of antidiabetic drug activity)[4b] with molecular volume of the drug. The correlation suggests that there is maximum activity of vanadium drugs with a volume of ≈ 500 Å^3. Perhaps this is due to the chemical interactions between the vanadium drug and the drug receptor site. A nice illustration of this relationship between size and efficacy is the lock and key hypothesis. The drug must fit inside the substrate just as a key fits inside a lock; thus, size greatly affects activity. It is of interest in the future to investigate relationships between drug activity and other chemical properties such as hydrophilicity (which determines solubility in water) and chirality (related to the three-dimensional shape of the drug). These properties, along with size, have been shown by experimentalists to be important determinants of antidiabetic activity.

Other future work will include exploring further this relationship between activity and volume. In addition, potential vanadium drugs must be limited to those that are stable in the acidic environment of the stomach. Systems that meet this criteria will be isolated. Acid stability and the other chemical properties mentioned are intimately related to the structure of the drug, and hence accurate prediction of this property is paramount. Our preliminary results are therefore very encouraging in this regard.

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REFERENCES

1. Stinson, S. Chem. and Eng. News. (September 30, 1991), pp. 35 - 59.
2. Chasteen, N. D. In Structure and Bonding. Springer-Verlag Berlin Heidelberg (1983), pp. 105 - 138.
3. Caravan, P.; Gelmini, L.; Glover, N.; Herring, F. G.; Li, H.; McNeill, J. H.; Rettig, S. J.; Setyawati, I. A.; Shuter, E.; Sun, Y.; Tracey, A. S.; Yuen, V. G.; Orvig, C. J. Am. Chem. Soc. 1995, 117, 12759 - 12770.
4. a) Shechter, Y.; Shisheva, A.; Lazar, R.; Libman, J.; Shanzer, A. Biochemistry 1992, 31, 2063.

   b) Posner, B. I.; Faure, R.; Burgess, J. W.; Bevan, A. P.; Lachance, D.; Zhang-Shun, G.; Fantus, I. G.; Ng, J. B.; Hall, D. A.; Lum, B. S.; Shaver, A. J. Biol. Chem. 1994, 269, 4596 - 4604.
5. Cundari, T. R.; Sisterhen, L. L.; Stylianopoulos, C. L. Inorg. Chem. - submitted.
6. Nugent, W. A.; Mayer, J. M. "Metal-Ligand Multiple Bonds;" Wiley: New York, 1988.
7. Allinger, N. L.; Burkert, U. "Molecular Mechanics;" ACS: Washington, D. C., 1982.

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Characterization of Liquid Crystalline Thermoset Networks

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ABSTRACT

Liquid crystalline networks combine the high dimensional stability typical of thermoset networks with the electrical and mechanical orientability of liquid crystals, allowing vastly different properties in the parallel or perpendicular directions of thin films to be locked-in upon curing to form a network. Accordingly, mixtures of a mesogenic dicyanate (DCN), bis(4-hydroxy-methyl-phenyl)terephthalate, and a commercially available thermosetting monomer, bisphenol-A-dicyanate (AroCy B10), were studied for curing behavior by polarized light optical microscopy. It was found that the time to the start of nematic phase development is an exponential function of curing temperature and seems independent of mixture composition. Remarkably, it was also found that mixtures containing up to 90 mol% B10 in DCN formed liquid crystalline mixtures capable of uniaxial orientation by magnetic or electric field alignment.

INTRODUCTION

Recently there has been a growing interest in the preparation and characterization of liquid crystalline (LC) networks. Such networks provide both the high dimensional stability and mechanical orientibility typical of polymer networks and the unique anisotropic behavior of LC materials. LC networks with a high degree of crosslinking further offer favorable properties for nonlinear optics and electronic packaging. Specifically, great interest has been shown in the use of LC networks as thermosetting resins for circuit board fabrication. For this use, such a network should combine the excellent thermal stability and dielectric properties that make cyanate esters very attractive in this area. In addition, the LC character allows such networks to be oriented either by electric field or surface alignment. Furthermore, because LC thermosets are transparent to microwave radiation, they can be used as the base material for radar apparatus, while their light weight, high impact resistance, and chemical stability make them very attractive materials for aircraft structures.

The use of thermosetting LC networks opens the possibility for selective orientation and subsequent "locking-in" of different structures, providing very different physical and chemical properties in select regions. Mesogens can be aligned prior to curing through the use of an electric field on the order of 1 V/μm. In addition, the cross-linked network retains locked-in orientations up to 100°C above the glass transition temperature.

A mesogenic dicyanate (DCN) of *bis(4-hydroxy-methyl-phenyl)terephthalate* shown in Figure 1a, was used as reported elsewhere[1]. The thermosetting agent used is a commercially available monomer, bisphenol-A dicyanate (AroCy B10), shown in Figure 1b.

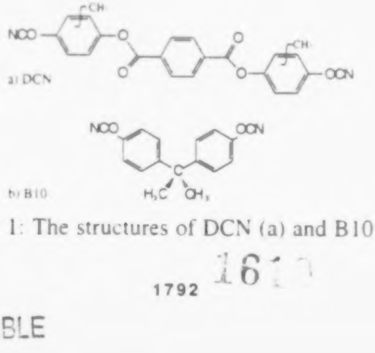

Figure 1: The structures of DCN (a) and B10 (b)

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When DCN and B10 are dissolved in chloroform or dichloromethane, and the precipitate is dried and cured, a cyclotrimerization of the cyanate groups form a compact, six-membered triazine ring at each cross-link site on heating. Possible mechanisms for such a reaction[2] are shown below in Figure 2.

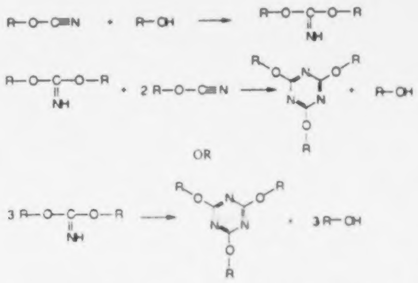
R—O—C≡N + R—OH ⟶ R—O—C(=NH)—O—R
R—O—C(=NH)—O—R + 2 R—O—C≡N ⟶ + R—OH
OR
3 R—O—C(=NH)—O—R ⟶ + 3 R—OH

Figure 2: Suggested mechanisms for the formation of triazines

It has been estimated that the cured compound will remain liquid crystalline up to 20 mol% B10 in the mixture[3]. The actual saturation value is of great interest, however, as often a balance between the thermosetting properties of B10 and the liquid crystallinity of DCN is desired.

Another variable in the curing reaction is the temperature at which the reaction is carried out. It has been estimated that the curing will continue to completion for temperatures in the range of 180°C to 240°C[4]. As expected, higher curing temperatures lead to a shorter LC phase induction time due to the increased kinetic energy driving the reaction.

This paper will present evidence showing that mixtures of DCN and B10 could be liquid crystalline up to 90 mol% B10 in DCN. Polarizing optical microscopy observations show that high B10 mixtures are in many cases indistinguishable from low B10 mixtures after curing and that mixtures containing up to 90% B10 become liquid crystalline and show a vivid Schlieren texture. In addition, the curing reaction was monitored for mixtures of B10 and DCN and analyzed for the start of nematic phase development as a function of curing temperature and mixture composition. It was found that composition does not affect the nematic phase induction time whereas there is an exponential relationship with curing temperature.

EXPERIMENTAL SECTION

DCN was provided by Hilmar Korner, who synthesized *bis(4-hydroxy-methyl-phenyl)-terephthalate* as reported elsewhere[1,5]. AroCy B10, bisphenol-A dicyanate, was kindly provided by IBM Endicott and used without further purification.

Mixtures of DCN and B10 were made by weighing the appropriate amount of DCN and B10 to total 200 mg into glass vials and adding excess chloroform or dichloromethane. The mass of DCN, m_{DCN}, to be added to make a mixture of total mass 200 mg and of mole fraction of B10 X_{B10} is given by (1) where the molar mass of DCN is 428 g/mol and B10 is 278 g/mol.

$$m_{DCN} = \frac{(0.200\mathrm{g})\left(428\frac{\mathrm{g}}{\mathrm{mol}}\right)(1 - X_{B10})}{\left(278\frac{\mathrm{g}}{\mathrm{mol}}\right)(X_{B10}) + \left(428\frac{\mathrm{g}}{\mathrm{mol}}\right)(1 - X_{B10})} \quad (1)$$

Samples analyzed for the curing reaction were taken as flakes of dried precipitate from solution. The flakes were placed on cleaned glass slides without cover-slip and heated in a Mettler FP-82 hotstage. Light intensity data was collected as a measure of sample birefringence by a Mettler 17517 photomonitor in an eyepiece of a Nikon *Optiphot2-Pol* polarizing optical microscope (POM) at 50x magnification. Data was collected with a custom program written for LabView.

Samples prepared solely for the purpose of determining liquid crystallinity were prepared from droplets of solution on glass slides, also without cover-slip so as to reduce external stress on the samples. The slides were all cured on a hot-plate at 200°C ± 5°C for 1 h and were examined at room temperature by POM. Color photographs were taken on Kodak color film by a 35 mm Nikon camera attachment on the microscope.

Flake and solution deposited film compositions were compared by Fourier transform infrared spectroscopy (FT/IR) using a Mattson 2020 Galaxy Series FT/IR.

RESULTS AND DISCUSSION

Curing Behavior of the Mixtures

As samples are heated it is observed the transmitted polarized light intensity increases briefly on melting but remains near zero until the start of nematic phase development, t_s, measured in minutes. Subsequently the whole sample becomes birefringent and the light intensity reaches a maximum after t_e minutes. In general, the light intensity varies with time as shown in Figure 3.

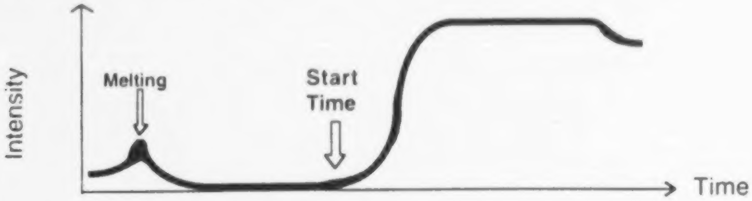

Figure 3: Sample birefringence at high temperature

Figure 4 shows the results of the tests, averaging points at the same temperature, for the start of the nematic phase development at various curing temperatures. The end time versus T gives similar results.

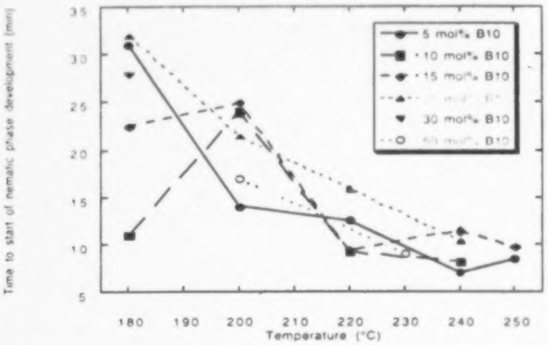

Figure 4: Relationship between time to start of nematic phase development and curing temperature

It is clear from the graph that there exists an exponential relationship between curing temperature and time to the start of nematic phase development. However, Figure 4 also indicates that there is no clear relationship between composition and either variable. Figures 5 separates estimates an exponential relationship between time and temperature by fitting a linear relationship to ln(t) versus 1/T

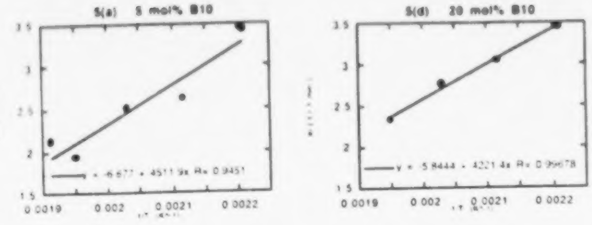

Figure 5: Arrhenius plots showing the exponential relationship between time and temperature for 5 mol% B10 and 20 mol% B10 mixtures.

The slope of the extrapolated lines in Figure 5 is directly related to the activation energy for network formation. It is clear that the 20 mol% sample has a smaller slope and thus a smaller activation energy associated with it than the 5 mol% sample. However, samples of other compositions do not show this same trend. This may indicate that further testing is required while more vigorously controlling sample dimensions.

Liquid Crystallinity of B10/DCN Mixtures

It was predicted that B10/DCN mixtures would be liquid crystalline only up to 20 mol% B10[1] and the observation of a LC phase up to 50 mol% B10 raised the question of how much B10 can be added to the LC DCN in order for the mixture to remain LC. Solutions were made in increments of 5 mol% B10 and the films were cured for later examination by POM. It is clear from such observations that films of up to 90 mol% B10, but less than 95 mol% B10, are LC and show a clear Schlieren texture.

There are differences, however, between samples with low B10 content and those with more B10 than DCN. To be sure, these differences may be due to variations in film thickness as all solutions of more than 50 mol% B10 were made with dichloromethane, while those of less than 50 mol% B10 were made with chloroform simply because those solvents were available at the time the solutions were made. Because dichloromethane has a larger vapor pressure than chloroform, the films deposited from the former solution could be thinner than those from chloroform. As the color of LC samples is primarily a thickness effect, the less vibrant color of higher B10 samples may be explained by the possibly thinner films made from dichloromethane solution.

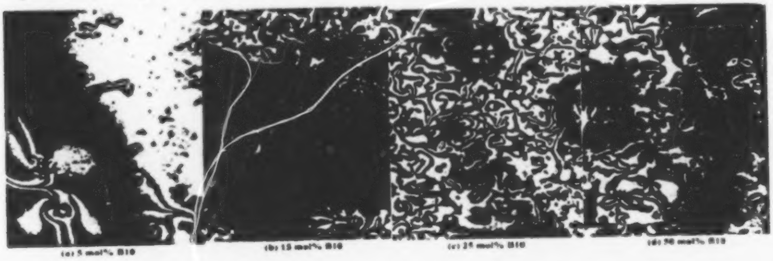
(a) 5 mol% B10 (b) 15 mol% B10 (c) 25 mol% B10 (d) 50 mol% B10

Figure 6: LC mixtures prepared from chloroform solution

Figure 6 shows photographs taken at room temperature of 5, 15, 25, 50 mol% B10 while figure 7 shows 55, 60, 70, and 90 mol% B10. It is interesting to note how similar 25 mol% B10 and 50 mol% B10 look (both from chloroform solution) and how different 50 mol% B10 is from 55 mol% B10 (the later from dichloromethane).

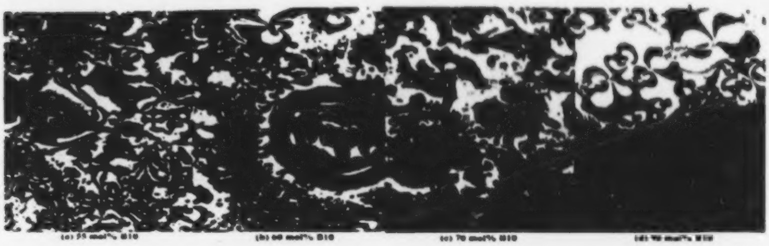
(a) 55 mol% B10 (b) 60 mol% B10 (c) 70 mol% B10 (d) 90 mol% B10

Figure 7: LC mixtures prepared from dichloromethane solution

Some samples were noted to develop a feathered, brushed texture on the surface. It is possible that there is a crystalline phase developing on the surface. Wide angle x-ray diffraction testing of the mixtures failed to show any sharp peaks. Rather, the broad and diffuse pattern is indicative of an amorphous or LC structure.

CONCLUSION & FUTURE WORK

Mixtures of a thermosetting monomer B10 and a mesogenic dicyanate DCN were analyzed for the time to start of LC formation as a function of curing temperature. It was found that there exists an exponential relationship between the time to the start of LC formation and the curing temperature, though there is no clear relationship at this time between either variable and mixture composition.

Mixtures were also examined for the presence of an LC phase by POM. It was found that samples of up to and including 90 mol% B10 in DCN appear liquid crystalline. Some samples developed a feathered texture on the surface which may indicate the presence of a crystalline phase. Synchrotron x-ray diffraction will be used to test this. In addition, solid state NMR will be used to determine if curing mixtures are LC entirely or are phase separating, as exposure to high-intensity electric or magnetic fields will align LC samples.

Continuing investigation into the liquid crystallinity of low mesogen concentration mixtures will continue to develop the theory behind LC formation as well as many possible industrial end-uses, allowing more efficient production of LC thermosetting resins and a fuller understanding of their properties.

ACKNOWLEDGEMENTS

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REFERENCES

1. G.G. Barclay, C.K. Ober, K. Papathomas and D. Wang, *Macromolecules*, 25, 2947 (1992)
2. M. Bauer, J. Bauer, in *Chemistry and Technology of Cyanate Ester Resins*, I. Hammerton Ed, Chapman and Hall, N.Y., 1994
3. H. Korner, A. Shiota, C.K. Ober, M. Laus, *preprint*
4. H. Korner, A. Shiota, T.J. Bunning, C.K. Ober, *Science*, 272, 252 (1996)
5. C.K. Ober, Y.S. Freidzon, H. Zhong, M. Laus, *Chem. Mater.* in press

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Faraday Rotation of a Photogenerated Organic Triplet Molecule in Polyvinyl Alcohol Films

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INTRODUCTION

Faraday rotation experiments on the sodium salt of 2-napthoic acid doped in polyvinylalcohol (PVA) films have been employed to explore the paramagnetic properties of its excited triplet state. To the best of our knowledge Faraday rotation data for an excited electronic state of an organic molecule has not previously been reported in the literature.

The most unique feature of the 2-naphthoate/PVA system is the observed room temperature phosphorescence. Previous research on 2-naphthoate salts adsorbed on cellulose paper support has shown the experimentally determined lifetime of the triplet state to be in the range of 0.5 to 1.0 seconds at room temperature.[1] The observed room temperature phosphorescence is due to the strong hydrogen bonding interaction between the hydroxylic sites on the polymer backbone of the host and the delocalized negative charge on the carboxyl group of the 2-naphthoate salt (Figure 1). The hydrogen bonding greatly reduces the movement of the 2-naphthoate, which hinders the motional quenching of the triplet state[2] and allows for room temperature phosphorescence data to be obtained. In order to measure phosphorescence, photochemists usually have to cool the sample to liquid nitrogen temperatures to form a rigid glass, which reduces collisional effects. The hydrogen bonding environment in the PVA host provides a rigid environment at room temperature, which is similar to the environment found in the low temperature glasses.[1] The unusually long lifetimes of the triplet state, which result from the environment the host provides, make it possible to obtain relatively large steady state populations of the paramagnetic state making it possible to probe the system with Faraday rotation. The transparent nature of the PVA film in the region of visible light also makes it a good host matrix for Faraday rotation measurements.

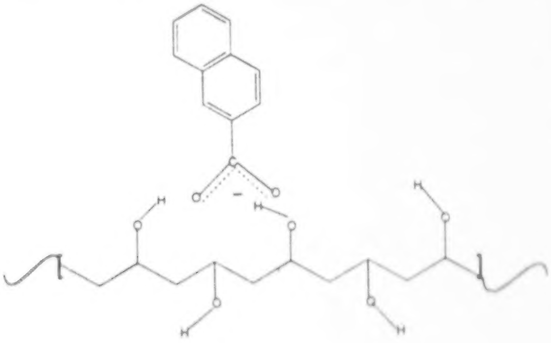

Figure 1. The hydrogen bonding interaction between the 2-naphthoate salt and the hydroxylic sites in the PVA polymer backbone.

Faraday rotation is the amount of rotation detected when a plane of linearly polarized light is rotated by passing through a sample in the direction of a magnetic field. Microscopically, the rotation is created by the unequal splitting of the ground or excited state energy levels due to the applied magnetic field. This rotation is described by[3]

$$\Theta_r = VHL \qquad (1)$$

where V is the Verdet constant (in degrees $gauss^{-1}$ cm^{-1}), H is the magnetic field strength (in gauss), and L is the sample length (in cm) The Verdet constant (V) is a proportionality constant which generally increases as the wavelength of plane polarized light approaches the fundamental absorption wavelength of the sample of interest[3] The magnitude of the Verdet constant is effected by several inherent properties of the sample These properties include the maximum concentration density, the refractive index, and the transition matrix elements[3,4] Since the amount of rotation is directly proportional to the length of light transversing the sample, a longer sample length would normally be desirable In this case, however, the sample thickness also needs to be optimized in regards to generating the excited naphthoate molecules in the sample with an ultraviolet light source

According to Weber[3], the Verdet constant of a diamagnetic substance is determined by

$$V_{dia} = 4\pi^2 N v^2 \sum_b \frac{P(a,b)}{(v^2 - v_{ab}^2)^2} \qquad (2)$$

where V is the frequency of the probe laser, V_{ab} is the electronic absorption wavelength of the sample, N is the number of sample molecules and P(a,b) is a electronic transition matrix element

For paramagnetic molecular systems the Verdet constant is[3,4]

$$V_{para} = \frac{4\pi^2 v^2 \chi}{g\beta ch} \sum_{a,b} \frac{P(ab)}{v^2 - v_{ab}^2} \qquad (3)$$

where β is the electronic Bohr magneton, g is the electron g-value, and χ is the magnetic susceptibility of the sample The other constants have their usual meaning For paramagnetic species χ depends on temperature as[5]

$$\chi = \frac{C}{3kT} \qquad (4)$$

where C is the Curie constant for a specific sample, T is the absolute temperature, and k is Boltzmann's constant As a result, the Verdet constant for paramagnetic species in a sample matrix can be increased by lowering the temperature, while V for the diamagnetic species would remain unchanged

The presence of a rotation of plane polarized light by the triplet state can be described by the effects of the magnetic field on the triplet sublevels In the presence of a magnetic field the triplet state is split into three states with projections of the magnetic moment along the field of $1h\ 2\pi$, $0h\ 2\pi$, and $-1h\ 2\pi$, respectively The contribution of each state to the optical rotation is obtained by dividing the interaction energy by the corresponding excitation energy[4] Even though the interaction energies of the two triplet states with magnitudes $1h\ 2\pi$ and $-1h\ 2\pi$ are equal but opposite in sign, the corresponding excitation energies are slightly different so that the total rotation caused by the three triplet sublevels is different from zero[4] As a result, Faraday rotation data for the excited triplet state of 2-naphthoate has the potential to yield information about the relative energies of the triplet sublevels as well as their populations Information about the triplet sublevel energies and relative populations for 2-naphthoate in the PVA host can be used to learn about the physical properties of the polymer host This data may also serve as a useful experimental model of the excited triplet states of the naphthalene ring system, which is an important paramagnetic probe system used in many recent studies[6,7]

EXPERIMENTAL

Sample Preparation

Naphthoic acid was purchased from Aldrich and purified by fractional vacuum sublimation. The purified acid was then dissolved at an appropriate concentration in standard NaOH solutions. Aliquots of the NaOH solutions were then added to a solution of 99% hydrolyzed 105-110 kdal PVA from Baker dissolved in hot water. The resulting solutions were rotoevaporated to a viscous paste and caste into a film well. Typically films were dried under nitrogen gas for several hours and then left to dry overnight in a vacuum desiccator. The optimum sample dimensions for the Faraday rotation experiment were determined to be a film of 1cm long (along the axis of the Faraday laser probe) and 0.05 cm thick (along the axis of the UV lamp source) at a naphthoate concentration of 2.5 mM. The optimum film thickness and concentration for UV excitation were based on the absorption coefficient for the naphthoate salt at the excitation wavelength.

Phosphorescence Decay Measurements

Phosphorescence decay data was measured with a Lambda Physik M2000 pulsed-nitrogen laser exciting the PVA sample with a 337 nm pulse (4.5 ns in width at ca. 8mJ/pulse). The subsequent emission was recorded from emitted sample light which was focused onto a Hitachi 139 photomultiplier tube (PMT) ($\tau_{RC} < 0.1$ μs). The PMT output voltage was signal averaged on a Tektronix 2221A 100MHz digital oscilloscope with 1 K of data points. The timing of each decay acquisition was controlled by a Keithly System 570 data acquisition workstation which triggered the acquisition of the PMT signal on the scope at ca. 20 ms after triggering the laser pulse in order to avoid averaging any signal from scattered laser light or fluorescence. The room temperature measurements were made inside of an optical cryostat with the sample bathed in room temperature dry nitrogen gas. The low temperature measurements were obtained in the same cryostat with the sample immersed in liquid nitrogen at 77 K.

Faraday Rotation Measurements

The experimental apparatus that was used for Faraday rotation measurements is a modified version of a design described in previous work.[8] A helium-neon laser generates electromagnetic radiation at a wavelength of 630 nm. The resulting light is optically chopped at a lock-in reference frequency of 210 cycles/sec to reduce any external noise received by the detector. The light travels through a plane polarizer and then through a hole bore into the electromagnet where it encounters the sample. The magnetic field strength was measured with a Rawson-Lush rotating coil gaussmeter. The sample is placed between the poles of the electromagnet in a fused quartz dewar. The dewar is connected to a heat exchanger which is filled with liquid nitrogen. Dry nitrogen gas is pumped through the coil in the bottom of the heat exchanger and the cold nitrogen gas is blown over the sample in the dewar. The dewar can also be filled with liquid nitrogen in order to work at 77 K. After the plane polarized light leaves the opposite pole of the magnet it transverses another plane polarizer which is connected to a stepper motor. The stepper motor increases the angle of polarization by 1° at which point the intensity of the light is detected via lock-in amplification and recorded. The paramagnetic triplet state of the 2-naphthoate salt was generated by irradiating the sample perpendicular to the magnetic field direction with a Spectral Energy 500W Hg lamp fitted with a, water filter, 320 nm band pass filter, and a 1 m Oriel light pipe. The polarizer rotates 360° and a computer program records the intensities which are then fitted to a cosine squared curve. A second program computes the angular shift difference between the two minimum values of the curve. The curve is then plotted and analyzed.

DATA ANALYSIS

The phosphorescence decay data at room temperature and 77 K was transferred from the digital scope to a computer and fit to a simple monoexponential decay. The best fit to the decay data at room temperature produced a lifetime $\tau = 1.25 \pm 0.05$ s (where τ is the 1/e time). The best fit of the data at 77 K resulted in $\tau = 1.19 \pm 0.05$ s. A typical room temperature decay is shown in Figure 2.

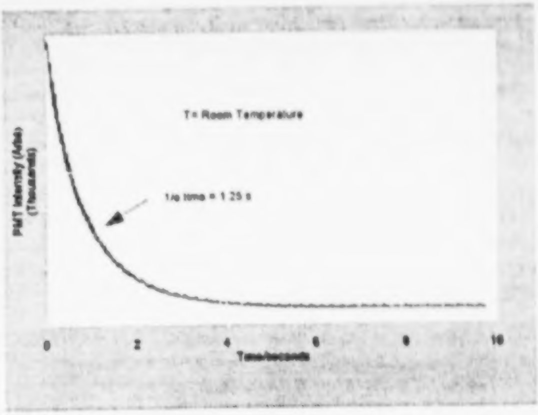

Figure 2. Room temperature phosphorescence decay of 2.5 mM 2-naphthoate in a PVA film.

To determine the faraday rotation of the paramagnetic species, two successive runs were performed both with an applied magnetic field, however, during one run the sample was irradiated with ultraviolet light and during the other run the sample was not irradiated. So the resulting spectra compared the rotation due to the diamagnetic ground state of 2-naphthoate and the paramagnetic triplet state of 2-naphthoate. The rotation spectra acquired with the UV lamp on and off at room temperature showed no observable change in the Faraday rotation due to the paramagnetic triplet state, which is present when the lamp is on. By cooling the samples we expected the value of χ in Equation 3 to increase in magnitude thereby increasing the Verdet constant for the paramagnetic state relative to the diamagnetic state and increasing the observed relative magnetic rotation. The rotation spectra acquired with the UV lamp on and off at 77 K produce a measurable change in rotation of 3.05° ± 0.01°. The Faraday rotation data for the doped PVA sample at 77K is shown in Figure 3.

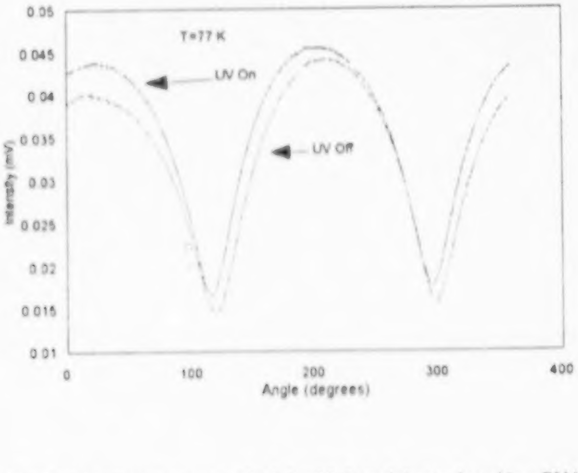

Figure 3. The Faraday rotation spectra for 2.5 mM 2-naphthoate doped in a PVA film at 77 K.

DISCUSSION

The experimental lifetimes of 2-naphthoate in PVA film at room temperature are in agreement with what is known in the literature for 2-naphthoate on paper support.[1] Clearly the PVA film is providing an environment which is as rigid as the paper host for the naphthoate salt. The fact that τ does not change significantly in going from room temperature to 77 K indicates that the rigid nature of the PVA host has not changed in regards to restricting the motion of the probe molecule. Apparently, the hydrogen bonding interactions between the salt and the PVA film are so dominant that any changes in the polymer density with temperature are relatively insignificant.

Using Equation 1 the Verdet constant was calculated to be .10±0.05 minutes/(gauss cm). Although there is no precedent in the literature to compare this result to, literature values for the Verdet constant of similar diamagnetic organic molecules are ca. five orders of magnitude larger for the neat solids.[9] The dilute concentration of the naphthoate salt can account for ca. 3-4 orders of magnitude difference in the Verdet constant, which reflects a steady-state population of the excited triplet state of 1% to 10% of the ground state. This is at least reasonable.

In Figure 3 the intensities of the non-irradiated spectrum and the irradiated spectrum are different. The extinction angles do not reach zero on the intensity scale. Possible explanations may be that either scattering of the laser light was occurring in the polymer medium or that the light had become elliptically polarized. Elliptical polarization occurs because of unequal absorption by the medium of the left and right components of circularly polarized light resulting in some amount of probing light reaching the detector at the extinction angles. It is probable that both of these explanations occurred because each comparative run was accomplished with the sample in the same location.

ACKNOWLEDGEMENTS

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REFERENCES

1. Schulman, E. M., Walling, C., *J. Phys. Chem.*, **1973**, *77*, 902
2. Turro, N. J., "Modern Molecular Photochemistry," **1978**, Benjamin/Cummings, Menlo Park, Ca, pp. 127-130
3. Weber, M. J., *SPIE Proc.*, **1986**, *681*, 75
4. Brown, S. H.; Ying-Nan, C., *J. Chem. Phys.*, **1978**, *69(8)*, 3579
5. Alberty, R. A., Silbey, R. J., "Physical Chemistry," John Wiley & Sons, New York, N.Y., **1992**, 516
6. Ghosh, S.; Petrin, M, Maki, A.; Sousa, L., *J. Chem. Phys.*, **1987**, *87(8)*, 4315
7. Ramamurthy, V.; Eaton, D. F.; Casper, J. V., *Acc. Chem. Res.*, **1992**, *25*, 299
8. Boehly, C. R., Bewicke, M. M., Knop, J. M., *NCUR VI Proceedings Volume II*, R. D. Yearout editor, **1992**, 1189
9. Lide, D. R., "CRC Handbook of Chemistry and Physics," 73rd ed., CRC Press, Inc., Boca Raton, FL, 3-637

HPLC Analysis of Eicosanoids in Response to Valproic Acid (VPA), Endotoxins (LPS) and Tumor Necrosis Factor (TNF)

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Valproic acid(VPA) is an anticonvolsant drug that is associated with a rare, but serious liver toxicity. It has been suggested that a prodromal infection may play a role in the development of this hepatotoxicity. Recent studies in rats have shown that VPA increases the lethal toxicity associated with bacterial endotoxin(LPS) and tumor necrosis factor(TNF). Eicosanoids, prostaglandins and leukotrienes, are known mediators of the normal response to an infectious illness. An on-line extraction, reverse phase high-performance liquid chromatography (HPLC) procedure has been developed to investigate the hypothesis that eiconsanoid concentrations are altered by treatment with combinations of VPA and TNF. Rat eicosanoid production is altered by *in vivo* treatment with VPA, TNF, and VPA-TNF combinations. Future studies will investigate the effects of VPA and TNF on eicosanoid production in rats.

INTRODUCTION

Valproic acid(VPA) is an anticonvulsant drug associated with a rare but serious human liver toxicity syndrome. It has been suggested that a prodromal infection may play a role in the development of this hepatotoxicity. Recent studies in rats have shown that VPA increases the lethal toxicity of bacteria endotoxin(LPS) and tumor necrosis factor(TNF). (Stephens et al, submitted for publication) Circulating endotoxins result in the release of eicosanoids, cell mediators, from blood cells, vascular endothelial cells, and smooth muscle cells. Eicosanoids are ubiquitous, potent vasoactive compounds with important cellular effects and most have one or more pathophysiologic effects consistent with involvement of mediators of circulatory shock and associated cardiovascular derangement. (Bottoms et al.,1995) An on-line extraction, reverse-phase HPLC procedure was developed to measure the changes in rat plasma concentrations of eicosanoids in response to treatment with VPA, TNF, and combinations of VPA and TNF.

OBJECTIVES

The objective of this work is to develop a technique which separates and measures eicosanoid standards using on-line extraction, reverse phase HPLC and to analyze eicosanoid concentrations in plasma obtained from Sprague-Dawley rats treated in-vivo with VPA, TNF or the combination of VPA and TNF.

METHOD

Sprague-Dawley rats were divided equally into four treatment mg/kg, i.p.) and TNF (17.5 mg/kg, i.v.) Blood samples were obtained 2 hours after treatment. Blood plasma was obtained by centrifugation and frozen at -20°. 200 µL of plasma from each sample were treated with 700 µL of MeOH, 4.0 mL of H_2O, and 100 µL CH_3CN:MeOH (1:1) containing 125 ng/mL of PGB_2. Following overnight storage at -20°, samples were centrifuged at 2000 g for 20 minutes. The supernatant was removed and immediately subjected to on-line extraction and HPLC analysis or placed at 4° until analysis.

The extraction column, a LICHROSPHERE RP-18 5 MICRON guard column, was equilibrated with 7.4 mL pre-wash solvent (2.5mM $H_3PO_{4(aq)}$:MeOH (85:15)). The 5 mL sample was pumped onto the extraction column with an Altex Model 110 A pump. The extraction column was washed with a total of 6 mL of pre-wash solvent. The sample was then injected onto the analytical column, LICHROSPHERE 100 RP-18 N-ENCPD 54 - 150mm x 4.6mm.

The initial HPLC conditions were 25% Solvent A (H_2O:CH_3CN:TFA, 70:30:0.04), 75% Solvent B (H_2O:CH_3CN:MeOH:TFA, 20:60:20:0.05) at a flow rate of 0.75 mL/min. A linear solvent gradient was run from 75% Solvent B to 100% Solvent B over 20 minutes. The detector wavelength, initially set at 280nm to detect prostaglandins and leukotrienes, was changed to 237nm at 15 minutes in order to detect HETEs. Data were collected for 25 minutes.

RESULTS

An on-line extraction, reverse phase HPLC procedure was designed which successfully separated seven eicosanoid standards, fig. 1. The procedure, based on one developed by Yu and Powell(1995), involved a 20 minute linear gradient and a lambda shift from 280nm to 237nm at the 15 minute mark. PGB_2, LTC_4, LTD_4 and LTE_4, absorbed at 280 nm and eluted at 7, 10.5, 12 and 12.9 minutes respectively. 5-hete, 12-hete and 15-hete, absorbed at 237nm and eluted at 17.4, 19.1 and 20.8 minutes respectively. Figure 2-5 displays eicosanoids present in the plasma of rats treated with saline, VPA, TNF and VPA-TNF. Changing concentrations of eicosanoids create a unique pattern for each treatment. Notably, peaks appear at 13.1, 21.6 and 22.3 in all rats treated with VPA or VPA and TNF relative to untreated rats. There is a significant increase in peak 10.8 among rats treated with TNF. Further, there is an increase in peak 10.8 between rats treated with TNF and VPA-TNF. Lastly, there is a notable difference in peak 4.1 between untreated rats and rats treated with TNF of VPA-TNF.

CONCLUSION

An on-line extraction, reverse phase HPLC technique was developed which successfully separated and measured seven eicosanoid standards.

Analysis of rat plasma samples suggest that rat eicosanoid production is altered by *in vivo* treatment with VPA, TNF and VPA-TNF. The variety of differences in eicosanoid concentrations provide enough information to warrant further investigation of the effects of VPA and TNF on eicosanoid production.

REFERENCES

Bottoms, Gerald D and Adams, Richard., JAVMA, Involvement of prostaglandins and leukotrienes in the pathogenesis of endotoxemia and sepsis. Vol 200, June 1992, 1842-1848.

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Henden, Strand, Borde, Semb and Larsen,. Prostaglandins Leukotrienes and Essential Fatty Acids, Measurement of Leukotrienes in Human Plasma by Solid Phase Extraction and High Performance Liquid Chromatography, Vol 49, 1993, 851-854.

Stephens, Mather, Knasiak, Liggitt and Levy. The effect of VPA on the lethal toxicity of Endotoxin and Tumor necrosis factor, submitted fo publication.

Yu and Powell,. Analytical Biochemistry, Analysis of Leukotrienes, Lipoxins, and Monooxygenated Metabolites of Arachidonic Acid by Reversed-Phase High-Pressure Liquid Chromotography, Vol 226, April 1995, 241-251

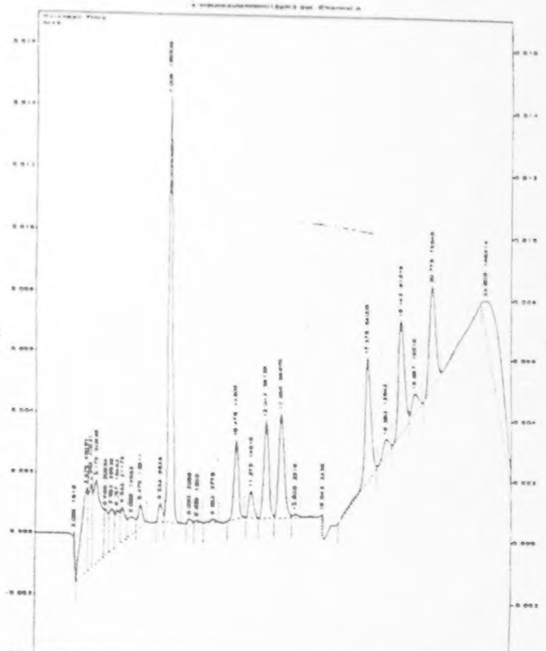

Figure 1

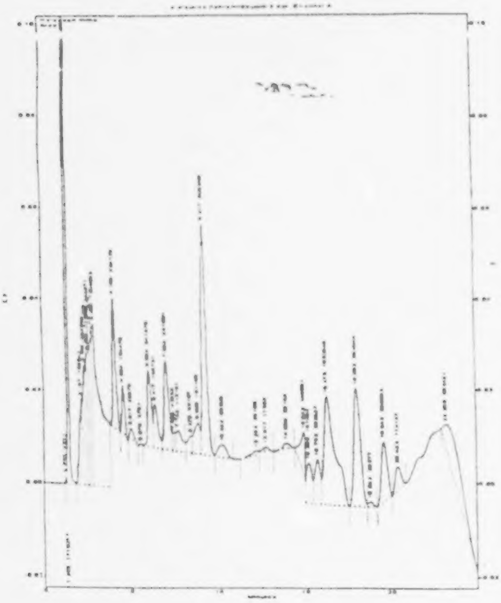

Figure 2, Rats Treated with Saline

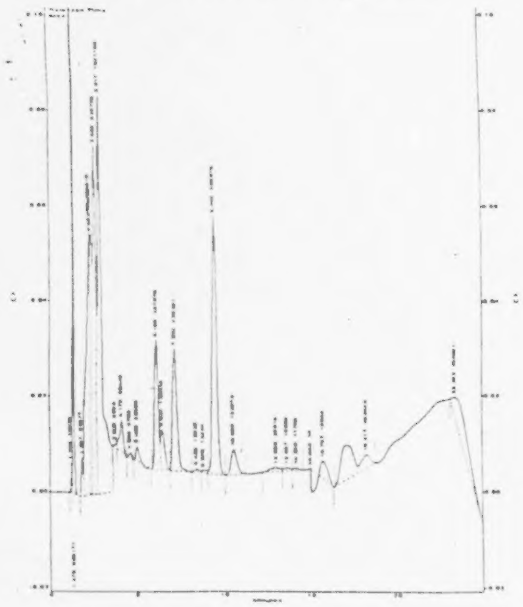

Figure 3, Rats Treated with TNF

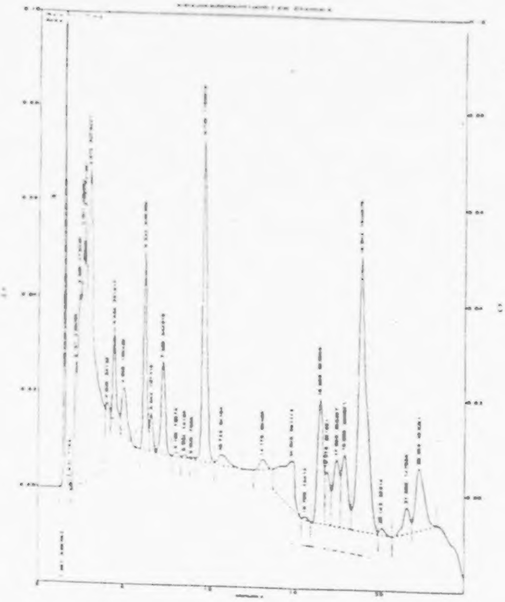

Figure 4, Rats Treated with VPA

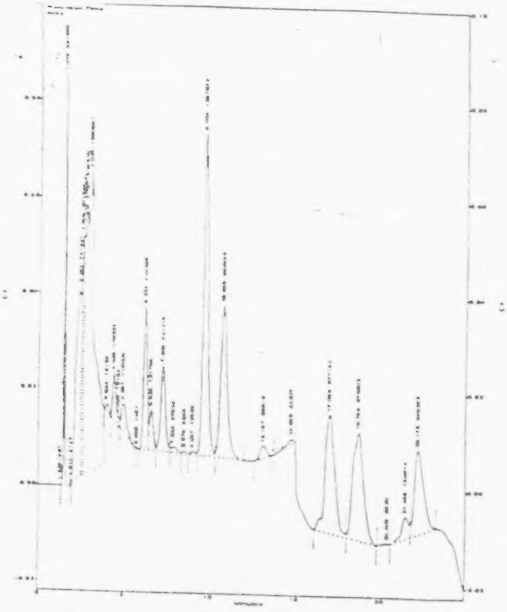

Figure 5, Rats Treated with VPA-TNF

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Preparation of an Iron Complex of Pyo$_2$[18]dieneN$_6$.

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ABSTRACT

Macrocyclic ligand chemsitry has been a recent field of interest combining organic and inorganic chemistry. New and traditional techniques of organic synthesis have been derived to make a wide variety of macrocycles that can bind numerous cations. This study has focused on the iron chelating properties of a polyazamacrocycle with six nitrogen donors.

The synthesis and identification of an iron complex of (pyo)$_2$[18]dieneN$_6$. (3,6,14,17,23,24-hexaazatricyclo[17.3.1.]tetracosa-1(23),8,10,12(24),19,21-hexane) is reported. A previous synthesis was refined in which the complex was formed from reactions of pyo$_2$[18]dieneN$_6$ with iron(II) sulfate and was isolated as a sulfate salt. The spin and oxidation state of Fe were confirmed through magnetic susceptibility tests. Infrared spectra are consistent with the presence of ligand pyo$_2$[18]dieneN$_6$ in the complex. While the compound has yet to be obtained pure, preliminary elemental analysis results are consistent with the other characterization data. A discussion of future goals for the resolution of the enantiomers is included.

INTRODUCTION

Macrocyclic ligands that bind metals have several applications including metal extraction and modeling for metal binding proteins. Hemoglobin and chlorophyll are two examples of metal binding proteins that contain macrocyclic ligands. Stable macrocyclic ligands have also been used in medical imaging and chemotherapy.[1] The (pyo)$_2$[18]dieneN$_6$ ligand is of particular interest because when coordinated it has helical topology which is a fundamental structure in nature as seen in proteins and DNA.[2]

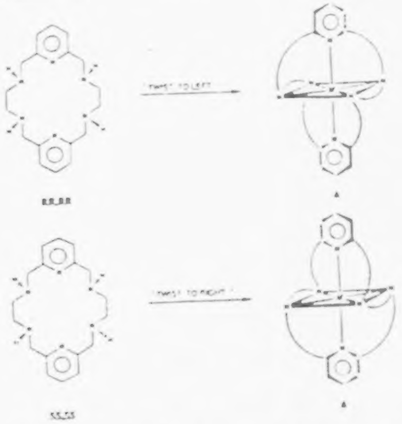

Figure 1. (pyo)$_2$[18]dieneN$_6$ isomers and the helical morphology of the enantiomers in the "right" and "left" octahedral wrap.

The polyaza macrocycle, $(pyo)_2[18]dieneN_6$, and its complexes with several metals have been synthesized and reported.[3] Polyaza macrocycles have recently received much attention; triaza and tetraaza macrocycles have been extensively studied in coordination chemistry and more recently macrocycles with N = 5 or 6 have been of interest, where N is the number of coordinating nitrogens.[4] $Pyo_2[18]dieneN_6$ is intriguing because it was found to bind a variety of metals, and in some cases more strongly than the closely related and previously studied $[18]aneN_6$.[3] Furthermore, the metal complexes found to have a unique structure.

The presence of pyridine rings is presumed to add stability to the coordination by contributing favorably to the enthalpy and entropy. Some possible explanations for these effects are detailed by Rothermel et al. The enthalpy of coordination might be favored due to the larger dipole moment of pyridine compared to secondary amines. Second, pyridine may relieve potential steric hindrance caused by ortho hydrogen atoms since it is connected to the macrocycle through the 2,6 position. Thirdly, the pyridine rings may preorganize the ligand for coordination by effecting a rigid structure.

The ability for this ligand to bind metals of varying sizes led to the hypothesis that the macrocycle could wrap and unwrap to accommodate differently sized cations. Rothermel et al. found that the planarity and rigidity produced by the two pyridine rings limited the structure to wrap only in the meridional mode. When bound to a metal, the $(pyo)_2[18]dieneN_6$ twists in Δ and Λ helical forms. This produced D_2 symmetry corresponding to a hexacoordinated pseudooctahedral wrap.[3] Bryant et al. measured the angle of wrap of the ligand bound to several different metals including alkaline earth, transition, and lanthanide metals. As predicted, the angle changed with the size of the metal.[7]

Since the ligand can twist in either of two directions it forms two enantiomers. Bryant et al. resolved the enantiomers by separating diastereomeric salts of barium (+)-tartrate. The resulting diastereomers were separated based on their differing solubilities.

Each metal introduces a unique chemistry. This current study continues the previous work by exploring the ligation of $(pyo)_2[18]dieneN_6$ with a new cation. This project investigates the synthesis and characterization of the macrocyclic iron complex, $[Fe((pyo)_2[18]dieneN_6)]^{2+}$, isolated as a bisulfate salt.

EXPERIMENTAL

The preparation of $(pyo)_2[18]dieneN_6$ was done according to published methods.[1,3] Chemicals were reagent grade and used as purchased.

Preparation of $[Fe((pyo)_2[18]dieneN_6)]^{2+}$

Equimolar amounts of $(pyo)_2[18]dieneN_6 \cdot H_2O$ and $FeSO_4 \cdot 7H_2O$ (0.745 mmol) were dissolved in anhydrous methanol(10 ml). The mixture was heated for 45 minutes during which color of the cloudy solution changed from a deep red to a reddish brown. Once the solution had cooled the reddish precipitate was collected through suction filtration, washed with cold MeOH and dried in a vacuum desiccator. The dried product was a rust color. (Yield, 24%)

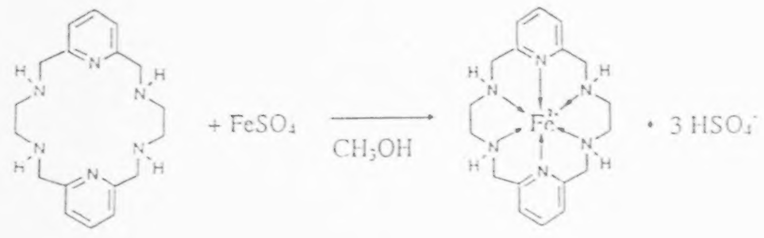

Figure 2. Synthesis of the iron complex

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Infrared spectra were collected using a diffuse diffraction apparatus on a Perkin-Elmer Paragon 1000. The solid sample was mixed in KBr.

The Evans Balance was used for magnetic susceptibility measurements.

CHARACTERIZATION

The methods attempted for characterization of the product include IR spectroscopy, NMR spectroscopy, magnetic susceptibility, and elemental analysis.

Infrared spectral results. (KBr pellet, (cm-1)) v_{C-H} aromatic, 3146 (w); v_{C-H} aliphatic, 2939, $v_{C=N}$ and $v_{C=C}$ 1573, 1455, v_{SO} 1110 - 1130.

Proton nuclear magnetic resonance. The bands were broadened due to the paramagnetic effects of iron.

Magnetic susceptibility tests. The magnetic susceptibility, $X_g = 0.663 \times 10^{-6}$ cgs/g. To calculate the spin state, a correction for diamagnetic contribution of other atoms in the molecule is required. The result, X_A is used in determining a value for the spin state, $\mu_{eff} = 2.828(X_A T)^{1/2} =$ 0.86 BM. This number was compared to the known values for the spin states of iron.

DISCUSSION

Elemental analysis was not completed in this study due to difficulties in recrystallizing the product. The product which is either a sulfate or bisulfate salt was not soluble enough in any solvent for thorough recrystallization. This problem may also affect other results for the characterization of the salt.

In a previous unpublished study that attempted synthesis of the complex using ferrous sulfate or ferric sulfate, it was shown through magnetic susceptibility tests that the product form each synthesis was the same. An elemental analysis was attempted with the ferrous sulfate crude product. The results indicated that the product was most likely a tris-bisulfate salt. This would indicate that the iron was in the 3+ oxidation state.

Further evidence for the 3+ oxidation state and conclusion that the product is a tris-bisulfate salt is given by the yield results. In the preparation of $[Fe((pyo)_2[18]dieneN_6)]^{3+}$, the ratio of iron(II) to sulfate in the ferrous sulfate is 1:1. In the proposed tris-bisulfate product, the ratio of iron(III) to sulfate is 1:3. Therefore, at most one would expect a yield of 33% of the expected iron complexes since the limiting reagent is the bisulfate. The observed yield was around 24%. The iron is oxidized from 2+ to 3+ in the reaction, most likely by O_2 in the air. It is well known that iron(II) can be easily oxidized presence of oxygen. We did not attempt the reaction under an inert gas.

When NMR spectroscopy was attempted in the previous study the peaks were distorted. This is due to paramagnetism of the iron. To further study the magnetic moment of the iron, magnetic susceptibility measurements were made. The results indicated that the product was paramagnetic. If the Fe is in the 3+ state, then the results indicated that the spin state is low, so the iron(III) is in the t_2g^5 state. The number 0.86 BM is compared with known values for the spin states of iron(III). The range for low spin iron(+3) is 2.2 - 2.7 BM. The observed experimental value of 0.86 BM is somewhat lower than the accepted range and the discrepancy could be due to incomplete purification.

The reported IR results give evidence for the presence of the $(pyo)_2[18]dieneN_6$ ligand and the bisulfate salt.

The proposed 3+ oxidation state and low spin state for the iron is supported by the fact that iron prefers these states when in complexes with the strong chelating amines 2,2-dipyridil and 1,10-phenanthroline. Furthermore, the most stable binding state for iron(III) is octahedral. As discussed in the introduction the $(pyo)_2[18]dieneN_6$ ligand coordinates with the metal in a pseudooctahedral wrap.

CONCLUSIONS

The completed characterization tests indicate that the preparation of $[Fe((pyo)_2[18]dieneN_6)]^{3+}$ as a bisulfate salt was successful. The insolubility of the crystals prevented thorough purification of the product, so some error may have been introduced into the characterization tests.

Future goals include purification and upon success elemental analysis. Purification will be attempted by exchanging the bisulfate anion for a tartrate anion. The procedure will also lead into prevented thorough purification of the product, so some error may have been introduced into the characterization tests.

Future goals include purification and upon success elemental analysis. Purification will be attempted by exchanging the bisulfate anion for a tartrate anion. The procedure will also lead into resolution of the two enantiomers of the iron complex. The + tartrate salt diastereomers can be resolved based on their differences in physical properties.

ACKNOWLEDGEMENTS

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REFERENCES

1. Fitzsimmons, P.M., & S.C. Jackels, *Inorganica Chimica Acta*, 1996, 246, 301-310.
2. Bryant, L.H., et. al., *Inorganic Chemistry*, 1995, 34, 4230-4238.
3. Rothermel, G.L., et. al., *Inorganic Chemistry*, 1992, 31, 4854-4859.
4. Wilkinson, Sir Geoffrey, Comprehensive Coordination Chemistry, Volume 2, Pergammon Press, New York, 1988.

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The Plasma Etching of Metals and Metal Compounds

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ABSTRACT

Historically, pattern transfer technology in microdevice synthesis (e.g. the manufacturing of integrated circuit chips) has used aqueous (water based) wet etching technology. Increasingly, gas phase plasma dry etching is necessary for the fabrication of the very small features of modern microdevices. With plasma dry etching, like many of the other processes currently used in the semiconductor industry, technology has advanced so rapidly that a clear understanding of the underlying scientific principles have not kept pace for many etching processes. Most kinetic studies in the literature focus on silicon. Etching many metals is also often a critical issue in microdevice synthesis. The current study proposes to investigate the kinetics of the plasma dry etching of titanium and tungsten. The etch rate, halogen and metal atom concentration in the gas phase will be determined as a function of the etch gas pressure and composition.

INTRODUCTION

In recent years, the microcomputer industry has been expanding rapidly. With this expansion has come a staggering wave of advancement in the production of computer chips. The scale on which the circuitry of a cutting-edge microchip must be manufactured is often in the micrometer range (Sze,1988). This clearly requires the use of methods which go beyond direct manipulation of wires by humans or even precision machinery. Plasma etching is just such a method.

In making a computer chip, a thin metal film is deposited on a semiconductor substrate in a process called chemical vapor deposition (CVD,) a chemical reaction outside the scope of this project. The thin film is covered by a non-reactive mask in the shape of a circuit the manufacturer intends to produce. The chip is then subjected to the plasma etching reaction. The process of plasma etching, the chemical reaction being studied in this project, involves the removal of small amounts of metal from a sample reactive gas. The parts of the metal layer not covered by the mask are etched away, and when the mask is removed, the portion of the film covered during etching is left behind as a thin film circuit. These processes are used to deposit layer after layer of metal on a silicon substrate to form the microscale electrical connections necessary for modern microcircuitry.

The plasma etching of titanium and tungsten are of importance to microchip manufacturers. Tungsten is frequently used as a material to form connections between the different areas of the microchips, i.e. in microcircuit interconnects. Titanium is proposed as a diffusion/adhesion barrier if, in the future, copper replaces tungsten as an interconnect material. Copper has an inherent advantage as a microcircuitry material because of its low electrical resistivity. This allows for smaller wire, and hence a more complex, faster circuit. The only drawback is that copper tends to have difficulty adhering to silicon surfaces, and when it does, the metal atoms diffuse into the silicon, making for an unreliable connection. If a layer of titanium is deposited on a silicon surface, and then the copper on top of that, the titanium layer serves the dual purpose of aiding adhesion, and preventing diffusion (Sze, 1988), hence this titanium layer is referred to as a diffusion/adhesion barrier.

Although the etching of these metals is of great importance to industry, the reaction process is not very well understood. It is known that if an electrical discharge is applied to a low pressure gas flow system, a mixture of charged and neutral reactive gas species known as a plasma results. Light emitted from the glowing plasma can be used in emission spectroscopy to determine the concentration of various gaseous species in the plasma. Absorption spectroscopy can also be used to probe plasma chemistry. It is suspected that reactive gaseous species in the plasma combine chemically with the metal sample forming a gaseous metal compound as a product. If light passes through the plasma in a region where these gaseous metal atoms are present, wavelengths of light corresponding to atomic absorption lines will be absorbed, and in situ atomic absorption spectroscopy can then be used to determine the metal atom concentrations. Details of the reaction scheme remain a mystery in the case of tungsten and titanium. The purpose of this project is to develop a kinetic model or reaction mechanism for the plasma etching of titanium and/or tungsten.

EXPERIMENTAL

The apparatus used in this project consists of a Pyrex glass reaction cell, which is kept at a pressure of 0.1 to 0.3 torr by a vacuum pump. The reaction gases used were CF_4, $CFCl_3$, CF_2Cl_2, CHF_3, SF_6, or BCl_3. The gas is flowed through the system at a steady rate regulated by MKS mass flow controllers. With the gas flowing, a current is applied to two parallel plate electrodes inside the reaction cell. The current alternates at a radio frequency (13.6 million cycles per second) and has a power of about 50 watts. This current dissociates the gas molecules into both electrically charged reactive gas species (ions) and electrically neutral gaseous free radicals. This mixture of reactive gaseous species, the plasma, reacts with a bulk metal sample etching a layer of metal atoms off.

In this project, the metal sample (titanium or tungsten foil) is weighed, and then placed on the bottom electrode and allowed to react with the plasma for a determined amount of time. When the sample is removed, it is weighed again. The amount of metal removed per unit time is called the etch rate, and is used as an indicator of the reaction rate of the plasma with the metal.

$$\text{Etch Rate} = \frac{\text{(change in sample mass)}}{\text{(etching time) (sample density) (sample surface area)}} \qquad (1)$$

Emission spectroscopy measurements were taken using a Princeton Applied Research model 1450 photodiode array plasma monitor to determine the concentration of the primary reactive etching species (halogen atoms). The F-atom and Cl-atom concentration were assumed to be proportional to the intensity of emission lines at 755 nm and 728 nm respectively.

Atomic absorption spectroscopy data was obtained by passing light from a titanium hollow cathode lamp through the reaction cell during etching. The 399.8 nm emission from the lamp is absorbed by gas phase Ti-atoms present in the cell. The concentration of these Ti atoms can be determined using Beer's law:

$$\ln (Io / I) = \sigma \, l \, c \qquad (2)$$

where Io is the intensity of the light before absorption, I is the light intensity after absorption occurs in the plasma, σ is the effective cross section which is estimated from electronic transition probabilities to be about $1*10^{-12}$ atoms/cm2 (Halstead et.al. 1990,) l is the length of the light's path in which metal atoms, and hence absorption, will occur (for this project, it is assumed that metal atoms can only exist between the electrodes, so l is the length of the electrodes: 7.5 cm.) C is the concentration of metal atoms in the given region.

RESULTS/DISCUSSION:

In a typical experiment, the etch rate, metal atom and halogen atom concentration were determined as a function of various other system parameters including gas flow rate, type of gas mixture, system pressure, and amount of electrical power.

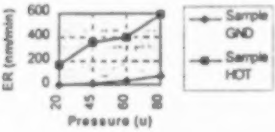

Figure 1: hot and gnd etch rates

As shown in figure 1, etch rates in which the metal sample was in direct contact with the powered (hot) electrode were more than an order of magnitude higher than etch rates during experiments in which the sample was on the grounded electrode. Presumably, the interaction of the charged particles with the metal to is greater when the sample is in contact with the hot electrode since there is electrostatic attraction between gaseous ions and the charge on the electrode. The increased etch rate when this is the case supports the argument for including some kind of interaction with charged gas particles in the plasma etching reaction mechanism. An in depth discussion of the role of ions in the physical removal of metal during plasma etching of silicon is presented by G. Hancock 1994, J.W. Coburn 1994, and W. Yoo, et. al. 1994.

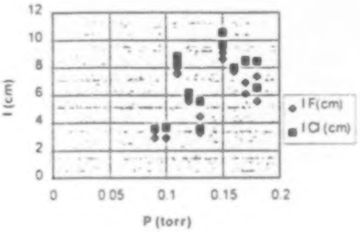

Figure 2: halogen concentration vs. P

Using the emission and absorption spectroscopy techniques described earlier, the fluorine and chlorine atom concentrations in a CFCl3 plasma were measured concurrently with the etch rate and gas phase titanium-atom concentration during an etch. Figure 3 shows that the intensity of both F-atom and Cl-atom emission intensity increases with the pressure of the etch gas (CFCl3.) and hence on the halogen atom concentration in the plasma. There is also a possibility that a double peak in X-emission intensity exists, with one maximum around 0.11 torr, and one around 0.15 torr.

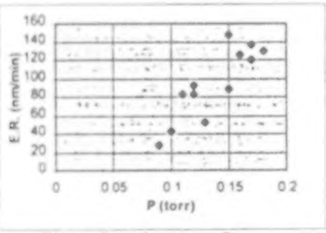

Figure 3: etch rate vs. P

As shown in figure 3, the etch rate also increases with the pressure of CFCl, and exhibits the double maxima around 0.11 and 0.15 torr. This supports the presumption that halogen atoms are the primary initial reactive etching species.

In a previous study of Ti etching with SF6, by Halstead et.al. 1990, it is proposed that F free radicals react at the surface of the metal to produce TiF, which dissociates in the plasma leaving gaseous Ti atoms.

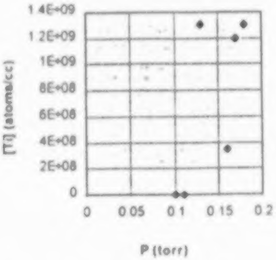

Figure 4: gas phase [Ti] vs. P

Absorption spectroscopy data summarized in figure 4 shows an increase in gas phase Ti atom concentration over the pressure range studied, and once again a double maximum in roughly the same area as the maxima of X-emission and etch rate. This verifies the presence of Ti atoms in the plasma, and solidifies the connection between halogen atom concentration and etch rate.

It is known that varying the oxygen concentration has a significant effect on the concentration of fluorine radicals in the plasma (Kim, et.al. 1995) The results presented in figures 5 and 6 show that oxygen content of the etch gas mixture significantly affects the etch rates of both titanium and tungsten respectively in a CF4 plasma.

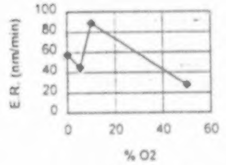

Figure 5: Ti E.R. vs. %O2

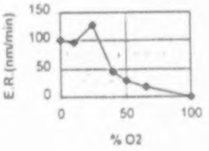

Figure 6: W E.R. vs. % O2

CONCLUSION:

Features of the plasma etching reaction were studied by varying the system's parameters. The fluorine and chlorine atom concentration under various reaction conditions were examined using emission spectroscopy. Absorption spectroscopy was used to determine the concentration of gas phase Ti-atoms in the etching plasma, and support the finding that etch rate increases with halogen atom concentration. It has also been verified that introduction of oxygen into an etching plasma significantly affects the etch rates of both W and Ti. From the data, a kinetic model of the etching mechanism will be constructed. This will provide useful insights into the reaction process of plasma etching. Among them, whether fluorine atoms are enough to account for the etching reaction, or whether some other species are involved.

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REFERENCES:
J.W. Coburn, *J.Vac. Sci. Technol.* 12, 1417, 1994
J.W. Coburn, M. Chen, *J.Appl.Phys.*, 51, 3134, 1980
J.A. Halstead, R.R. Reeves, M. Rutten, S. Ramaswami, P. Roessle, *J. Electrochem. Soc.* 137, 3517, 1990
G. Hancock, L. Lanyi, J.P. Sucksmith, J.B. Woodcock, *Pure & Appl. Chem*, 66, 1207, 1994
J. Kim, Y. Kim, W. Lee, *J.Appl.Phys*, 78, 2045, 1995
S.M. Sze, VLSI Technology, McGraw Hill, 1988
W.J. Yoo, C. Steinbruchel, *J.Vac. Sci. Technol.* 12, 2758, 1994

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Pipelines and Potential Disaster
An Introduction to Cathodic Protection

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Society's continued dependence on fossil fuels, such as crude oil and natural gas, necessitates that there be a mode for safe, dependable transmission of these fuels The method most often used to move huge quantities of oil and gas is through an extensive system of underground metal pipelines Because these transmission lines are hidden from our view, few of us ever consider the potential danger lurking beneath the surface The natural process of oxidation-reduction (corrosion), over time, will cause metal pipes to fail, resulting in tremendous losses An electrochemical approach, cathodic protection offers a simple, cost-efficient means of insuring pipeline reliability, thus safeguarding human life and our environment

INTRODUCTION

Beneath concrete and asphalt, our pasturelands and waterways, lie a maze of oil and gas transmission lines This network is so vast in its scope, encompassing large sections of the land and water we depend on for our continued subsistence, that we cannot afford to behave irresponsibly in its maintenance

Of primary importance in the effort to maintain safe, reliable transmission lines, is the necessity of dealing with the perpetual threat of corrosion and eventual degradation of those metal lines Cathodic protection has been the method used most often to protect metal in buried fuel tanks and pipelines, employing the basic concept of a galvanic cell, with a cathode and anode [1] Simple in approach, cathodic protection halts the natural process of metal to metal ion loss from pipe to its surrounding electrolyte through installation of one of two types of systems galvanic or impressed current [2] Either of these systems produce sufficient levels of protective current that serve to polarize the cathodic area (pipeline) in relation to the anodic area (the galvanic or impressed systems) establishing an equilibrium, thus preventing further flow of ions from the metal into solution [3]

Oxidation-Reduction Reactions

The chemical reaction responsible for corrosion of metals is referred to as an oxidation--reduction reaction, or redox reaction[4] which describes the chemical process of corrosion of metal pipelines Prior to installation of a cathodic protection system, a pipeline will contain corrosion cells, with each cell containing a cathode and an anode Left unprotected, metal ions are lost (oxidation) at the anodic areas, with acceptance of electrons (reduction) occurring at the cathodic areas (See equations 1-3)

Half-reaction at the anode $2Fe \dashrightarrow 2Fe^{2+} + 4e^{-}$ (oxidation) (1)
iron ------> dissolved iron ions + electrons

Half-reaction at the cathode $O_2 + 2H_2O + 4e^{-} \dashrightarrow 4OH^{-}$ (reduction) (2)
dissolved oxygen + water + electrons ------> hydroxide ions

Total reaction $2Fe + O_2 + 2H_2O \dashrightarrow 2Fe^{2+} + 4OH^-$ (3)
iron + dissolved oxygen + water ------> dissolved iron ions + hydroxide ions

Once cathodic protection is implemented, contrasting application may be made with oxidation taking place at the anode(s) of the system and reduction occurring at the pipeline [5]

Galvanic System

The galvanic (sacrificial) system of cathodic protection is usually applied when required levels of current needed for pipeline protection and electrolyte (soil or water) resistivity is low [6] Adequate protection is achieved by utilizing a metal more reactive to oxidation than the metal to be protected as the sacrificial anode, and connecting it to the pipeline by a wire Because the sacrificial metal is a better reducing agent (more easily oxidized) than the iron pipe, needed electrons are supplied from the anode, flowing through the wire to the pipe, preventing oxidation of the pipe and further loss of metal [7] (See figure 1)

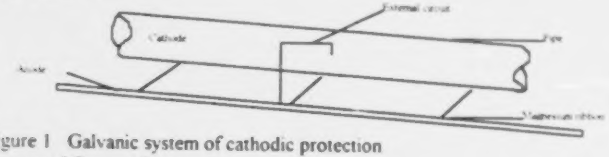

Figure 1 Galvanic system of cathodic protection

Impressed Current System

Impressed current systems are employed when current requirements and resistivity of the electrolyte are high, necessitating that dc voltage levels be adjusted to fit specific conditions Adequate levels of protection are achieved through installation of a transformer rectifier control unit and several anodes These anodes, placed in the electrolyte and joined to the positive terminal of the rectifier with a wire, provide a flow of electrons that pass through the rectifier, out its negative terminal, and on through another wire to the metal pipe [8] (See figure 2)

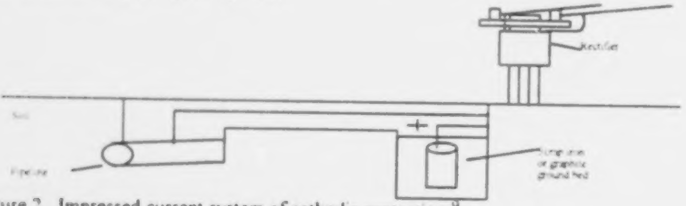

Figure 2 Impressed current system of cathodic protection [9]

Brief History of Cathodic Protection

The concept of protecting metal from ion loss is not a new one As early as 1823, Sir Humphrey Davy was commissioned by the British Admiralty to examine the corrosion of the copper sheathing on their naval vessels By 1824, Davy reported that the loss of copper could be decreased by using sacrificial blocks of iron coupled to the hulls of the ships, effectively halting further ion loss into the surrounding salt water [10] So efficient was this method that marine growth (formerly poisoned by copper ions going into solution) multiplied upon the hulls of British vessels and reduced their speed, prompting the Admiralty to decide against it After Davy's death in 1829, his cousin, Edmund Davy, employed methods of localized protection of iron buoys with zinc anodes Yet, overall cathodic protection of marine vessels was not examined again until about 1950, this time by the Canadian Navy With the use of antifouling paints in combination with anticorrosion paints, it has been proven that it is possible to cathodically protect ships and considerably lessen maintenance costs [11]

With the availability of AC current, impressed cathodic protection systems of metal underground structures took place in England and in the United States, about 1911 By the 1930's, most, if not all of the major pipeline companies were, to some degree, using cathodic protection and coatings to protect their pipelines from corrosion [12]

Cost of Corrosion

The cost of metallic corrosion extends far beyond the estimated $300 billion spent in the United States each year on both direct and indirect losses, which include shutdowns, loss of product, loss of efficiency, contamination, and over-design. Gas pipeline incidents, at a high of about 400 in 1970 and a low of around 60 in 1989, each resulting in serious injury and fatalities to humans, as well as damage to the environment, are losses that cannot be measured in dollars and cents.[13] Corrosion and Cathodic Protection engineers, working with N.A.C.E. (National Association of Corrosion Engineers), the petroleum industry, and the U.S. Department of Transportation, have contributed immensely to the current decreases in pipeline failures within the United States.[14]

CASE HISTORIES OF PIPELINE DISASTERS

Technical descriptions of corrosion and cathodic protection, though informative, are inadequate in depicting the reality of what occurs when high-pressure oil and gas transmission lines are not consistently maintained. The December 9, 1987 issue of the Tulsa World reports that the Williams Pipe Line Company had been fined $209,000 for violations of federal pipeline safety regulations between 1983 and 1985. This fine, the maximum amount permitted by law, was a result of a federal investigation that began after a Williams pipeline, in Mounds View, Minnesota, exploded in July of 1986, injuring one person and killing a woman and her daughter. Two hundred thousand dollars of the total fine was penalty for failure of the pipeline company to maintain adequate cathodic protection on several sections of pipeline. A National Transportation Safety Board report on the explosion stated that the rupture was due to "failure of the Williams Pipe Line Company to correct known deficiencies in the cathodic protection applied to the lines."[15]

Although ruptures of pipelines due to corrosion account for about 12.4% of reportable incidents between 1970 and 1993, this percentage represents a way to simply and significantly lower the likelihood of similar incidents in the future and is, in fact, now taking place. U.S. Gas Pipeline Safety Records indicate that injuries from gas incidents have steadily declined, despite the fact that there over 1.6 million miles of regulated pipelines spread out over this country. With the combined efforts of oil companies, whose standards often exceed those imposed by the U.S. Department of Transportation, it is conceivable that corrosion-related incidents in oil and gas transmission lines will continue to decrease in the coming years.[16] Yet, this expected decrease does not permit us to lessen our vigilance in this area. A "worst-case scenario" of what can happen to us here, in the U.S., is taking place in Russia, right now.

The February 1996 issue of Discover reports that for the past 20 years, oil has been pumped through the Kharyaga-Usinsk regional pipeline, stretching across 100 miles of northern Russia into its heartland, with little regard for the environment. Carrying as much as 220,000 barrels of oil each day, the World Bank estimates that since 1994, close to 730,000 barrels--more than 100,000 tons of oil--have seeped out of miles of corroded pipeline into the surrounding water, land, and air. A U.S. government report estimates the amount of oil leaked as closer to 270,000 tons. Either way, if we accept the 100,000 ton estimate in favor of the higher one, this spill surpasses that of the Exxon Valdez nearly three times over. Initially, huge ponds of oil, standing six to seven feet deep and 20 to 30 feet across, covered an area of approximately two to three miles. Today, most of the wildlife have gone and studies indicate that the freshwater fish catch in the region has plummeted by about 85%. This incident's far-reaching consequences in irreparable damage to Russia's Earth capital, with loss of biodiversity to the surrounding ecosystems render the economic expense of massive clean-up efforts to be negligible in comparison. Yet, all over Russia, old and corroded pipelines continue to carry tons of oil in an attempt to support a teetering national economy.[17]

FIELD HISTORY

Cathodic protection may be measured by using an electrode which has a relatively fixed value of potential (or electromotive force in volts), regardless of the environment in which it is used, called a reference half-cell or reference electrode.[18] For our purposes, the Saturated Copper-Copper Sulfate Half-Cell was the electrode chosen. This electrode consists of metallic copper immersed in saturated copper sulfate. It is most often used in taking field measurements and adequate for most corrosion investigations.[19]

The designated site for testing was a 30" line, currently being operated by Arco (Seaway) Several feet away from the Seaway line and parallel with it, are the test leads for a pipeline operated by Aquila, so it was tested for cathodic protection, as well Testing began at the Seaway mile marker #96 + 0500 ft , off of FM 362, and ended at Seaway's mile marker #98 + 3310 ft , at Reids Prairie Road

Potentials were taken by placing the tip of the electrode into the soil (electrolyte) over the pipeline near one of its test leads The positive (red) wire from the voltmeter was connected to that test lead, while the negative (black) wire was connected to the copper-copper sulfate half-cell Using the 2-volt DC scale, readings registered upon the face of the voltmeter (a Beckman HD-110 digital multimeter) and were subsequently recorded Results are recorded on table 1

Table 1 Results of potentials taken with copper-copper sulfate electrode

Mile Marker	Location	Seaway	Aquila
#96 + 0500 ft	S S FM #362	- 0 608V	- 1 455V
#96 + 4210 ft	S S Howell Rd	- 0 615V	- 1 469V
#98 + 3310 ft	Reids Prairie Rd	- 0 503V	- 1 438V

Potentials registering more negative than - 0 850V indicate that cathodic protection is in place and operating The potentials taken on the Seaway line showed that it was not cathodically protected, while the Aquila line was A call to Kyle Coslow of Arco revealed that the 30" Seaway line and its facilities were being changed in order to accommodate transmission of oil instead of gas, necessitating that the cathodic protection system be turned off until construction on the line could be completed

CONCLUSION

As the demand for fossil fuels grows, the network of underground oil and gas transmission lines expands with it Advanced methods of corrosion prevention and cathodic protection are now routinely applied to these new lines Yet, interspersed throughout the country are their aging predecessors, many of which have been in operation for more than forty years Originally placed beneath uninhabited sections of land, these pipelines now lie beneath large residential and commercial areas where it would be impractical and/or impossible to replace them with newer pipe Properly applied, galvanic and impressed current systems of cathodic protection continue to be the preferred approach for preventing pipeline failures

During the course of my research, several pipelines were examined Of this number only one (Seaway) was found to be without cathodic protection This discovery highlights the fact that although most oil and gas transmission lines are never seen, they must not be forgotten Failure to properly protect these lines, whether it be due to corporate down-sizing, ignorance, and/or gross negligence, will eventually result in catastrophic consequences This is something none of us can afford

ACKNOWLEDGMENTS

I would like to thank Dr Brian Hale, Dr Verne Lehmberg, and the people of N A C E (National Association of Corrosion Engineers) for their guidance and support Special thanks to my father, Jerry C Cochran, without whose help I would never have attempted to research a subject such as cathodic protection

REFERENCES

[1] Steven S Zumdahl, "Oxidation-Reduction Reactions and Electrochemistry," in *Introductory Chemistry A Foundation*, Third ed (Lexington Heath, 1996), 558

[2] Joseph A Lehmann, "Cathodic Protection Fundamentals," NACE North Central Region Conference, Oct 1-3, 1963, Kansas City, Mo

[3] Herbert H Uhlig and R Winston Revie, "Polarization and Corrosion Rates," in *Corrosion and Corrosion Control An Introduction to Corrosion Science and Engineering*, Third ed (New York Wiley-Interscience, 1985), 58

[4] Steven S Zumdahl, 538

[5] Jerry C Cochran, Personal Conversation

[6] Joseph A Lehmann

[7] Steven S Zumdahl

[8] Joseph A Lehmann

[9] Herbert H. Uhlig and R. Winston Revie, "Cathodic Protection," 219

[10] Sir Humphrey Davy, "On the Preservation of Metals by Lectro-Chemical Means" (Facsimilies of original papers), Philosophical Transactions of the Royal Society, London, 1824 -1825 (Reproduced by Shell Pipe Line Corp.)

[11] Herbert H. Uhlig and R. Winston Revie, 218

[12] Jerry C. Cochran, "Brief History of Cathodic Protection," Phillips Petroleum Company, E & P, Current Awareness Seminar, Houston, TX, 1995

[13] Jerry C. Cochran, "Cost of Corrosion," Seminar, 1995

[14] Patrick Crow, "U.S. industry, government efforts seek to improve pipeline safety," *Oil & Gas Journal* (April 24, 1995) 23

[15] Minneapolis (AP), "Williams Pipe Line Hit With Fire," *Tulsa World*, December 9, 1987

[16] Patrick Crow, 28

[17] Shanti Menon, "Russia's Black Future," Discover, February 1996 30

[18] Herbert H. Uhlig and R. Winston Revie, "Corrosion Tendency and Electrode Potentials," 31

[19] Herbert H. Uhlig and R. Winston Revie, 34

Twin City Water Quality Initiative Program

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Monitoring water quality and quantity is necessary in order to effectively manage land use decisions upstream. It is also needed to plan flood control structures and estimate the dependability of water supplies. This project was conducted on the Rum River in Anoka, MN. The purpose was to monitor the River for one sampling season and determine the quality and quantity of the water body, and also compile much needed baseline data on the river. The study revealed that the Rum River has acceptable water quality.

BACKGROUND

The Metropolitan Council Environmental Services (MC) is required by state legislature to determine target loads for every watershed in the Twin Cities Metropolitan Area. The MC developed a program which issues grants to local governmental agencies in order to collect water quality baseline data. The MC purchases the water sampling equipment and analyzes the water samples for the local agencies. The MC believes this program will get local governmental units involved in keeping water quality a top priority and increase their desire to educate the people living in each watershed and contributing to the water quality. The Anoka Conservation District (ACD) was one of the governmental agencies to receive a grant from the MC. The ACD tests the Rum River outlet to the Mississippi River in Anoka, Minnesota.

The Rum River starts at Vineland Bay of Mille Lacs Lake, threads together several lakes near the city of Onamia, then makes its way along a 148 mile course to the city of Anoka and the Mississippi River (Homuth, 1977). The river flows through three major cities: Anover, Ramsey and Anoka, where it empties into the Mississippi River. Along this course it travels through forested areas, agriculture farmland, cities and industrial developments. Monitoring of the Rum River is necessary in order to effectively manage land use decisions upstream. It is also needed to plan flood control structures, and estimate the dependability of water supplies (Brooks, et al, 1991). The overall objectives of this research project are to: (1) compare water quality results of the Rum River to standards determined by the Pollution Control Agency and the Environmental Protection Agency and (2) establish a streamflow-elevation rating curve so water quality values can be related to streamflow discharge.

MATERIALS AND METHODS

Sampling equipment (ISCO 6700) which collects streamwater was set up near the outlet of the Rum River. The location was chosen based on accessibility, safety from vandalism or accidents with boats and canoes, ability to take measurements of the river, and stormwater outlet locations. The sampling equipment included a 24 unit water sampler, a staff gauge, and a shelter box which stores the water sampler under lock and key. The water sampler was triggered when the river level reached a certain elevation. It collected water samples every three hours during a stormflow event. Samples were then weighed based on elevation and combined together. The MC tested the samples for the following water quality parameters: Total Suspended Solids (TSS), Volatile Suspended Solids (VSS), Total Phosphorous (TP), Dissolved Phosphorous (DP), and Chemical Oxygen Demand (COD). The MC chose these parameters because they were determined to give the best measure of water quality with the least amount of testing.

Discharge was measured at relatively the same time water samples were collected and at approximately the same location of the water sampler. It was determined by:

$Q=V*A$ (1)

where:

Q=Discharge (ft^3/s)

V=Velocity (ft/s)

A=Area (ft^2)

The cross sectional area of the stream was determined by wading across the river with a rope marked at 10 foot increments. Every ten feet the depth of the River was measured with a ruler and the velocity was measured with a Pygmy flow meter at .6 meters from the surface. Elevation was determined by taking a staff gauge reading at the same time discharge was measured. Once all data was collected for the season, it was used to develop a streamflow-elevation rating curve. The rating curve is shown in figure 1, it is convenient because it allows the ACD to look at previous data and approximate how much water will be discharging from the river given a certain elevation. With this data the ACD can determine if any flooding precautions need to be made.

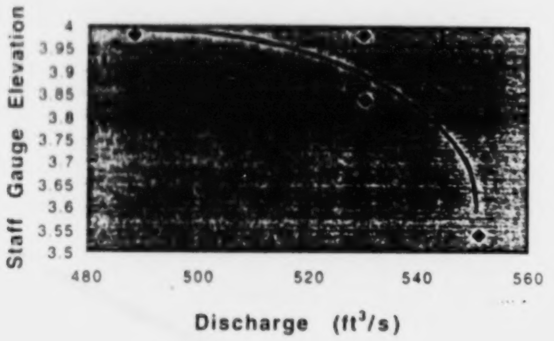

Figure 1: Rating curve, relates elevation to streamflow discharge

RESULTS AND DISCUSSION

The results of the water quality parameter tests remained fairly consistent. Table 1 indicates the results. The average level of each parameter tested for the sampling season was below acceptable water quality parameter guidelines for in-stream nonpoint source pollution. These guidelines were based on Minnesota Pollution Control Agency criteria and the Environmental Protection Agency standards. These results verify that the Rum River has acceptable water quality. One thing should be considered when reading the water quality test results; the composites made for each stormflow event were based on elevation and not

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discharge. That could have caused the results to be off because it was not taking into account how much water was actually discharging for that particular stormflow event. For example, a larger river may rise the same amount throughout a storm event as a smaller one, but because the cross-sectional area is larger there is more discharge (Brooks, et al, 1991).

The results of the streamflow-elevation rating curve were not accurate (Figure 1). In theory, as the elevation of the river rises, so should the discharge. This discrepancy was most likely due to limited data and also imprecise data collection. The staff gauge was difficult to read at times and could have been tampered with. Also, the Rum River was approximately 200 feet wide at the site where data was collected, so some error was likely to occur when measuring the cross sectional area. Each time it was difficult to follow the same path when crossing the river and keep that path straight. Also a rope was used to determine depth from shore. Due to the inaccuracies in the rating curve there is a lack of reasonable correlation between water quality parameters and streamflow discharge.

Table 1: Water quality test results

	Period of Sampling					
Parameters (mg/L)	9/7/14	9/21/25	10/17/21	10/22/24	10/24/31	Acceptable Levels
COD	31	17	20	35	30	50
TP	0.06	0.07	0.09	0.06	0.06	0.1
DP	0.04	0.06	0.05	0.03	0.02	-
% Dissolved	67%	86%	56%	50%	33%	20-80%
TSS	6	4	3	4	5	30
VSS	2	2	2	2	<2	-
% Volatile	33%	50%	67%	50%	40%	50%

Peak Discharge (ft^3/s)	542	560	553	541	470	-

CONCLUSION

Many of the procedures used for monitoring in this project were not the most accurate. However, given funding, time constraints, and degree of accuracy required, they were satisfactory. The results of this project will allow the ACD to improve upon future monitoring programs.

Changes, are already underway. A dam downstream of the Mississippi River (Coon Rapids Dam) was down during this project so water levels of the Mississippi and Rum were low, making it easy to wade across and measure the cross sectional area and velocity. Next season the Dam will be up again, which will cause the water levels in the Mississippi and Rum to rise and no longer be shallow enough to wade across. The Dam will also cause the Mississippi to back water into the Rum and effect water quality results. The ACD, with advise from the MC decided to move the location of the water sampler for next season. The new location of the sampler will be upstream of this summers site and below the Anoka Dam. At this site a rating curve of the river was already determined by engineers and a continuous monitor will be set up to take elevation readings every half hour. Results for next season will be much more accurate.

REFERENCES

Brooks, K.N., P.F. Ffolliott, H.M. Gregersen, and J.L. Thames. 1991. Hydrology and the Management of Watersheds. Iowa State University Press/Ames.

Homuth, Dale etc. 1977. A Management Plan for the Rum River. MN Department of Natural Resources.

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Lead Contamination of Canned Food Products from Argentina

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The Argentinean food industry uses lead-alloy solders to seal cans containing food products, posing a serious problem of lead contamination in the food. Lead levels greater than 10 ug/day, if ingested, are considered toxic to humans and can lead to measurable neurological damage. The type of food (e.g., acidic, in oil,) contained in the can plays an important role in how much lead is being leached from the solder. This study analyzes 586 food samples of four different food types and 583 can samples by Atomic Absorption Spectrophotometry to determine the lead concentration of the food and to see if there is any lead remaining in the solder of the cans. The USFDA standard for lead in canned food is 0.250 ug/g. The results of this study indicate that 72% of the Argentinean food sample groups have at least one sample with lead levels that exceed the USFDA's standard. It is also found that tomato based products and fish in oil exceed the standards by the widest margin. Additional areas of interest within this discussion may include, the importance of keeping the laboratory equipment and environment free from lead that could possibly contaminate the analysis.

INTRODUCTION

Lead is a toxic substance that has been harmful to human health since ancient history and has become increasingly evident since the beginning of the Industrial Revolution. The implications of lead on the human body are particularly severe with children and pregnant women. It is known to affect cognitive behavior and learning development in children as well as cause miscarriages, premature delivery, and stillbirths in pregnant women[1]. There are many other serious health problems associated with lead that begin showing signs at lead levels as little as 10.0 ug/day. This hazard can be prevented with the elimination of lead from our environment. With the increased awareness of the implications from lead, great strides are being made to eliminate lead from our daily intake. There is considerable interest and concern in the amount of lead intake from paint, dust, soil, water and food. Lead in any of these may come into direct contact with a person through their daily activities. Removal of the source and restriction of further use is necessary as preventive medicine.

Lead enters the human body primarily by way of inhalation or ingestion. The major source of ingested lead is from the food we eat. The food may possibly be contaminated by a number of different sources which include:

-Biological uptake of lead from soils into plants consumed by man. Root vegetables contribute more lead than surface vegetables.

-Contact with industrial machinery and greases during harvesting and processing.

-Manufacturing and storage in cans.

-Location where vegetables are grown in relation to major highways. Airborne lead from automobile emissions accumulates on the vegetation. An inverse relationship between distance from the road and lead content has been observed. Although, in the United States, the problem of lead contamination from automotive sources has been reduced over the years by banning of leaded gasoline, in many other parts of the world, including Argentina, leaded fuels are still being used.

-The addition of lead in the kitchen. For example, the lead-containing glazes in pottery used to contain food or the tap water used in cooking.[2,3]

The interest of this research is the extent of lead contamination of food from the lead-alloy solder used in the manufacturing of cans by the Argentinean food industry. The cans are assembled in such a way that the contents of the can are exposed to the available lead along the seam of the wall. Further contamination results from the splashing of molten solder used in the manufacturing process.[4] The United States has taken great measures to reduce the daily lead intake by eliminating lead in the solder used to seal cans. Argentina, however, is in the process of elimination and considerable amounts of lead are still being detected.

The sample must proceed through a series of preparations to ensure the most representative sample. Initially, the food sample is blended for complete homogeneity. The food settled closest to the seam of the can typically contains the highest concentration of lead, so blending the entire contents is necessary to ensure thorough mixing. Next, the sample must sit through 16 hour nitric acid predigestion in order to break up all lead particulates. Lastly, the nitric acid/peroxide digestion process is performed to solubilize the metal and to remove any organic matter.[5] The sample is then ready for analysis.

The theory behind Atomic Absorption Spectrophotometry involves atoms in their ground state energy level being excited to higher energy levels by absorption of particular wavelengths of radiation. A hollow cathode tube made up of the element of interest, in this case Pb, emits wavelengths of radiation at which the elemental atoms absorb. The sample is converted to atomic vapor by aspirating it into a flame or graphite furnace which lies in the path of the radiation source. The larger the population of ground state atoms the greater the absorption of light. The absorption signal is used quantitatively in that the absorption is proportional to the concentration.

METHOD

Apparatus and Reagents

a) Atomic absorption spectrophotometer - Thermo Jarrell Ash Smith-Hieftje 11 with furnace atomizer 188 was used for all food samples. Single beam. Automatic background corrector with Deuterium background. 283.3 nm wavelength. 1.0 nm bandwidth.
Thermo Jarrell Ash Smith-Hieftje 12 with a long path air/acetylene burner was used for all can samples. Smith-Heiftje background. 217.0 nm wavelength. 1.0 nm bandwidth.
b) Food Processors - Black and Decker Power Pro FP 1000 and Black and Decker HC 2000
c) Ammonium dihydrogen phosphate -Dissolve 5.00 g in 0.3%(v/v) nitric acid and dilute to a volume of 1L.
d) Nitric acid - 2%. Dilute 10.0 ml concentrated HNO_3 to 500.0 ml
e) Lead Standard - NBS Standard Reference Material, 1566a Oyster Tissue 0.371%Pb

Sample Preparation

The tops of each can are washed with soap and water, rinsed three times with lead-free tap water and three times with deionized water. The top is removed and the contents of the can are transferred to a clean food processor. The food is blended for 3-5 minutes to ensure complete sample homogeneity.

25.0 g of blended food is weighted into a clean, labeled, weighed 250 ml polyethylene sample bottle and recorded to the nearest 0.01 g. Approximately 25.0 ml of 50% HNO_3 is added, shaken and allowed to stand for 16 hours to break up any particulate lead present. After the predigestion, the bottle with sample is weighed to determine the exact weight of the 50% HNO_3 used.

Approximately 1.0 g (weighed to the nearest 0.0001 g) of the food/nitric acid mixture is weighted into a tared, clean, labeled 50.0 ml Pyrex beaker and covered with a watch glass. For every ten food samples a duplicate of one food sample, a digestion blank, a spiked sample and a reference sample are prepared. The digestion blank is prepared by treating 360 ml of deionized water using the same procedures as a canned food sample. The spiked sample is prepared by adding 200.0 ul of 1.00 ppm lead reference solution to a one gram food sample. The reference standard is prepared by weighing 0.25 - 0.60 g (weighed to the nearest 0.0001 g) of a National Institute of Standards and Technology into a tared 50 ml beaker, dissolving in 20.0 ml of 50% HNO_3 and evaporating on a hot plate to approximately 5.0 ml.

To each food, duplicate, blank, spike and reference sample, 6.0 ml of concentrated HNO_3 and 2.0 ml of 30% H_2O_2 are added then placed on a hotplate and heated slowly to near dryness. This procedure is repeated twice using 3.0 ml HNO_3 and 1.0 ml H_2O_2 each time allowing it to reach complete dryness on the final step. If charring should occur, repeat last procedure.

Remove samples from hotplate and allow to cool. Rinse watch glasses into the beaker with 1.0 - 3.0 ml of 2% HNO_3. The solution is next gravity filtered through Whatman 43 or 54 filter papers into 10.0 ml volumetric flasks being sure to rinse the sides of the beakers with 2% HNO_3. The filter paper is removed and the funnel is rinsed. Fill to volume with 2% HNO_3. The samples are transferred to labeled 50.0 ml polypropylene vials and are ready for analysis.

The can samples are prepared by washing the cans thoroughly to remove all food, rinsed five times with lead free tap water and three times with deionized water. The cans are filled with 5%(v/v) acetic acid and allowed to sit 24 hours before analysis.

Instrument Analysis

EPA method 239.2 is used to analyze all food samples with the modifications of all samples being prepared in 2% HNO_3 and the addition of 20%(v/v) of ammonium dihydrogen phosphate just prior to each sample analysis.

A calibration curve to analyze the food samples is installed using a series of lead standard solutions of 0.0, 5.0, 10.0, 20.0, 30.0, and 50.0 ppb Pb in 2%HNO_3. The acceptable line correlation being greater than 0.995 and quality control standards of 2.0, 15.0 and 40.0 ppm having absorbencies within ±10%. The samples are analyzed for absorbance. After every ten samples the instrument is calibrated with a control and duplicate sample run having absorbencies within ±10%.

To install the calibration curve to analyze the can samples a series of lead standards solutions of 0.0, 0.1, 0.3, 0.5, 1.0 and 2.0 ppm Pb in 5% HOAc are used with an acceptable line correlation being greater than 0.995 and quality control standards of 0.2, 0.6, 1.5 ppm Pb having absorbencies within ±10%. After every ten samples a calibration with a control and duplicate sample run having absorbencies within ±10% is performed.

The amount of lead in the food is calculated as follows

$$\text{Pb Concentration (ug/g)} = \frac{\text{(AA signal ug/l)(0.0100 l)(Dilution Factor)}}{\text{(Mass of Analytical Food Sample g)}} \qquad (1)$$

where

$$\text{Dilution Factor} = \frac{\text{(Mass of gross food sample + mass of 50\% } HNO_3\text{)}}{\text{(Mass of gross food sample)}} \qquad (2)$$

RESULTS AND DISCUSSION

Table1 Statistical Analysis of Lead in Food and Can Extract Categorized by Food Type

Food				Lead Extracted from Can	
Food Type	n	Mean Lead (ug/g)	%>FDA Standard	n	Mean Lead in Can (ug/l)
Fish with no Oil or Tomato Sauce	57	0.453	28.1%	57	583
Fish in Oil	121	0.580	52.9%	121	506
Tomatoes or Product in Tomatoes	300	1.333	60.7%	298	931
Other	108	0.705	48.1%	107	385

The results indicate that 72% of the Argentinean food sample groups have at least one sample with lead levels greater than 0.250 ug/g. Table 1 gives a breakdown of lead levels according to food type. It can be seen that all food types have lead levels that exceed the USFDA standard with the highest concentrations of lead found in the tomato based products giving evidence that the chemical properties of the food play an important role in the amount of lead being leached from the solder. It is also found that there is a considerable amount of lead still available to be leached from the solder. A correlation between the amount of lead in food and the amount of lead remaining in the solder was considered but found to be difficult with the reasoning that the initial concentrations of lead in the solder are unknown and that the food may have already been contaminated by the sources mentioned previously.

Table 2 categorizes lead concentrations by brand name. It can be seen that all but 1 of the 19 brand name groups have percentages of lead in food that exceed the USFDA standard with the brand names Arcor, Margarita and Santa Isabella having the highest exceedences. It can also be seen that Arcor and Santa Isabella have the highest concentrations of lead still remaining in the can. This is an indication that the solder is the primary source of contamination in the food.

Table 2. Statistical Analysis of Lead In Food verses Can by Brand Name Category

	Food			Lead Extracted From Can	
Brand Name	n	Mean Lead (ug/g)	% Food> USFDA Standard	n	Mean Lead in Cans (ug/l)
Alco	55	1.177	61.8%	55	776
Arcor	20	6.866	100%	20	2156
Canale	53	0.589	58.5%	52	681
Cica	30	.660	36.7%	30	1640
Coinco	23	1.559	69.6%	22	537
Estrella del	10	1.656	70.0%	10	291
La Banda	15	0.656	40.0%	15	360
La Calete	15	0.252	46.7%	15	1245
La Mar Platens	5	0.055	0.0%	5	209
Marbella	75	0.509	40.0%	74	555
Margarita	15	1.111	86.7%	15	530
Mellino	60	0.815	58.3%	60	476
Parmalat	20	0.324	45.0%	20	1171
Puglisi	30	0.266	20.0%	30	503
Rural	20	0.550	25.0%	20	313
Santa Isabella	20	1.993	75.0%	20	1286
Silvia	35	0.821	48.6%	35	734
Supremicia	42	0.536	66.7%	42	504
Versalles	43	0.748	58.1%	43	186

A problem encountered throughout the analysis was obtaining zero concentrations of lead in the blank reagents. Before estimating the lead concentrations of the samples a mean concentration of the blanks is subtracted from all samples to adjust for non-zero blanks.

The blank, duplicate, spiked and standard samples undergo the same digestive procedures as the food samples in order to expose all the samples to the same conditions. If a situation occurs where theoretical values are not observed within certain percentages then measures must be taken to find and fix the problem.

Analysis was done on equipment and reagents used throughout the experiment to determine at which point the blank was being contaminated. Starting at the beginning of the experiment and in a step-by-step manner, samples from squirt bottles, pipets, polyethylene bottles, etc., were obtained and analyzed. It was found that the major source of contamination occurred from the Pyrex glass beakers and watch glasses employed during the hotplate digestion procedure. A certification process was then installed involving daily analysis of samples obtained from laboratory equipment that was thoroughly cleaned and run through an acid digestion procedure before the equipment was to be used in the actual digestion of the food samples.

It was later found that switching to Teflon beakers greatly reduced the lead contamination of the blank. An other observation that may be considered an advantage in using Teflon is in the handling beakers. It was found that the Teflon beakers can be removed from the hotplate using one's hands as opposed to tongs. Emphasis must be made here in that this is not a recommendation but an observation. Disadvantages in using Teflon are that the digestive procedure appears to take longer and the beakers are transparent prohibiting the visual progress of the digesting sample. The reduction of lead contamination by using Teflon was possibly the most important finding of this research and should be stressed upon at the beginning of any further experimental procedures involving lead analysis.

REFERENCES

1. Needleman, Herbert L., Human Lead Exposure, CRC press, 1992, pg 38
2. Millichap, J. Gordon, M.D., Environmental Poisons in Our Food, PNB Publishers, Chicago, 1993, pg 7-8
3. Needleman, Herbert L., Human Lead Exposure, CRC press, 1992, pg 80-81
4. Needleman, Herbert L., Human Lead Exposure, CRC Press, 1992, pg 80
5. Kennedy, John H., Analytical Chemistry: Principles, Second Edition, Saunders College Publishing, 1984, pg 487

Don't Die With TDI: Dynamic Calibration of MDA Isologgers for Toluene Diisocyanate

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ABSTRACT

An Isologger is a lightweight personal toxic gas monitoring device recommended and used by industrial hygienists and product safety employees interested in workplace safety. If toxic gases are present in an environment, Isologgers warn the user of potential danger by sounding an alarm and recording the concentration of the gas. An experimental method used in the calibration of five of these devices subjected them to varying concentrations of the toxic gas, toluene diisocyanate (TDI), at different humidities. Because of the great risk to human health, it is important that these devices function properly at all times. Unfortunately, under extreme humidity conditions, these devices fail to indicate potentially dangerous levels of toxic gases. It was concluded that a lapse in quality control had occurred at the manufacturing facility, which could have severely affected the health of the exposed workers.

INTRODUCTION

Over the past 30 years, steady improvements and refinements have been made in the understanding and application of environmental sampling and analysis. One important application is the sampling of the workplace environment to protect the health of workers. Toluene diisocyanate (TDI) is a workplace pollutant associated with the production of polyurethane foams, elastomers, and nylons. Newer sampling and analytical procedures have been developed to achieve lower limits of detection for TDI due to lowering of exposure limits and eliminating some inherent problems with the older methods. Some other purposes for airborne sampling of isocyanates include assessment of worker exposure, compliance with exposure limits, assessment of ambient air quality, toxicological studies, and evaluation of monitoring methods and instruments. Innovative technology has advanced the field of isocyanate sampling. At the present time, paper-tape monitors are the most popular instruments available for monitoring for TDI. These are personal devices which can be worn at the workplace, as seen in Figure 1. The purpose of this study was to determine the reliability of paper-tape toxic gas monitoring devices in detecting levels of TDI at extremes in relative humidity in order to ensure user protection.

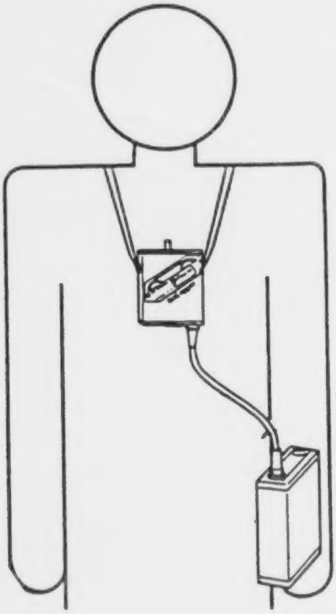
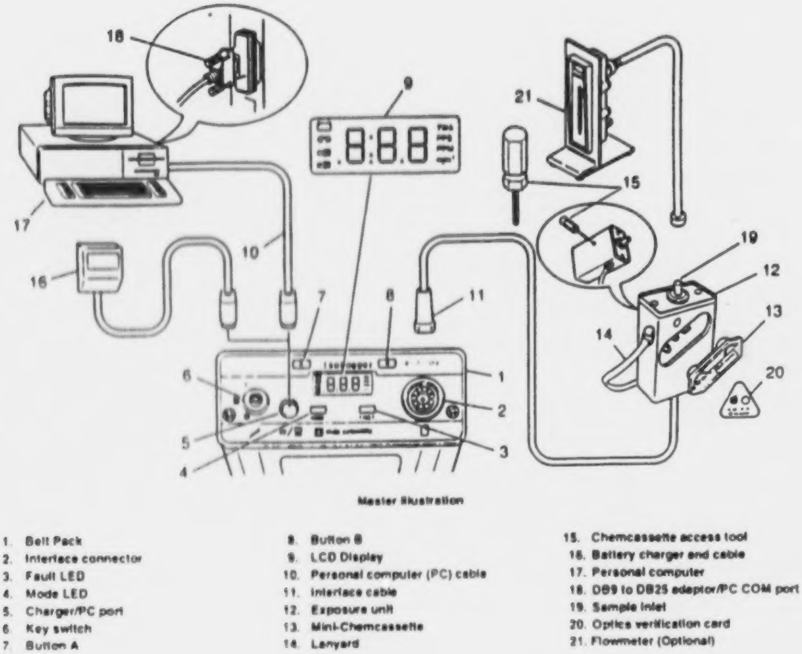


Figure 1. Isologger system on a person (MDA Scientific 1994).

MDA ISOLOGGERS

In April 1995, Bayer Corporation Product Safety Department in Pittsburgh, Pennsylvania, purchased five Isologger devices from MDA Scientific. An Isologger is a lightweight, personal toxic gas paper-tape monitoring device recommended and used by industrial hygienists and product safety employees interested in workplace safety. A master illustration of the Isologger systems is shown in Figure 2. Calibration of these toxic gas monitoring devices is essential in industrial settings where harmful gases often result as a product of manufacturing. If toxic gases are present in an environment, Isologgers record the concentration of the gas. Isologgers, as paper-tape monitors, indicate toxic gas exposure based on the collection of isocyanates on chemically impregnated filter paper tapes. The isocyanate reacts with the chemicals on the tape to produce a characteristic color stain. The intensity of the color stain, which is proportional to the concentration of isocyanates in the air, is measured photochemically and displayed directly on the tape. Inside the Isologgers is a white chemically coated tape called a Chemcassette. Chemcassettes indicate the level of toxic gases present in the environment by inscribing a discoloration on the tape. The Isologger monitors run on a rechargeable battery which can sample continuously for about 10 hours. At the end of a sampling session, the electronically stored data can be retrieved via a personal computer. Built-in alarm systems warn the user of potentially dangerous exposures. Because of the great risk toxic gases pose to human health, it is important that these devices function properly at all times.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Master Illustration
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2. Interface connector
3. Fault LED
4. Mode LED
5. Charger/PC port
6. Key switch
7. Button A
8. Button B
9. LCD Display
10. Personal computer (PC) cable
11. Interface cable
12. Exposure unit
13. Mini-Chemcassette
14. Lanyard
15. Chemcassette access tool
16. Battery charger and cable
17. Personal computer
18. DB9 to DB25 adaptor/PC COM port
19. Sample inlet
20. Optics verification card
21. Flowmeter (Optional)

Figure 2. Master Illustration of MDA Isologger (MDA Scientific 1994)

THE EFFECTS OF TOLUENE DIISOCYANATE (TDI)

TDI is created in the production of many pharmaceutical products and is dangerous to employees exposed to the toxic gas. Some of the acute harmful effects of exposure to TDI are: dryness of the throat, tight feeling in the chest, itchy and red eyes, headache, nausea, fatigue and loss of appetite. Chronic exposure to the gas causes neurotoxic damage, including permanent brain and nervous system damage, loss of memory, and liver and kidney damage (Bayer Corporation 1992). Because of these severe human health effects, it is essential that significant precaution is taken when handling TDI. Calibration techniques are necessary in order to ensure their reliability. However, an inherent problem with the devices is that operation in harsh environments tends to cause false readings, subsequently not warning the user of potentially dangerous levels of toxic gases.

CALIBRATION METHOD

The experimental method used in this research involved subjecting the Isologgers to varying concentrations of TDI at different relative humidities to assess their reliability in extreme, but realistic environments. Atmospheres containing TDI at various concentrations and relative humidities were generated in the Bayer Industrial Hygiene Lab using a diffusion technique (three 2-mL volumetric flasks served as the diffusion cells). The TDI concentrations were obtained by controlling the temperature of the diffusion cells (51.5 C• for ~9 ppb (parts per billion), 59.5 C• for ~15.6 ppb, and 75 C• for ~44.6 ppb of TDI). The desired relative humidity of the atmosphere was obtained by controlling the humidity of the diluent air using a Miller-Nelson-Flow-Temperature-Humidity Control System (Model HCS-401).

The TDI atmosphere was measured concurrently with the five Isologgers and two 13-mm diameter 1-(2-pyridyl) piperazine (PP) coated filters as controls. The results of the Isologgers and the two control filters were then compared using a High Performance Liquid Chromatograph (HPLC). By comparing the 13-mm PP filters to the Isologger readings, conclusions were made about the validity of the five Isologgers.

Daily configuration and data retrieval of Isologgers was accomplished via a personal computer software program called *Isologger*. When employees use this program in an ordinary working situation, a profile with a graph of their results can be obtained and the data stored for future reference. During this experiment, each Isologger was subjected to a daily configuration in this program before a test could be run. Utilizing this software greatly facilitated the graphing and summarizing of test results.

RESULTS

In conducting the calibration of these devices, it was discovered that at certain humidities and concentrations of the gas, the devices were reading falsely. The calibration procedure revealed that the devices were consistently underestimating the TDI concentrations at various humidities and concentrations tested. At 50% relative humidity (RH), the Isologgers read the TDI concentration correctly. However, at lower humidities (25%RH), the tape monitors were ~30% lower, and at higher humidities (75%RH), the monitor responses read ~20% higher than the true concentration. A graph of the results represented in Figure 3, which portrays the deviancy of the monitoring systems from the ideal. The devices are designed to give a concentration measurement every two minutes. At higher humidities (75%RH and higher), consecutive two-minute readings oscillate around the true mean reading. These oscillations are due to the tape becoming slightly more transparent as water is absorbed. The oscillations can be very dramatic and the user must be made aware of this effect. Compared with the reference method, the Isologgers underestimated TDI concentrations at extreme measurements of relative humidity. Many of the Isologger readings fell below the ideal region, shaded in Figure 3, underestimating the concentrations of TDI.

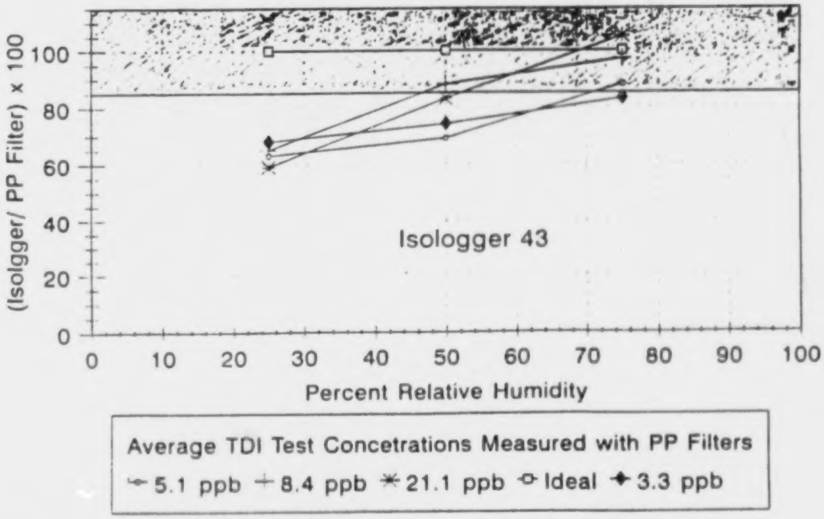

Figure 3. Percent relative humidity readings of one Isologger subjected to varying concentrations of TDI and then compared to the ideal (Dharmarajan 1996)

Further experiments revealed that the Chemcassette tapes for the Isologgers were coated with a partially-degraded chemical which deteriorated even further during transport in the hot summer months during the calibration period. A quality control problem had taken place at the manufacturer's and could have severely affected the health of the users of these devices. Those individuals involved in preparing the Chemcassettes had not properly checked the chemicals, allowing degraded substances to be used on the tapes. Based on these findings, until the quality control problem could be ameliorated, the paper-tape Isologger monitors were used only as screening instruments for TDI, and not for government exposure compliance purposes.

CONCLUSIONS

A significant conclusion of this research is that toxic monitoring devices designed for user safety may not always function reliably, subsequently exposing workers to toxic gas. The responses of the paper-tape monitors in reading TDI concentrations were affected by extreme, but common, measures of relative humidity. These fluctuations caused the monitors to read falsely, subsequently not warning the user of a potentially dangerous atmosphere of TDI. Exposure to a gas as harmful as TDI can cause severe health effects, drastically impairing a worker. The chronic effects of the gas may cause the individual to exhibit symptoms years after the exposure and the acute effects are extremely painful and dehabilitating. This calibration study was critical in that it tested the reliability of an instrument necessary for detecting a dangerous workplace atmosphere. It is important that studies such as this be made known to future users of paper-tape monitoring devices and that employees in hazardous workplaces be made aware of the discrepancies in technology presumably protecting their safety.

REFERENCES

Bayer Corporation. 1992. Methods for Sampling and Analysis of Airborne Isocyanates. Corporate Industrial Hygiene Laboratory.

Dharmarajan, V. 1996. Evaluation of Paper-tape Monitors in Laboratory-generated TDI Atmospheres at Various Humidities and Concentrations. Poster presentation at the Polyurethanes EXPO'96 in Las Vegas, Nevada.

MDA Scientific. 1994. Isologger Monitoring System Technical Handbook. Subsidiary of Zellweger Analytics.

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THE EFFECT OF CARBON CONTENT ON THE REDOX POTENTIAL AND FERMENTATION PRODUCTS OF WETLAND SOILS

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INTRODUCTION

The objective of this study was to observe the effects of carbon content on redox potential and fermentation products of flooded soils. The cycling of the element carbon in the environment is a well-understood phenomena. Carbon moves from the gaseous phase in the atmosphere to the solid phase in plant and animal tissue and then is either mineralized by decomposition or transformed back to the gaseous phase through respiration. However, the processes of metabolism differ greatly between terrestrial and flooded soils. In an aerobic soil, carbon is readily decomposed for respiration by soil microorganisms. This process takes place rapidly because oxygen, the preferred electron acceptor in the decomposition process, is plentiful. The predominant decomposition product is carbon dioxide and there is little carbon storage in the system.

In a water-saturated, oxygen-poor soil, carbon decomposition must be carried out by anaerobic decomposers. These anaerobic organisms function at a much slower rate than aerobic decomposers and use other ions such as NO_3^-, Fe^{3+}, and Mn^{4+} as electron acceptors in decomposition reactions (Ponnamperuma, 1972). Most carbohydrates are incompletely decomposed by these processes and form intermediate decomposition products such as low-molecular-weight organic acids and alcohols, and gases such as methane, hydrogen sulfide, and hydrogen gas (McKee and McKevlin, 1993). Due to the very slow breakdown process, called fermentation, the non-gaseous intermediate decomposition products tend to accumulate and much of the carbon deposited in an anaerobic soil remains undecomposed (Ponnamperuma, 1972). Therefore, flooded or hydric soils are much higher in organic matter content than terrestrial soils and provide an important sink for carbon.

The potential capacity of the soil to undergo oxidation-reduction (redox) reactions is called redox potential. Because oxygen is the preferred electron acceptor for these reactions, the lack of oxygen in a flooded soil causes the redox potential (Eh) to drop considerably. A lowered Eh value indicates the absence of oxygen as well as the presence of reduced forms of soil nutrients such as nitrogen, iron, manganese, and sulfur, which are substances used as reductants in place of oxygen. Redox potential is the single most important electrochemical property that distinguishes anaerobic soils from aerobic soils (Ponnamperuma, 1972).

Although much is known about the cycling of carbon and other nutrients through the environment, little information has been gathered on the fermentation products of decomposition in hydric soils. Different processes of anaerobic decomposition yield different products, and the availability of substrates for those different reactions hypothetically have an influence on the rate of formation and composition of fermentation products in the soil. The kinetic and thermodynamic characteristics of each reaction limit the rate at which it can proceed, and the varying availability of each substrate determine which reactions are dominant. Carbon content is one parameter that should have an effect on the rate of production and composition of fermentation products of a flooded soil

METHODS

Field collection. Soils were collected from a mountain bog in Graham County, North Carolina in May of 1996 and from a Carolina bay in Aiken County, South Carolina in 1993. The soils were air-dried, crushed, and homogenized, and all coarse materials were removed. The physical characteristics of pH, texture, cation exchange capacity, and organic carbon content of the soils were determined.

Soil Characteristics. Soil texture was determined with a hydrometer after removing organic matter with 10% hydrogen peroxide and suspending the soil samples with 0.5 N sodium hexametaphosphate (Gee and Bauder, 1986). Hydrometer readings were corrected for the temperature of the suspension water and the density of the dispersing agent. Soil organic matter content was determined by the dichromate oxidation method (Nelson and Sommers, 1982). The pH of each soil was measured in a 1:1 soil and water (weight to volume respectively) slurry. The cation exchange capacity of each soil was determined by a method similar to Plumb (1981). Exchangeable cations were first displaced using ammonium acetate buffered at pH 7. All samples were then washed with isopropyl alcohol to remove excess ammonium acetate. Finally, ammonium ions were displaced using a 10% NaCl solution and quantified using an ammonium electrode.

Development of GC/MS Methodology. Analytes were separated by gas chromatography and identified by mass spectrometry. Certain low-molecular-weight organic acids and alcohols were chosen as analytes because they were known to be common fermentation products. The method used on the gas chromatograph-mass spectrometer (GC/MS) was developed by adjusting the temperature programming of the instrument to achieve separation and detection of target analytes. Solutions of known concentrations of low-molecular-weight organic acids and alcohols were run under varying conditions to determine the optimum conditions for maximum analyte separation and identification. Two standards of high concentration were made for the common fermentation products. The alcohol standard included ethanol, 1-propanol, 1-butanol, 2-butanol, isopentanol, 1-pentanol, and the acid standard contained formic acid, acetic acid, propanoic acid, butanoic acid, and lactic acid. After achieving the best separation, the detection limit of each analyte was found by systematically diluting a solution containing only a single analyte. All acids were detectable at concentrations above 400 ppm. All alcohols were detectable at concentrations above 100 ppm except for ethanol which was detectable only above 500 ppm. However, when the standards were mixed the ethanol, formic acid, and lactic acid peaks were undetectable, even at concentrations of 1000 ppm. Therefore, only the presence of the other eight analytes were considered in this experiment.

Experimental Procedure. Three PVC columns were constructed for each soil (Figure 1). Each column was 17 cm tall with a PVC cap sealed with silicone sealant at the bottom. Each column was filled with soil to a depth of five centimeters, at which point a five-cm long segment of tygon tubing (8 mm inner diameter) was placed upright in the center of the column. A five-cm long rhizon soil moisture sampler was inserted in the tygon tube followed by sand that had been washed with hydrochloric acid and hydrogen peroxide. After placing soil around the tygon tube it was extracted, leaving a five centimeter column of sand to act as a filter surrounding the soil moisture sampler within the soil column. An additional five-cm layer of soil was placed on top of the sand filter and soil moisture sampler. A redox electrode was inserted into each soil column to one side of the soil moisture sampler. Then the columns were flooded with distilled water, leaving a two-cm layer of standing water at the top of each soil column. Soil solution was extracted from each soil column and the redox potential of each soil was monitored over a period of 50 days at intervals of 1, 2, 3, 4, 5, 7, 8, 10, 12, 14, 16, 18, 21, 24, 26, 28, 30, 35, 42, and 50 days. Distilled water was added to each column following the extraction of soil solution to maintain the two-cm water layer.

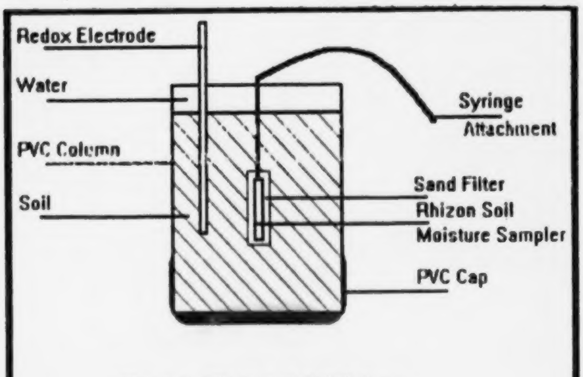


Figure 1. Diagram of Soil Column

On each sampling date the mass spectrometer was tuned and a standard containing all analytes at 1000 ppm was run. A 1-microliter sample of each soil solution was injected into the GC/MS and analyzed for the presence of analytes. Redox readings were corrected for the potential of the standard calomel electrode by adding 245 mV to each reading (Faulkner and Patrick, 1992). The fermentation products detected in the soil solution were analyzed in relation to redox potential and carbon content of the soil.

RESULTS

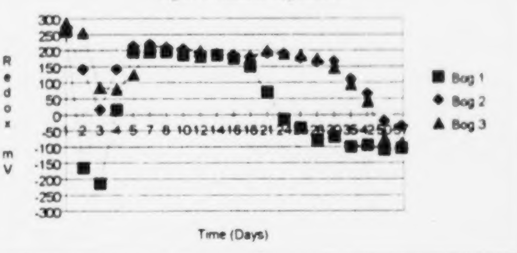
The two soils had very similar pH values and clay content (Table 1). However, the bog soil had more silt and less sand than the bay soil. The organic matter content of the bog soil was almost twice that of the bay soil. The CEC of the bog soil was much higher than that of the bay soil. This is probably due to the higher organic matter content.

Table 1 Soil Properties

	Mountain Bog	Carolina Bay
pH	4.19	4.26
% Organic Matter	13.3	6.9
CEC (cmol/kg)	31.4	17.9
% sand	44.9	59.6
% silt	41.7	23.0
% clay	13.4	17.4

The redox potential of all the samples showed similar trends (Figs. 2 and 3). After an initial dip over the first five days, redox decreased gradually until day 30, after which redox decreased more rapidly. This trend is characteristic of redox behavior in soils after flooding (Ponnamperuma, 1972). The exception to this general trend was the Bog 1 soil, the redox of

Figure 2 Redox of Bog Columns



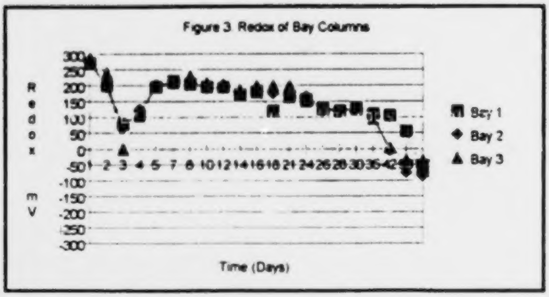


Figure 3 Redox of Bay Columns

which decreased dramatically after Day 18

None of the analytes were regularly detected in the bay samples Acetic acid was detected regularly in all three of the bog samples after a period of 14 days The certainty of computer identification of the acetic acid generally increased with time (Fig 4)

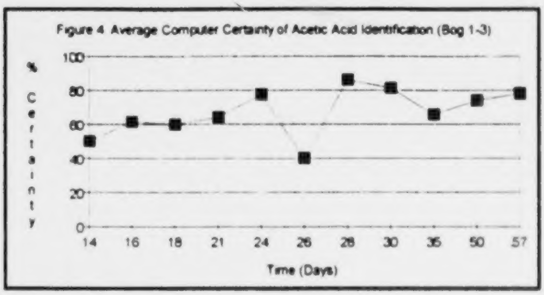


Figure 4 Average Computer Certainty of Acetic Acid Identification (Bog 1-3)

DISCUSSION

Redox values between 200 and -200 mV are considered characteristic of reduced soils (McKee and McKevlin, 1993) The redox of the bog and bay columns did not differ significantly although the carbon content of the two soils differed greatly Redox was consistently below 200 mV for all of the soil columns after Day 12 The bog columns showed acetic acid regularly after Day 14 while the bay columns did not Acetic acid appeared more frequently in Bog 1 before Day 14, and the redox of that column stayed consistently below 200 mV after Day 5 Acetic acid began to appear regularly in all the bog samples only after the redox of all three remained under 200 mV Acetic acid appeared only sporadically in the Bay samples, although the redox potentials were similar to those of the bog samples This suggests that the appearance of acetic acid was linked to greater carbon content of the bog soil

The results of the experiment were not as anticipated We consistently failed to detect lactic acid and ethanol, two of the more important fermentation products, in our standard Ethanol moved through the column almost as quickly as the solvent and could not be separated from the solvent Lactic acid was never identified as a solution component, even when a standard of commercial material was used This result is possibly a function of the specific nature of our GC column and the broadening of the sample peak into the baseline Also, lactic acid and ethanol can be metabolized by soil microorganisms into other substances like acetic acid (Ponnamperuma, 1972) Products could have been lost through these metabolic processes or by volatilization on contact with air in the sampling syringe

Our results suggest that the presence of acetic acid may be key in determining whether fermentation is occurring in a flooded soil The mountain bog soil, with an organic matter content of 13 3%, consistently yielded acetic acid, suggesting that for this soil fermentation begins to occur within two weeks of flooding The Carolina Bay soils, with only 6 9% organic matter content, showed no consistent pattern Further research could determine if acetic acid is the primary indicator product of fermentation One way to approach the problem is to conduct a similar experiment with soils containing more organic matter Another option is to refine the methodology, perhaps with a more sensitive detection method, and repeat the experiment If acetic acid is an indicator product, soils could easily be evaluated for the fermentation process

ACKNOWLEDGMENTS

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REFERENCES

Faulkner, S P., and W H Patrick, Jr 1992 Redox Processes and Diagnostic Wetland Soil Indicators Soil Sci Soc Am J 56 856-865

Gee, G W and J W Bauder 1986 Particle Size Analysis p 383-411 In A Klute (ed) Methods of Soil Analysis Part 1 2nd ed Agron Monogr 9 ASA and SSSA, Madison, WI

McKee, W H Jr and M R McKevlin 1993 Geochemical Processes and Nutrient Uptake by Plants in Hydric Soils Environmental Toxicology and Chemistry 12 2197-2207

Nelson, D W , and L E Sommers 1982 Total Carbon, Organic Carbon, and Organic Matter p 539-579 In A L Page et al (ed) Methods of Soil Analysis Part 2 2nd ed Agron Monogr 9 ASA and SSSA, Madison, WI

Plumb, R H Jr 1981 Procedures for handling and chemical analysis of sediment and water samples Environ Lab , Vicksburg, MS

Ponnamperuma, F N 1972 The Chemistry of Submerged Soils In N C Brady (ed), Advances in Agronomy 24 29-96 New York, NY Academic

The Invasion of Carrotwood (*Cupaniopsis anacardioides*) A Study Comparing the Impact of an Exotic Species on two Islands in Sarasota, Florida

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ABSTRACT

The Carrotwood tree is a native of Australia, but is commonly planted for landscaping purposes in southern Florida. After it escaped cultivation in the 1980s, it quickly established itself on mangrove and spoil islands where it thrives under the shade of Australian Pines and among coastal and inland mangroves. The species has recently been added to a Sarasota County ordinance (along with Australian Pine, Brazilian Pepper and Melaleuca trees), banning its future sale, transport and propagation. This is the first step in controlling Carrotwood growth. However, a lack of research into the species, particularly in southern Florida, limits the action county officials can take. Therefore, my thesis will focus on baseline scientific experiments that determine Carrotwood density as well as elevation and soil requirements. Two islands will be studied: John MacDonald island in Robert's Bay- formed completely from spoil, and Otter Key in Sarasota Bay- a natural island onto which spoil was dumped in the 1920s. These data will be used to compare the impact of the exotic species on two islands of different historical and vegetative origins and to evaluate environmental factors that may limit its growth.

BACKGROUND

The Carrotwood tree (*Cupaniopsis anacardioides*) is the most recent arrival of a group of exotic pest plants from Australia that were originally introduced to Florida as landscape plants. The species is a native of southeastern Queensland where it is common in depauperate rainforests along creek banks (Peter Mackey, personal comm.). Once thought to be "the perfect landscape tree", for the region (Newton, 1985), Carrotwoods began to escape from cultivated areas in the 1980s, and are currently invading the coasts of southern Florida - particularly mangrove and spoil islands. It is an aggressive species that can turn natural landscapes into dense exotic cover. Scientists with the bureau of Aquatic Pest Management surveyed the vegetation on over 100 spoil islands on the eastern coast of Florida. In 1988, no Carrotwoods were found, but a re-inspection in 1990 found many young Carrotwood plants (J. Jordan, personal comm., phide Oliver, 1992). Since Carrotwood is such a new arrival, not many of its natural history characteristics or distribution factors are known. Furthermore, there are no published scientific papers resulting from research conducted in Florida. This lack of information makes control and eradication of the pest even harder. Sarasota County has taken the first step by passing a stringent ordinance banning its sale, transport and propagation. Other coastal counties in Florida have passed similar, usually less strict, ordinances, but until more is known about the species and what affects its growth, control will be difficult.

To study the impact and habitat preference of non-cultivated Carrotwoods in natural areas, two islands were chosen for the analysis of plant density, soil salinity, soil pH and elevation. John MacDonald island (T37S R17E S1, Robert's Bay, Sarasota County) is a man-made spoil island created in the late 1960s. A relatively small strand of mangroves line the coast, while the interior is dominated by exotics - primarily Carrotwood and Australian pine (*Casuarina equisetifolia*). Unevenly distributed spoil piles are still evident in the ridge and swail system on which the vegetation grows. Otter Key is not a man-made island, but human intervention has played a minor role in the vegetational history of the island. In the 1920s, while the waterfront area of Sarasota was being developed, a plan arose to connect Otter Key to the mainland and develop it. This plan was never completed, but spoil was dumped onto the northern tip of the island and rows of Australian Pine trees were planted. However, the make-up of the two islands is drastically different. Otter Key is characterized by dense mangrove cover throughout the island and noticeably less exotic invasion. Human disturbance is less common because the vegetation is so thick in some areas that it is not possible to walk from one end of the island to the other. The hypothesis which forms the basis of my study is: the density of Carrotwoods will be different on these two islands because of the differential environmental characteristics of each island (i.e. pH, soil salinity, elevation).

METHODOLOGY

Four belt transects were set up on each island, beginning in areas of Carrotwood invasion (Transects 1, 2, 3 and 4 on John MacDonald Island and Transects A, B, C and D on Otter Key). Each transect was 25 meters long and 2 meters wide, consisting of five adjacent plots running in the same compass heading (the transects on John MacDonald Island followed the North-South compass line, while the transects on Otter Key ran parallel to the East-West compass line). Each plot was five meters long and two meters wide. All plants along the transect were identified, counted and placed into one of three size classes: Small (less than 0.5 meters), Medium (0.5 - 2 meters) and Large (taller than 2 meters). Carrotwood densities were calculated as number of plants found per square meter. Habitat type, disturbance and dominant species were also recorded for each plot.

Four soil samples were collected from each plot and analyzed for soil salinity and pH. Starting from the first plot, the samples were taken at 2.5 meter intervals, alternating between right and left side edges of the plots. Collections were made at two different depths from each of the sampling areas by using a soil auger. The auger was used to reach 9 inches into the ground, and again to take the second sample at 18 inches deep. The first depth, 0-9 inches, was labeled "X", while the second depth, 9-18 inches, was labeled "Y". Each time a sample was taken, a hand-held Kelway pH meter was used to find the pH of each sample before they were prepared for salinity analysis. Preparation and filtration of the samples followed the methods outlined by Head (1980) and Black (1965). All samples were allowed to air dry for a total of three days before being placed into the oven for further drying (the temperature in the ovens did not exceed 120 degrees Fahrenheit). After 24 hours, they were removed from the drying oven and placed into a sealed dessicator for an additional three days. This prevented the dry soil samples from collecting moisture from the surrounding air. All dry samples were crushed, passed through a 2mm sieve and prepared in a 1:1 soil to distilled water ratio. From there, they were filtered using a vacuum filtration apparatus. The filtrate was then placed onto a hand-held refractometer to record salinity.

The elevation of the transects was determined by using a combination of surveying techniques. Points of known elevation were found on the mainland by using city and county benchmarks. Differential leveling was used to transfer the established elevation of these points to the seawalls of two houses nearest the islands. Once the elevation was known, a computerized tachymetry level was placed on the seawall and a receiving prism was placed onto the island in sight of the level. The tachymetry level surveys in three dimensions, the level recorded the vertical and horizontal angles between the seawall and the island as well as the distance between the two points. The tachymetry level was then transferred to the island were the elevation was recorded for points of interest. In each plot, elevation was recorded at all four boundary pegs, soil sample locations, all Carrotwoods (with the exception of seedlings), other tree species that were taller than 2 meters and any point on the ground with noticeably higher or lower elevation. The information stored in the tachymetry level was used to plot points and construct contours.

RESULTS AND CONCLUSIONS

John MacDonald Island has a much higher density than was found on Otter Key. Figure 1 outlines the difference in densities between plots and between islands. Most of the density on John MacDonald was from seedlings, which were scarce on Otter Key. In fact, many plots on Otter Key had no Carrotwoods at all. Average Carrotwood density on John MacDonald Island transects ranged from 6.98 to 26.1 Carrotwoods per square meter, whereas the range on Otter Key was .29 to 1.68 per square meter.

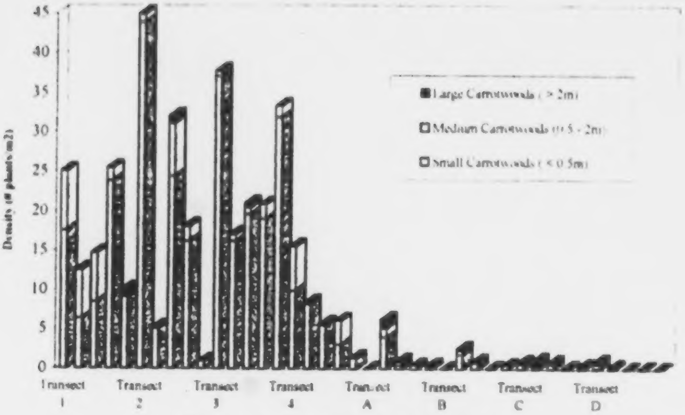

Figure 1: Carrotwood density in each plot.

Although there were a few plots on John MacDonald Island that were closer to sea level than any plots on Otter Key, in general, elevation on Otter Key was lower and less variable. Average elevation hovered around .85 meters. Extreme high and low elevations were not found on Otter Key, whereas the elevation fluctuated greatly between the plots on John MacDonald. This makes sense when you consider that the landscape on Otter Key is relatively constant: the interior is mostly flat, solid ground with even cover, surrounded by mangrove forest. Figure 2 shows the changing elevations on each island.

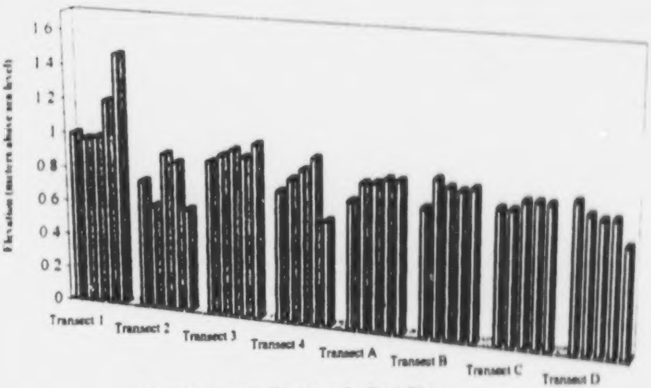

Figure 2: Average Elevation for Each Plot

A correlation was found between soil salinity and elevation. Plots with higher than average elevation were found to have lower salinity levels while more saline plots were usually those lower in elevation. Average salinity was 8.7‰ on John MacDonald Island and 6.8‰ on Otter Key. In plots were the salinity reached 15 or higher (the highest recorded was 35), the elevation never exceeded .80 meters above sea level, and sometimes dropped below 0.60 meters.

A correlation was also found between soil pH and elevation. Plots with higher elevations had pH levels close to 7, whereas surrounding plots were more acidic.

Elevation and specific soil characteristics are related to Carrotwood density on these two islands. However, there are no universal, overlying patterns that relate all of the variables. The pH range of Carrotwoods on these islands was found to be 6.1-6.8 (X) and 5.1-6.5 (Y). It is much easier to look at plots that have very little or no Carrotwood invasion, then examine their elevation and soil characteristics for an explanation. Figures 3, 4, and 5 show how Carrotwood density fluctuates with salinity and elevation.

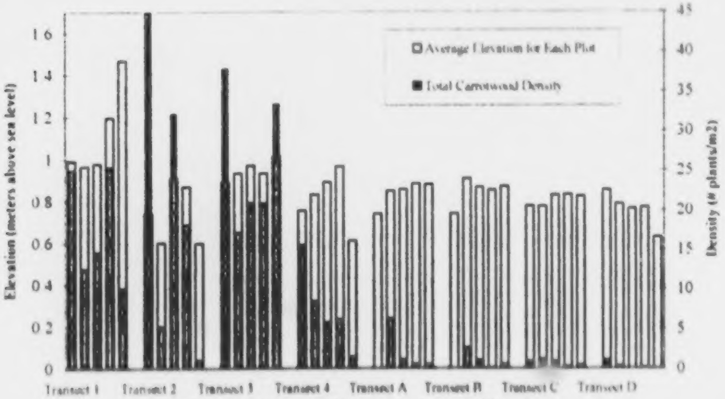

Figure 3: Carrotwood Density vs. Average Elevation

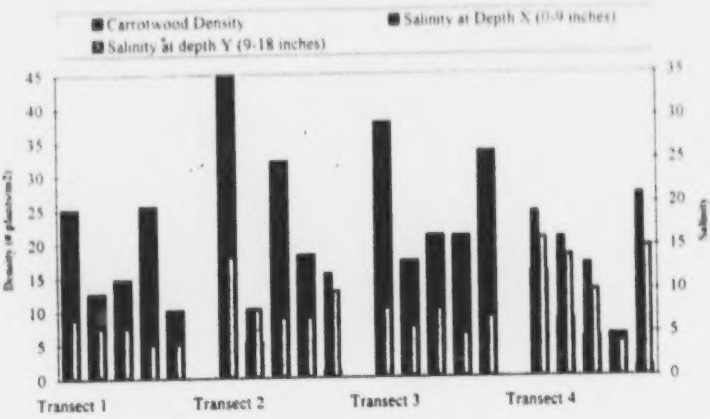

Figure 4: Carrotwood Density vs. Salinity on John MacDonald Island

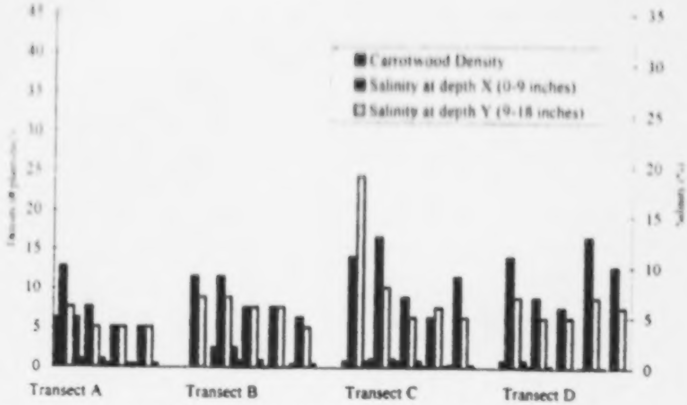

Figure 5: Carrotwood Density vs Salinity on Otter Key

By examining the elevation and soil pH and salinity of each of these plots, some patterns of Carrotwood growth and distribution can be explained. However, although theses are important factors affecting the growth and distribution of the species in Florida, there are many other environmental factors that, when working in concert with these factors, determine where Carrotwoods will grow. For example, Transect 4 on John MacDonald Island has areas of high elevation, neutral pHs and below average salinity levels. If only these three factors were taken into consideration, it would appear that Carrotwood density should be greater in this area. However, it is so close to the shore that the few Carrotwoods that have been able to establish themselves are frequently inundated and killed by the saltwater. This is an area on the island where Carrotwood density is actually the lowest. When trying to explain the growth patterns of Carrotwoods, it is important to consider other factors, such as light availability, exposure to salt spray, proximity to other plants (of the same or different species) and susceptibility to inundation. The data presented here, if analyzed in more detail, might also lead to patterns concerning different environmental requirements for Carrotwoods of different size, or how pH or salinity at different depths affect the growth of Carrotwoods differently.

These plants continue to be pests on the islands, invading inland mangrove habitats and producing dense Carrotwood thickets in some upland areas. Several individuals on each island have bloomed this year, and many other individuals are close in height and DBH to the blooming trees, indicating that they will soon be mature enough to reproduce as well. There has already been a Carrotwood population explosion, which will continue unless measures are taken to prevent or halt their growth and spread.

BIBLIOGRAPHY

Black (ed), 1965. Methods of Soil Analysis, Part 2. American Society of Agronomy: Madison.

Head, 1980. Manual of Soil Laboratory Testing, pps 933-951. John Wiley and Sons: New York.

Newton, 1985. "Carrotwood Tree" Brochure. Florida Cooperative Extension Service.

Oliver, 1992. "Carrotwood: A Review of the Literature" Florida Department of Environmental Protection, Bureau of Aquatic Pest Management.

Urban Forests and Wildlife
A Web Document

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ABSTRACT

Urban forests constitute over half the area of most cities These forests provide food and shelter for many urban wildlife species The present study examines the importance of forests to wildlife in urban areas Two districts of varying degree of urbanization were chosen as the study sites the Downtown District and the Far West End District The project includes the collection of data on trees in the Richmond region, assessment of wildlife common to Richmond and development of a Web document displaying research results A geographic information system, ArcView, was used to assess the interconnectedness of urban forests and wildlife The web document explains the use of geographic information systems in wildlife assessments and describes how characteristics of forests impact wildlife in urban areas The target group for this document are middle school students and educators in inner city Richmond

INTRODUCTION

Considerable potential exists in metropolitan areas for growing trees, shrubs, and other vegetation Many times, 60% to 80% of a city's area supports enough trees to meet the conventional definitions of a "forest" (Jones, 1995) Also common to the urban landscape are various wildlife species that have adapted well to the urban environment All wildlife must have four things to survive food, water, cover, and a place to live and reproduce (Grisom, 1994) The urban forests can provide three of these four necessities Often the survival of many wildlife species is dependent on the presence of urban forests Characteristics of the urban plant community influence wildlife in many ways

Urban forests provide homes and shelter for various kinds of animals Many types of bird's nests can be found in trees, often these nests are built of parts of trees, like twigs The white-tailed deer and red fox can often be found in wooded areas along urban edges (Mann, 1989) The urban forest also furnishes food for animals The eastern gray squirrel feeds mostly on nuts, flowers and buds of oaks, hickories, and a few other tree species (Mann, 1989) The eastern cottontail often eats green plants In the winter when green plants are scarce, cottontails eat woody plant parts like twig and bark of oak, dogwood, sumac, maple, and birch (Mann, 1989)

There are other indirect and less obvious ways in which vegetation influence wildlife The urban forest acts as buffers along streams and other waterways, soaking up nutrients washing from urban areas that might otherwise pollute these waters (Alore, 1995) Plants also help control soil erosion that would render ponds unsuitable for many water animals Urban wildlife like the mallard duck, snapping turtle along with various types of frogs are able to find suitable habitat in urban areas in part due to the presence of urban forests (Alore, 1995) Additionally the urban forests helps some wildlife by producing leaf litter Many animals make their homes in the leaf litter The red-backed salamander spends it entire life in leaf litter and underground (Glass, 1986)

Tree condition is important to wildlife Healthy trees will produce abundant amounts of food and provide strong shelter for animals Dead trees also offer benefits to wildlife and in actuality have great ecological value Many animals use the hollow of dead trees as their home The wood duck and barn owl use natural cavities in trees as nesting sites (Ross, 1983) Pair of raccoons often rests in the hollow of trees (Ross, 1983) A branch that falls on the ground or a log that may be present on the ground can provide a home for smaller animals like the red-backed salamander or a toad or frog A dead tree trunk will also attract a woodpecker (Ross, 1983)

This project characterizes urban forests in two districts of the City of Richmond the Downtown District and the Far West End Districts. Each district is evaluated based on tree species composition and health. The data is analyzed using a geographic information system (GIS), ArcView. The end product is a highly interactive, multimedia web document examining the urban forests in the two districts using ArcView to predict the types of wildlife and spatial occurrence associated with each of the two districts. The document is directed toward middle school inner-city students in the City of Richmond. Information inputted into ArcView on tree species and condition allows the student to predict the types of wildlife present in certain areas of the city.

MATERIALS and METHOD

Data Collection. Data on trees collected by City of Richmond officials were procured and served as the main source of vegetation data. Data was "ground truthed" via aerial photographs and field observations. The abundance and health of trees at 450 sites were measured. Tree species were identified and the health of each tree was rated as either good, fair, poor, dying or dead. Library research was conducted to obtain information on the types of food and shelter a particular type and condition of tree provides. Information was collected on wildlife largely through library research. Primary information sought was habitat requirements, eating behaviors, urban affinity, and how these characteristics relate to urban forests. Information was also obtained from the Department of Game and Inland Fisheries.

The Study Sites. The City of Richmond divides the city into nine districts. The boundary of these districts were kept intact for the purposes of the project. Ideally all nine districts would have been studied however due to time and resource constraints, the Far West End and Downtown Districts were chosen as the study sites. These two sites represent varying degrees of urbanization that affords an opportunity to study wildlife and vegetation along an urbanization continuum.

. Data Analysis. The types of trees present in the Downtown and Far West End Districts were analyzed. The most abundant trees in each district were noted. In addition to tree species, the condition of the trees in each of the two districts was investigated. Thus the two characteristics of trees focused on were tree type and condition. The geographic information system, ArcView, was used to couple the tree data with wildlife. Layers with tree species and health were created and overlaid on the City of Richmond. From these maps, predictions about the types and spatial arrangement of wildlife present in each district were made.

The Web Document. All of the preceding information was incorporated a Web document. The Web document target group is middle school students and educators in urban areas, particularly in the City of Richmond. These efforts culminated in an interactive document that teaches students about urban forests and wildlife in the City of Richmond.

RESULTS

Over 100,000 trees were found in the City of Richmond and most were in poor health. Tree composition varied slightly by district, but, for the city as a whole, oaks and maples were the most abundant trees but quite a few other trees were found. Linden, zelkova, and ginkgo were fairly common to the City of Richmond as well. The Downtown site and the Far West End site differed in vegetation composition and number (Fig. 1). The Far West End District contained a greater number to trees than the Downtown District. The most abundant trees in the Far West End were the oak, maple, linden, and pine. The most abundant trees in the Downtown District were the oak, zelkova, maple and elm. The Downtown District possessed a greater percentage of trees that were in good health (Figs. 2 and 3).

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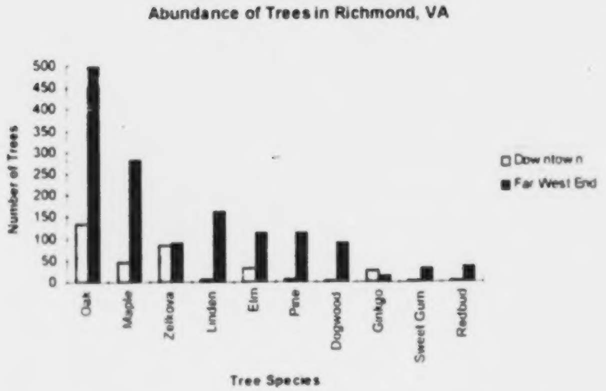

Fig. 1. A comparison of various species of trees found in the Downtown District and the Far West End District

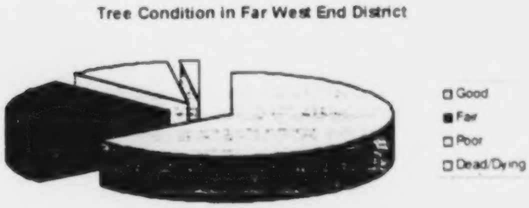

Fig. 2. Trees in the Downtown District based on condition: Good, Fair, Poor, Dead/Dying

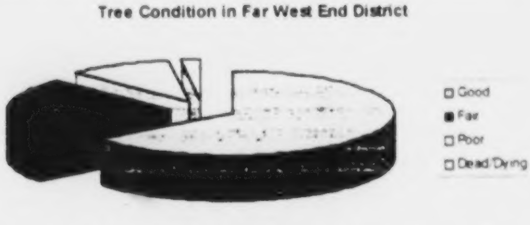

Fig. 3. Trees in the Far West End District based on condition: Good, Fair, Poor, Dead/Dying

DISCUSSION

Middle school inner city students were chosen as the target group for various reasons. This document serves a twofold purpose, (1) to introduce the student to ecology and (2) to acquaint the student with computers. It is recognized that most inner city schools are lacking in science instruction. This document is a means by which a great number of students can be introduced to urban ecology. This introduction is very pertinent to the lives of the target audience in that urban forestry and wildlife can be observed and studied in and around their neighborhoods and schools. With this document, it is hope that a sense of curiosity will be ignited for ecology. Secondly, computer skills are paramount for the future By bringing urban ecology to students via the internet, they are introduced to computers by the mere fact that the mode of communication is through the Web Furthermore, the document demonstrates how the use of GIS software has applicable uses and facilitates a better understanding of the world around us

Many hours of hard work went into designing the Web document to make is as appealing, interesting, and educational as possible to the target audience In doing this, the document utilized advance computer capabilities This document definitely on the cutting edge of technology The document is a multimedia show in which color pictures, maps, and other graphics illustrating points are flashed on the computer screen as a dialogue is heard is the background explaining the material Bullet summaries of the important points of the dialogue also appear on the screen The main character, Sandra, is modeled after an actual student who attends school in the City of Richmond Sandra visits a fictitious character known as Dr Greenetree, who shares with her information about Richmond's urban forests and wildlife The two characters discuss urban wildlife and forests as they tour the City of Richmond pointing out relevant sites along the way It is hoped that many of the areas featured in the document will be familiar to the target audience

The importance of GIS to this project cannot be stressed adequately It is the basis of the project that enables the student to indicate where the predicted wildlife will occur The use of GIS within this document was kept on an elementary level to meet the needs of the target audience However, the uses of GIS extend much further beyond the realms defined here In future modifications of this document, more extensive and in-depth use of GIS will be incorporated

There are several weaknesses of this project Information was presented as clearly and accurately as possible, however, assumptions had to be made about wildlife habitat preferences when predicting wildlife associations with various types of plants The underlining reasoning the document is based in is that since vegetation abundance and type influences wildlife and the vegetation differs in the Downtown and Far West End Districts then the wildlife in each area differs The characteristic wildlife of the two districts will differ based on these vegetation differences Exactly what these differences are can only be assessed in the field The conclusions drawn in the document are based on literature research, not field research which may present certain weaknesses

Regardless of the shortcomings of the project, it is hoped that students will find the document educational and beneficial in many ways Ultimately, it is hoped that the document will be adopted into the City of Richmond School System

LITERATURE CITED

Alore, C (1995) Urban Forests Benefits American Forests 21 34-37

Glass, L (1986) Reptiles and Amphibians of Virginia Charlottesville, Virginia University of Virginia Press

Grisom, C T (1995) Wildlife Habitats New York, Harper and Row Publishing

Jones, R V (1995) Forestry in the City American Forests 21 74-78

Mann, J M (1989) The Mammals of the Carolinas and Virginia Chapel Hill, North Carolina, Chapel Hill Press

Ross, B (1988) Dead Trees Full of Life American Forests 14 23-26

Effects of Stratification on Germination of Two Oak Species in Southeastern Arizona

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The goal of this experiment was to evaluate the roles of stratification time and pre-storage water immersion temperature on the proportion and rate of germination of two oak species in southeastern Arizona. 1,200 *Quercus emoryi* (Emory Oak) acorns were subjected to each of twelve possible treatment combinations of: stratification for 0, 40, 80, or 120 days and water immersion at 4, 25, or 45 degrees Celsius. Due to limited availability, *Quercus oblongifolia* (Mexican Blue Oak) acorns were only subjected to stratification treatments for 0, 40, or 80 days. Germination of *Q. emoryi* was affected by stratification ($P<0.0001$), but there was no main effect or interaction of water immersion temperature. Average *Q. emoryi* germination time decreased 4-fold and percent germination increased 10-fold after 80 days of stratification. Average *Q. oblongifolia* germination time decreased 14-fold after 80 days whereas maximal germination (12%) was obtained after 0 days of stratification.

INTRODUCTION

Oak woodland communities in southeastern Arizona provide important resources for humans and wildlife. Specifically, oak woodlands supply timber and firewood for humans in addition to food and shelter for wildlife. Oak woodlands at low elevations are dominated by *Quercus emoryi* Torr. or *Quercus oblongifolia* Torr. *Q. emoryi* is a member of the subgenus Erythrobalanus (red or black oaks) in the family Fagaceae. Typically, stratification enhances germination of members of this subgenus. However, previous studies of *Q. emoryi* in Arizona reported that stratification did not increase germination rates or proportions after 30 days (Nyandiga and McPherson 1992). Little information is available on the germination requirements of *Quercus oblongifolia* Torr., a member of the Erythrobalanus subgenus (red or black oaks). Prior observations have noted that acorns of this species typically mature beginning in November. Most *Q. oblongifolia* acorns had already reached maturity and fallen off the parent tree in mid to late October of 1996. The difficulty we encountered in predicting the timing of acorn maturity accentuates the need for determining information about phenology and germination requirements for this species in arid regions of the southwest.

Seed predation by herbivores and parasites, particularly weevils in the *Curculio* genus, may decrease germination of oaks. Occupation by weevils usually results in a decline in moisture content leading to acorn mortality. The goal of our experiment was to evaluate the roles of stratification time and pre-storage water immersion temperature on the proportion and rate of germination of low-elevation oaks in the southwestern United States.

METHODS

Q. emoryi acorns were collected at maturity in lower Garden Canyon.

Huachuca Mountains, and O'Donnell Canyon, Canelo Hills on 12 July 1996. *Q. oblongifolia* acorns were collected from Molina Basin, Santa Catalina Mountains, and Madera Canyon, Santa Rita Mountains, during mid to late October 1996. After collection, all acorns were inspected for weevil occupation and other damage. Acorn caps were removed without tearing the seed coat and subsequently float-tested as a screen for premature desiccation (Germaine et al. 1997; Gribko and Jones 1995).

Germination trials were conducted in a Percival model growth chamber with fluctuating 12 hour day and night cycles at 30 and 20 degrees Celsius, respectively. Germination medium was moistened filter paper inside a petri dish. Petri dishes were treated as replicates and randomized every 3 days. Each replicate received water every other day and antifungal treatment (Captan) as necessary. Stratification medium was moistened silica sand in a petri dish stored at 4 degrees Celsius for 0, 40, 80, or 120 days. Immersion medium was tap water at 4, 25, or 45 degrees Celsius for 45 minutes in a controlled-temperature water bath.

1,200 *Q. emoryi* and 225 *Q. oblongifolia* acorns were utilized in germination tests. *Q. emoryi* acorns were subjected to 12 different combinations: stratification period (0, 40, 80, or 120 days) and immersion temperature (4, 25, or 45 degrees Celsius). Due to limited availability of acorns, *Q. oblongifolia* acorns were subjected to stratification periods of 0, 40, or 80 days. Within each *Q. emoryi* treatment there were 10 replicates of 10 acorns. Within each *Q. oblongifolia* treatment there were 5 replicates of 15 acorns. Germination was defined as a radicle length of at least 3 mm. All germination trials were maintained for 2 weeks after the last observed germination or 40 total days, whichever occurred first.

RESULTS

Germination was affected by stratification ($P<0.0001$), but there was no main effect or interaction of water immersion temperature for *Q. emoryi*. Average *Q. emoryi* germination time decreased from 21 days without stratification, to 9 days after 40 days of stratification, and to 5 days after 80 days of stratification. *Q. emoryi* percent germination increased from 4% without stratification, to 43% after 40 days of stratification. Longer stratification periods did not affect germination ($P>0.15$). Average germination time for *Q. oblongifolia* decreased from 14 days without stratification, to 4 days after 40 days of stratification, and to 1 day after 80 days of stratification. Average percent germination of *Q. oblongifolia* was maximal (12%) after 0 days of stratification, decreased to 2% after 40 days, and was 6% after 80 days of stratification. Water immersion had no effect ($P>0.13$) on percent germination or germination time of either species.

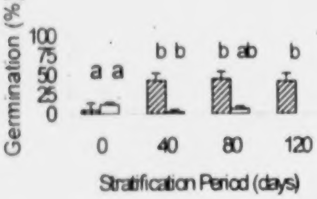

Figure 1. Average percent germination of *Quercus emoryi* (filled bars) and *Quercus oblongifolia* (open bars). Within a species, standard error bars with the same letter do no differ ($P>0.05$).

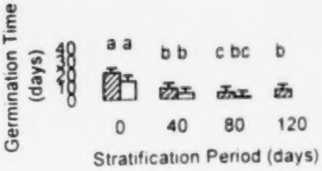

Figure 2. Average germination time of Quercus emoryi (filled bars) and Quercus oblongifolia (open bars). Within a species, standard error bars with the same letter do no differ (P>0.05).

DISCUSSION

Contrary to findings in earlier studies (Nyandiga and McPherson 1992), these results indicate that Q. *emoryi* germination is clearly enhanced by stratification. Stratification for 40 days decreased average germination time nearly 3-fold. Furthermore, percent germination increased 10-fold after 40 days of stratification relative to non-stratified acorns. Stratification for longer than 40 days did not produce additional increases in percent germination. Water immersion treatments did not affect percent germination or germination time. Therefore, these results indicate that a 40-day stratification period provides an appropriate stratification treatment to maximize percent germination and minimize germination time.

Subtle differences in handling techniques and an atypically dry year may have produced germination responses contrary to those observed previously. Acorn processing in this study was done immediately after collection (within 12 hours of collection) whereas Nyandiga and McPherson (1992) may have allowed one or more days to elapse prior to the completion of acorn processing. Young and Young (1992) observed that acorn moisture contents below 20-30% in the Erythrobalanus genus were lethal. Bonner (1996) reported lower tolerable moisture contents (10-15%) for the same subgenus. Bonner (1996) also reported that 25% of acorns with moisture levels below lethal thresholds would survive if rehydrated within 48 hours.

Germination time for Q. oblongifolia decreased 3-fold after 40 days of stratification, and 14-fold after 80 days of stratification. Percent germination was highest (12%) in the 0 day stratification treatment and decreased to 2% after 40 days of stratification.

NATURAL RESOURCE MANAGEMENT IMPLICATIONS

These results have important implications for the maintenance and regeneration of oak woodland ecosystems in southeastern Arizona. Increased population levels have subjected these communities to higher utilization and visitation levels than previously experienced. Urban developments and agricultural fields have been replacing oak woodlands in order to satisfy human demands. To maintain oak woodlands on a sustainable basis, resource managers need to concentrate on protective solutions before the option of regeneration is not available. The practical tools presented here will allow resource managers to achieve higher success rates in terms of increased total germination and decreased germination time. Limited funding for ecosystem conservation mandates the development of economically feasible maintenance and regeneration tools. Maintaining oak woodlands on a sustainable basis appears to be an economically feasible long-term option.

ACKNOWLEDGMENTS

I thank Heather Germaine and Jake Weltzin for their help in collecting data

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and editorial revisions and Laurie Abbott for her help in the editorial process. Finally, I thank Guy McPherson for his support and funding throughout the experiment. This project was funded by The University of Arizona Undergraduate Biology Research Program (UBRP), The University of Arizona Honors Grant Program, and the United States Department of Agriculture National Research Initiative Competitive Grants Program.

LITERATURE CITED

Bonner, F.T. 1996. Responses to drying of recalcitrant seeds of *Quercus nigra* L. Annals of Botany 78: 181-187.

Germaine, H.L., G.R. McPherson, K.J. Rojahn, A.M. Nicholas, and J.F. Weltzin 1997. Constraints on germination and emergence of Emory Oak. In R.B. Standiford (technical coordinator), Oak Woodlands: Ecology, Management, and Urban Interface Issues. USDA Forest Service Pacific Southwest Experiment Station General Technical Report, Berkeley, California. *In Press.*

Gribko, L.S., and Jones, W.E. 1995. Test of the float method of assessing northern red oak acorn condition. Tree Planter's Notes 46: 143-147.

Nyandiga, C.O., and McPherson, G.R. 1992. Germination of two warm-temperate oaks, *Quercus emoryi* and *Quercus arizonica*. Canadian Journal of Forest Research 22: 1395-1401.

Young, J.A., and Young, C.G. 1992. Seeds of Woody Plants in North America. Discorides Press, Portland, Oregon.

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Seasonal Fluctuations in Central Greenland Ice Sheet Radar Altimeter Return Characteristics

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Geosat altimeter returns from an area of the Central Greenland ice sheet were analyzed for spatial and temporal patterns. Return waveforms were geographically divided into twelve 1° latitude by 2° longitude cells, and then averaged for 21-day and 17-day periods. The maximum slope of the mean cell waveform and an averaged Automatic Gain Control (AGC) value were calculated. Spatially, cell mean maximum waveform slope and AGC strongly correspond to changes in surface slope over the study area. Temporally, maximum waveform slope and AGC exhibit seasonal cycles. Maximum waveform slope displays a biannual cycle with maxima in the summer and winter and minima in the spring and fall. AGC values demonstrate an annual cycle characterized by large drops during the fall months. Changes in snow surface properties are most likely responsible for the seasonal variability in maximum waveform slope and AGC. Surface roughness, snow grain size, and snow density, as determined by wind speed, temperature, and precipitation, influence the shape of the return waveform and the percentage of power returned.

BACKGROUND

Satellite radar altimetry has traditionally been used to measure the elevation of low-slope water, ice, and snow surfaces. Altimeter return characteristics can also reveal information about snow surface properties. The satellite emits a microwave pulse and then records power returned versus time as a waveform. Surface and volume scattering from snow can affect the shape of the return waveform. Snow properties, including surface roughness, snow grain size, and snow density, influence surface and volume scattering. Ridley and Partington (1987) and Davis and Moore (1993) have developed return waveform-fitting models containing snow property terms.

Surface slope is very important in determining the shape of the waveform and the percentage of power returned. Steeper surface slope produces a larger radar footprint. A larger footprint returns the radar pulse over a longer period of time, effectively stretching out the waveform. Larger slopes also scatter more radiation in non-nadir directions, returning less power to the altimeter. Surface roughness is a primary contributor to surface scattering of microwave radiation. Rough surfaces lengthen the period of the return and lower the percentage of emitted power returned to the altimeter. Snow grain size and snow density affect volume scattering. Smaller snow grain size and lower snow density both increase the amount of volume scattering in a snow body. Volume scatter-dominated waveforms typically have lower slopes than surface scatter-dominated waveforms.

METHODS

Geosat radar altimeter data returned from Central Greenland over a period of two years (1987-88) were analyzed for spatial and temporal trends. A study area in Central Greenland (Figure 1) was situated well away from higher slope areas of the ice sheet. Surface slope in the study area did not exceed 0.5° at a resolution of 5 minutes. The study area was divided into

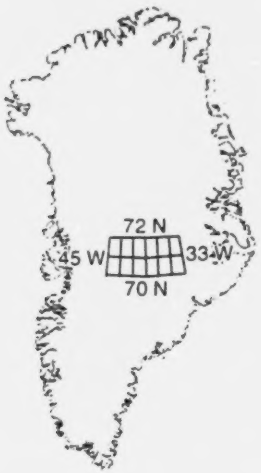

Figure 1. The study area, Central Greenland.

twelve 1° latitude by 2° longitude cells to control for slope effects. For each cell, 21-day averages of waveform shape and the Automatic Gain Control (AGC) were computed. AGC adjusts the sensitivity of the altimeter receiver, and is directly related to the amount of power returned. The 17-day period averages were also calculated to ensure the validity of the 21-day averages. The maximum slopes of the average waveforms were derived for each of the cell-periods. Normalized cell-mean maximum waveform slope and AGC were then combined by averaging the values over the entire study area.

RESULTS

Maximum waveform slope and AGC varied inversely with surface slope. Cells with steeper surface slopes tended to have low maximum waveform slope and AGC values. This spatial pattern was expected, because surface slope is known to contribute significantly to the shape of the return waveform and the power of the return. Steeper-slope regions of the study area had larger footprints and increased off-nadir scattering, lengthening the time of the return, thus lowering the slope and reducing the total power returned.

The temporal variations witnessed in both the 21-day and 17-day periods were much more complex. Both maximum waveform slope and AGC exhibited seasonal cycles. Maximum waveform slope displayed a biannual signal, with high values occurring in summer and winter months and low values occurring in spring and fall (Figure 2). AGC showed a more annual signal, with a sharp drop in AGC values during fall months (Figure 3). A much smaller minimum in AGC, corresponding to the spring minimum in maximum waveform slope, was evident. When plotted together, maximum waveform slope and AGC display similar trends (Figure 4). The two return measures experience similar temporal oscillations.

DISCUSSION

The discovery of a seasonal signal in Greenland radar altimetry data is not unprecedented. Andersen (1994) calculated annual variations in altimeter-determined elevations using one and a half years of ERS-1 data. The annual variation, which Andersen attributed to winter snow accumulation and summer melting, was lowest in the central part of the ice sheet. Andersen speculated that annual variation is near zero for the central ice sheet, where melting does not occur on an annual basis.

Seasonal changes in surface roughness are the most likely cause of the temporal fluctuations in maximum waveform slope and AGC. Through the construction and destruction of snow dunes, wind can alter the surface roughness of the Greenland ice sheet on a scale from

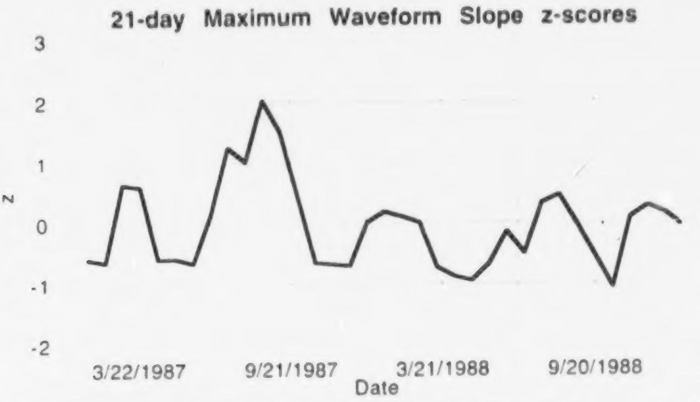

Figure 2. 21-day maximum waveform slope. Note high maximum slopes in the summer and winter, and low maximum slopes in the spring and fall.

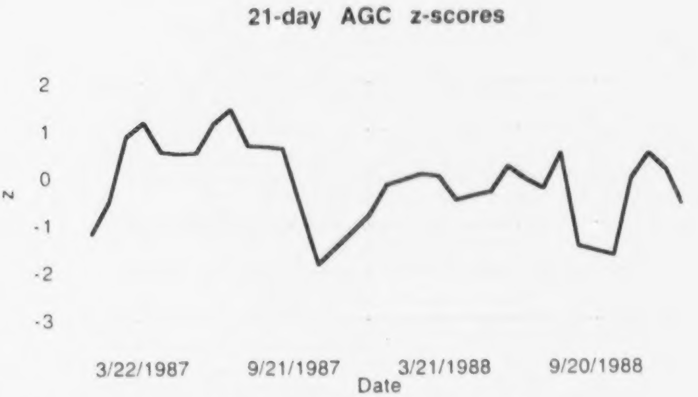

Figure 3. 21-day AGC. Note the large drops in AGC values in the fall.

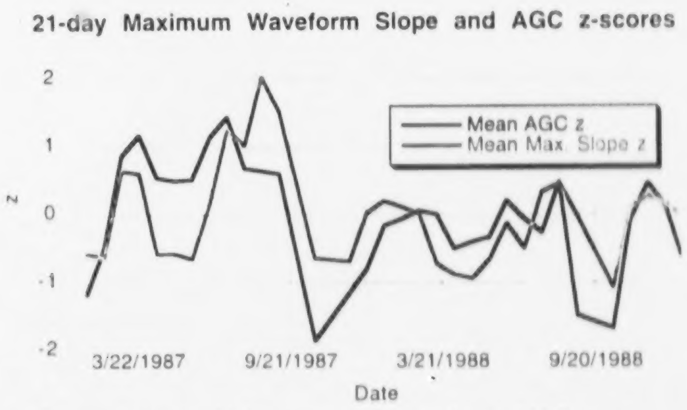

Figure 4. Comparison between 21-day maximum waveform slope and AGC z-scores.

centimeters to meters. Unfortunately, wind speed records for the interior of Greenland are short in duration and sparse in spatial coverage. Only a few months of wind speed data from an Automatic Weather Station (AWS) were available for the study period. The duration and quality of these data were not sufficient to merit detailed analysis. Better AWS data from 1991 point to an annual cycle for wind speed, with a maximum in late February to early March and a minimum in July, August, and September.

The timing of this cycle does not support seasonal fluctuations in wind speed as an influencing factor in the temporal variability witnessed in maximum waveform slope and AGC. The late-winter peak in wind speed corresponds to high values of both maximum waveform slope and AGC, which are associated with a smoother surface. Low maximum waveform slope and AGC values, which indicate increased surface roughness, occur in the spring and fall, when wind speed is changing. Although wind speed does not appear to play a major role in the determination of annual fluctuations in maximum waveform slope and AGC, it is possible that wind speed is a minor influence, or that changing wind speed reorganizes snow dunes, causing a lowering of maximum waveform slope and AGC values, or that the seasonal behavior of wind speed values were different during the study period and during the period of wind data collection.

Other factors that could influence the determination of temporal fluctuations in maximum waveform slope and AGC include precipitation and temperature, which affect centimeter and millimeter scale surface roughness, grain size, and snow density. Precipitation in Greenland generally peaks in the warmer months of June to September and is lowest in late winter (Shuman and others, 1995). The Greenland ice sheet is also warmest during the summer. Both higher temperatures and new snow produce larger grain sizes and less dense surface snow. The summer increase in maximum waveform slope supports a summer rise in surface scattering caused by increased snow grain size. The winter peak in maximum waveform slope, however, cannot be explained by snow grain size and snow density effects. Clearly, precipitation and temperature alone are insufficient to explain the seasonal variations seen in maximum waveform slope. Diurnal temperature changes during the spring and fall could have effects on surface roughness or snow grain properties, or snow density layering could influence return characteristics. There is no evidence to support these conjectures, however.

CONCLUSIONS

Central Greenland radar altimeter return characteristics, measured through maximum waveform slope and AGC, exhibit seasonal fluctuations for the years 1987 and 1988. Maximum waveform slope displays a biannual cycle, while AGC demonstrates a generally annual cycle. Both waveform measures are probably influenced by snow surface characteristics, although wind speed, precipitation, and temperature alone do not appear to be significant contributors to either cycle. Further definition of the biannual variability in return characteristics will require the fitting of a waveform model, which will allow the discrimination of which scattering type is causing the seasonal signal. If perfected, the ability to determine changes in snow surface characteristics using radar altimetry promises to be of great utility in detecting climatic change, which could presumably alter the characteristics of the seasonal cycle.

ACKNOWLEDGMENTS

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REFERENCES

Andersen, Ole B. "ERS-1 altimetry on the Greenland ice sheet: Preliminary investigations of annual variations." Geophysical Research Letters 21 (1994) : 1655-8.

Davis, Curt H., and Richard K. Moore. "A combined surface- and volume-scattering model for ice sheet radar altimetry." Journal of Glaciology 39 (1993) : 675-86.

Ridley, J. K., and K. C. Partington. "A model of satellite radar altimeter returns from ice sheets." International Journal of Remote Sensing 9, (1987) : 601-24.

Shuman, C. A., R. B. Alley, S. Anandakrishnan, J. W. C. White, P. M. Grootes, and C. R. Stearns. "Temperature and accumulation at the Greenland summit: Comparison of high-resolution isotope profiles and satellite passive microwave brightness temperature trends." Journal of Geophysical Research D5 (1995) : 9165-77.

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Results of a Microseismic Survey of the Front Range of Colorado

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ABSTRACT

Though the products of past tectonic activity are structurally evident along the Front Range of Colorado, modern seismicity has been relatively quiet, though not completely inactive. An earthquake of approximate M 6.6 (Spence et al., 1996) occurred in north-central Colorado in 1882, and a cluster of moderate injection-induced earthquakes occurred in 1967. Despite the ample geologic evidence for Quaternary fault movements, the seismicity of the Front Range has remained largely unstudied. The first microseismic data for the Front Range was only recently published.

During the fall of 1996, a local seismic network was deployed across the Front Range near Boulder to record local activity as part of a Field Geophysics course at the University of Colorado. These stations were supplemented by two other stations, operated by the United States Geological Survey, in Golden and Idaho Springs, Colorado.

Twenty-three small earthquakes were located within an approximate 50-mile radius of Boulder during a total of forty-five recording days. The earthquakes ranged from magnitude 0.2 to 2.0 on the Richter scale. The smallest earthquake that can be felt is about a magnitude 3, and an earthquake of magnitude 3.5 can cause slight damage. The levels of microseismicity for the study region are about thirty times less than those of the California/Nevada region and about twice as much as New England.

Using the crustal velocity model proposed by Prodehl and Lipman (1989) for the Denver basin, epicenter locations were determined for all local events. We have constructed a map of these epicenters. The most quake activity was located west and northwest of Golden. The microseismic distribution will help isolate faults which may still be active and perhaps to locate previously unknown faults. An understanding of fault locations and activities will lend insight into the dynamics of the Laramide orogeny and also the modern tectonics of the area.

ACKNOWLEDGEMENTS

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INTRODUCTION

Seismicity is the frequency of earthquakes occurring within a given area. Microseimicity is the frequency of small earthquakes that occurr within this area. An earthquake is generally considered small if it has a magnitude less than M 3. Magnitude

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simply refers to the energy, or strength, of a seismic event. A magnitude of M 3 is roughly the level at which an earthquake can be felt by humans. In general, the smaller an earthquake is, the closer together the recording instruments (referred to as seismometers or sensors) need to be to record the event and locate its source (or epicenter).

The level of microseismicity (or the amount of small earthquakes) along the Front Range of Colorado is poorly known. A map of the historic seismicity of Colorado has been produced (USGS, 1993). This map includes events from 1800 through 1993. It is a compilation of events that were recorded instrumentally (with seismometers), historical accounts of earthquakes felt by people and damage incurred, or both. This map is useful in determining areas of generally higher seismicity from areas of generally lower seismicity. However, since it relies largely on earthquakes that were felt and on earthquakes recorded by a sparse network of sensors, it is not useful for determining the levels of microseismicity of a particular area.

One previous microseismic study had been done specifically for the Front Range of Colorado and another in the Paradox Valley / Ridgeway area. The results were used to produce a map of the microseismicity recorded during a six month period. This map, however, covers a large area. It's resolution is not fine enough to pick up the multitude of smaller events that only a closely-spaced, local array can. Therefore, this map is useful because it lends insight into the larger-scale, general microseismicity levels of the Front range. However, it is not useful in determining the smaller-scale events of a very localized area, such as the Boulder-Golden region. This map did show a pattern of microearthquake occurrence that matches a pattern which showed up on our new map. This correlation is probably significant and will be discussed later.

The contemporary crustal stress regime in Colorado has been the subject of some debate and has only recently begun to be understood. Colorado seems to be extending along a roughly northeast-oriented axis. (Bott and Wong, 1995). A possible mechanism for seismogenesis in the area is reactivation of existing faults (possibly thrust faults dating back at least as far as the Laramide orogeny, 50-70 million years ago) which are oriented favorably to the contemporary stress field, i.e. oriented west-northwest to northwest (Bott and Wong, 1995). The presence of fault scarps between the ages of 5,000 and 15,000 years along the Rio Grande rift is further evidence of recent extensionally-driven seismicity in the region (Colman, 1986). Furthermore, focal mechanisms of two of the earthquakes related to the Rocky Mountain Arsenal fluid injection have indicated normal (or extensional) fault movement locally in the northern Front Range region (Wong, 1986).

The goal of the present project was to set up a very localized array around Boulder and Golden, Colorado, in order to accurately map local microseismicity patterns. Using three sensors of our own, and incorporating data from two other local United States Geological Survey (USGS) sensors, we set out to record very local earthquakes within a radius of approximately 50 km of the array. This area includes Boulder, Denver, Golden, Idaho Springs, Ward, Ft. Collins, and the Continental Divide region from near Eisenhower Tunnel in the south to about Long's Peak in Rocky Mountain National Park to the north. Within this small region, we hoped to record seismic events as small as M 0. The short spacing between the stations of this array was designed to facilitate this.

RESULTS

Many of the seismic events recorded occurred during the day. This would seem to suggest possible sources other than earthquakes because earthquakes should be random in time. Figure 2 shows a histogram of the number of events recorded (natural or otherwise) from the USGS station in Golden during certain hours of the day. The events seem to increase in number during daylight hours. However, it is important to note that the data from our three stations is biased towards daylight hours. This is due to the fact that the array had a tendency to turn off at night. This became more of an issue as time progressed toward the winter solstice and as the sun progressed lower in the sky. The station near Sugarloaf Mountain (SUG) was especially susceptible to this, as it was located in a forest clearing where trees hid the low-angle sunlight from the solar panels.

Figure 1 contains the final map of earthquakes. It shows locations, magnitudes, error ellipses, and station locations. The map seems to depict an alignment of earthquakes running in a southeast to northwest direction. This alignment is located just west of Golden. The map also shows a clustering of events near a known hard rock quarry where possible blasting may occur. Other events seem to be randomly distributed.

Figure 3 depicts what is known as a b-value plot. It depicts earthquake occurrence (on a logarithmic scale) versus earthquake magnitude. These plots define a roughly straight line. Also included in this figure are the plots for seismicity levels in the California/Nevada and New England regions. The seismicity levels indicated by this project seem to fall in between these two seismicity levels.

DISCUSSION

Most of the events recorded in this project occurred during the day. This may have been caused by a systematic biasing of data towards daylight hours resulting from stations 'powering down' at night. However, the histogram (see figure 2) from the USGS Golden station seems to indicate that seismic activity does indeed increase during the day. This suggests the possibility of mine blasts as significant seismic sources. This is further supported by the apparent clustering of seismic events near a known hard rock quarry in Clear Creek Canyon. These events are probably mine blasts. The fact that they cluster at a known mine (see figure 1) is encouraging because it indicates that the locations achieved through HYPOINVERSE were accurate. The remainder of the events were not clustered and can be considered natural seismic events, or earthquakes.

The apparent alignment of events west of Golden may delineate an active fault. The results of this project by themselves may not be enough to suggest this. However, an examination of the map produced in a previous study also showed an alignment of earthquakes in approximately the same orientation. This strongly suggests the presence of active movement along a fault oriented in a northwest-southeast direction located just west of Golden. This orientation correlates well with the seismogenesis characteristics previously proposed [Bott and Wong, 1995; Wong, 1986]. The earthquakes produced by this fault could indicate the reactivation of a pre-existing fault in response to regional extension.

The b-value plot resulting from this project (see figure 3) suggests a seismicity level for the Front Range that seems about thirty times less than that of the California/Nevada region and about twice that of New England. An extrapolation of the line for this region suggests a recurrence interval for a magnitude 6 earthquake to be between 100 and 1000 years. However, the window of magnitudes sampled by this project is narrow and this extrapolation is tenuous. A permanent array in the area would do a better job of producing an accurate b-value plot.

Also, the alignment of events along the northwest-trending fault near Golden may represent a smaller, more seismically active area. A b-value plot for this region could possibly reflect a shorter recurrence interval for a large earthquake. Not enough data has been collected to determine this. However, it is a serious consideration, especially due to the fault's proximity to the Golden/Denver metropolitan area. Further study is needed to adequately evaluate the seismic hazard potential of this fault.

CONCLUSIONS

Overall, the array recorded and located 23 microseismic events over a total recording time of about 45 days. These microseismic events ranged in magnitude from M_L 0.2 to M_L 2.0. Three of these seem to be a result of blasting in the area. The remainder are natural microearthquakes. An alignment of microearthquakes along a northwest-southeast trending line just west of Golden agrees with the geometry of a previously recorded alignment of microearthquakes. Furthermore, the alignment seems to correspond to generally northwest-southeast trending fault geometries of the area. This all seems to suggest active displacement occurring along a fault in this region. The overall microseismicity level recorded by this array suggests a reccurrence interval of between 100 and 1000 years for an event similar to the M 6.6 that shook the region in 1888.

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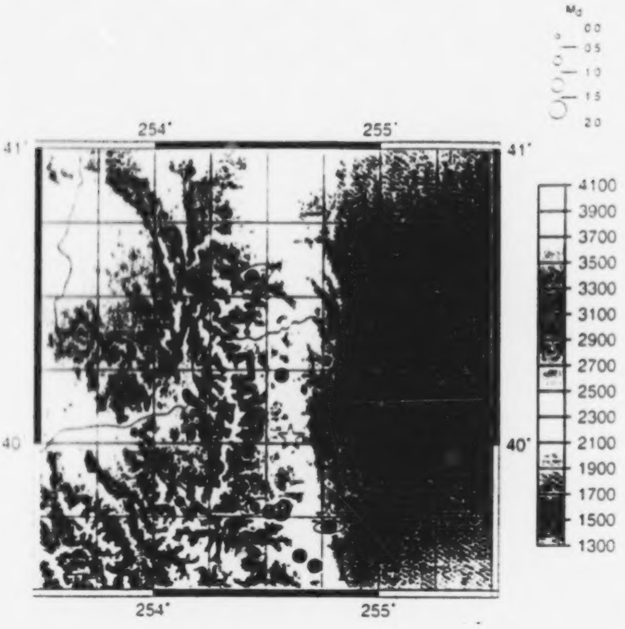
Md
0.0
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2300
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1900
1700
1500
1300
254°
255°

Figure 1 The final earthquake map. The color scale refers to topographical elevation in meters. The earthquakes are denoted by the red circles (smallest = M 0.0 to 0.5, next largest = M 0.5 to 1.0, next largest = M 1.0 to 1.5, largest = greater than M 1.5). The location errors are denoted by the ellipses centered on their respective earthquakes. The station locations are denoted by the stars.

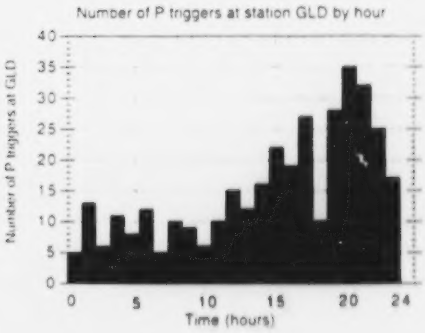

Figure 2. A histogram of the number of events vs. time of day for the USGS station in Golden. Note that the number of events recorded goes up during daytime hours. This indicates that "cultural noise", such as mine blasts, could be producing false seismic signals. The hours are displayed in GMT (subtract 6 hours to convert to MST).

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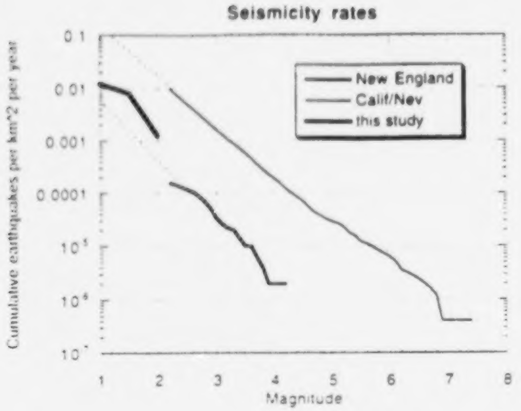
Figure 3 - A b-value plot which depicts earthquake occurrence by magnitude. When earthquake magnitudes are plotted against the occurrence number (on a logarithmic scale) for a given area, the result is approximately a straight line. Here the values for this array have been plotted along with values from other areas (California / Nevada and New England). Note that the Boulder area's level of seismicity falls in between the other areas.



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Atmospheric Teleconnections and United States Regional Climates

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This study attempts to understand the linkage between US precipitation and temperature regions and mean atmospheric flow anomalies represented by atmospheric teleconnection indices. Results indicate that mean zonal flow across North American relates to positive precipitation anomalies in many regions. The precipitation anomalies are especially strong during El Nino months when the moisture and energy flux from the tropics to the mid-latitudes increases. Relationships also exist between areas of mean atmospheric ridging (troughing) and positive (negative) regional temperature anomalies.

INTRODUCTION

The need to understand spatial and temporal variations of atmospheric related phenenomena has grown despite continued technological advances. This is especially evident at the regional-scale as phenomenon, both surface and atmospheric, are difficult to model, interpret, and link to larger-scale features. One method of linking surface parameter variations to generalized atmospheric flow is through correlations with atmospheric teleconnections. Atmospheric teleconnections are large-scale correlations fields in a variable (pressure or geopotential height) that represent standing long waves in the atmospheric flow. Wallace and Gutzler (1981) identified many such atmospheric teleconnections in the 700 mb geopotential height field. They also devised several simple indices to detect the presence and strength of the most important teleconnections in the Northern Hemisphere at a given time. Use of such indices for climate applications has grown tremendously in recent years (Leathers et al., 1991; Rogers and Rohli, 1991). However, many studies do not fully integrate aspects of many teleconnection indices to define links between the surface environment and the atmosphere. This study uses teleconnection indices determined to be most important to the climate of North America to further define the linkage between the atmosphere and United States regional precipitation and temperature variations.

DATA AND METHODS

The regionalization of US precipitation and temperature is fully described in Fiscus (1997). The derived climate regions and the associated climate anomaly time-series from Fiscus (1997) are used exclusively in this study. Surface data are composed of regionally clustered standardized precipitation and temperature anomalies calculated for annual and seasonal time-series.

For the teleconnection analysis, this study utilizes the Pacific-North American (PNA) teleconnection index, and the Southern Oscillation Index (SOI) to estimate generalized Northern Hemisphere atmospheric flow. Data were obtained from the Climate Analysis Center. The PNA time-series used here extends from 1947-1986, and the SOI time-series from 1895-1991. The indices were derived from either standardized geopotential heights (PNA) or standardized sea-level pressure variations (SOI). The teleconnection indices are tied to US regional surface parameters (precipitation and temperature) through Pearson correlation coefficients. Because the teleconnection indices have different record lengths, some bias may be introduced into the correlations analysis as higher degrees of freedom are associated with lower amounts of explained variance in significant correlations.

ANALYSIS

The PNA teleconnection is undoubtedly one of, if not the, most important teleconnection pattern with regard to the North American surface climate. This upper atmospheric pattern has centers of action near the North Pacific subtropical high, the Aleutian low, northwestern North America, and the Florida panhandle. The major characteristic of the PNA flow regime is a ridge, evident in the 700 mb geopotential height field, centered on the Rocky Mountains with adjacent long-wave troughs near the Aleutian and Florida action centers. Changes in the strength and amplitude of the PNA pattern are known to have significant impacts on North American temperature (Rogers and Rohli, 1991) and precipitation (Henderson and Vega, 1996). The pattern has been shown to be temporally persistent on a monthly (Barnston and Livezy, 1987) and intra-monthly (Vega et al., 1995) time-scale, in addition to being evident at various tropospheric levels. Wallace and Gutzler (1981) derived a simple index which estimates flow variations in association with the PNA teleconnection pattern. The index denotes meridional (amplified ridge-trough) long-wave flow through positive index values, zonal (deamplified) flow through near zero values, and reversed (meridional trough-ridge) flow through negative values.

Due to the discontinuous nature of precipitation, few significant relationships are found between the PNA index and the annual time-series. Only the Mid-West (PC1) and Southwest (PC9) regions show a direct relationship with the flow patterns. The weak correlations explain only a small amount of variance and are significant only at the 0.10 alpha level. However, the analysis indicates the relative importance of the long-wave flow regime on the surface climate as a negative correlation exists between the Mid-West region and the index. Zonal flow regimes are therefore responsible for positive precipitation anomalies in this area. Zonal flow ensures that mean wave cyclone trajectories pass over this region. Meridional flow places the mean cyclone trajectories too far to the south during the high positive PNA phase resulting in negative regional precipitation anomalies. Meridional flow associated with the revered phase of the PNA places the region under the influence of the mean upper-air ridge which also significantly reduces regional precipitation. Identifying physical causes associated with the positively associated Southwest region is more problematic. The correlation indicates that amplified longwave flow relates significantly to positive precipitation anomalies within the region. This relationship may extend from the dissipation of Pacific induced wave cyclones during positive PNA times. Zonal low places dissipating cyclones poleward of the region leading to negative precipitation anomalies.

Winter correlations fare much better than those of the annual time-series, validating many previous studies comparing the PNA to the cool season surface environment (Rogers and Rohli, 1991). Significant relationships are found between the index and the Mid-South (PC2), the Mid-West (PC3), the Northwest (PC5), the Upper Plains (PC7), and the Northern Rockies (PC9) precipitation regions. All of the significant correlations are negative indicating that zonal flow regimes, or reversed flow regimes, relate to enhanced precipitation in these areas. This is climatologically plausible as zonal flow is typically indicative of a poleward displaced mean jet, resulting in wave cyclone trajectories over the northern tier of climate regions in the west and the regions which traverse the upper Mississippi and Ohio River valleys in the east.

Of the four significant springtime regions, only the Upper Plains (PC7) shows a weak negative relationship. Positive relationships exist with the Southeast (PC3), the Southern Plains (PC8), and the Central Plains (PC9). This indicates the importance of wave cyclogenesis in the Colorado cyclogenetic region and the resulting trajectories. Positively amplified flow places the mean eastern trough in close proximity to all of the related regions except the upper plains (PC7) which lies poleward of the flow axis during these times. Studies have shown (Henderson and Vega, 1996) that the PNA is a reliable flow indicator during the warm season as it relates to the expansion/contraction of pressure cells in close proximity to the PNA action centers. This relationship is demonstrated by the positive correlations between the index and the Southeastern (PC1) and South Central (PC7) regions. The index is influenced by enhanced onshore flow and low level moisture advection associated with the North Atlantic Subtropical High (STH). Such flow induces low level instability in the southeastern US which enhances precipitation.

During the autumn season, the PNA index correlates negatively with the Mid-West (PC1), the Northwest (PC4), the Southern Plains (PC5), the Northeastern Plains (PC7), and the Northwestern Plains (PC8). Physical mechanisms responsible for such relationships are similar to the annual time-series as zonal flow significantly affects the northwestern tier regions due to a higher mean latitude of long-wave flow.

Surface temperature relationships are easily established with the PNA. Significant correlations agree with previous studies (Leathers et al., 1991) in the negative temperature departures exist in relation to mean troughing while positive relationships relate to prominent ridging. This is true of annual as well as seasonal relationships as many of the temperature regions correlate significantly with the index. The winter and autumn time-series relates especially well to index variations.

Many studies provide insight into the relationship between the SOI and the North American surface climate. Douglas and Englehart (1982) provide an indepth analysis of the links between US precipitation and the SOI, especially for Florida where the SOI explains approximately one half of Florida's precipitation variability. Further links have been established by Henderson and Vega (1996) for the southern US, Vega et al. (in press) for mid-tropospheric variations over the Gulf of Mexico related to extreme SOI phases, and US precipitation patterns and variability (Ropelewski and Halpert, 1989). Although many relationships are apparent, the physical link between atmospheric and SST variations in the equatorial Pacific and the North American surface climate remain ambiguous. Analysis of monthly geopotential height fields reveals a striking correlation between the negative (positive) phase of the SOI (El Nino) and the positive (negative) PNA pattern. It has been surmised that equatorial variations force the PNA into the highly amplified wave pattern through increases in tropic-to-mid-latitude energy and moisture. This is evident through a stronger and more persistent subtropical jet over the western and southern US which induces Gulf of Mexico cyclogenesis (Vega et al., in press) leading to positive precipitation anomalies in much of the US.

This study confirms the relationship between positive precipitation departures in much of the US and the negative phase of the SOI. On an annual basis, much of the central US (PCs 5-8) correlates significantly with the SOI. During the El Nino (La Nina) phase of the SOI, positive (negative) precipitation anomalies occur throughout these regions. The Southwest (PC9) region also negatively correlates to the SOI. This is due to increased cool season cyclogenesis off the Pacific Coast during El Nino times caused by an anomalous warm water pool which supports low level instability. This couples with upper level venting associated with the strengthened subtropical jet inducing Pacific cyclogenesis.

During the winter season, only three precipitation regions correlate negatively to the SOI; the Southeast (PC4), the Lower Plains (PC6) and the Southwest (PC8). During the winter season, the Southeast precipitation region is zonally more inclusive than during the annual time-series. The winter season region includes much of the South Central annual region, implying that much of the association between the Southeast and the SOI resides over the western portion of the region. The Southwest also correlates negatively to the SOI, signifying the link between the warm water anomalies in the southwestern Pacific and cyclogenesis near the west coast of the US. The impact of more frequent cyclogenesis carries through to the spring season as three precipitation regions correlate negatively to the SOI. All of the associated regions are located in the central to western US implying a significant impact from increases cyclogenetic frequency off the California coast.

During summer, two regions correlate significantly with the SOI, the Southeast (PC1) which is positively related and the Southwest (PC8) which is negatively related. The correlations are consistent with those found during other season. The autumn season depicts three regional relationships with the SOI. The Lower Plains (PC5), the Northeastern Plains (PC7), and the Southwest (PC9) are all negatively related. Physical links may be tied to increased frequencies of late season wave cyclones.

Regional surface temperature relationships (annual-autumn) show predominantly negative relationships to the SOI. Therefore, the physical relationship denotes positive (negative) temperature anomalies during the El Nino (La Nina) SOI phase. This physical link relates to the amplification of the mean longwave flow which produces greater temperature anomalies than during relatively steady zonal flow regimes.

CONCLUSIONS

This study attempts to relate previously derived precipitation and temperature regions to mean atmospheric flow anomalies represented by the Pacific-North American teleconnection pattern and the Southern Oscillation. Results indicate that mean zonal flow across North America relates to broadly defined precipitation increases. This is due to precipitation forcing along the greatest expanse of the conterminous US. During highly amplified flow regimes, precipitation forcing is confined to areas south and east of the deepened trough. Mean positive precipitation departures are also evident during El Nino events which relate well to increases in energy and moisture into the US. Temperature relationships are easily defined with areas near mean ridges recording positive anomalies while regions near mean troughs record negative anomalies.

REFERENCES

Barnston, A.G. and R.E. Livezy, 1987. Monthly Weather Review, Classification, seasonality and persistence of low-frequency circulation patterns, 115, 1083-1126.

Douglas, A.V. and P.J. Englehart, 1982. Monthly Weather Review, On a statistical relationship between autumn rainfall in the central equatorial Pacific and subsequent winter precipitation in Florida, 190:22377-2382.

Fiscus, D.M., 1997. Proceedings of the National Council for Undergraduate Research. The derivation of United States temperature and precipitation regions, this volume.

Henderson, K.G. and A.J. Vega, 1996. Physical Geography, Regional precipitation variability in the Southern United States, 17:2:93-112.

Leathers, D.J., B. Yarnal and M.A. Palecki, 1991. Journal of Climate, The Pacific/North American teleconnection pattern and the United States climate. Part I: Regional temperature and precipitation associations, 4:517-528.

Rogers, J.C. and R.V. Rohli, 1991. Journal of Climate, Florida citrus freezes and polar anticyclones in the Great Plains, 4:1103-1113.

Ropelewski, C.F. and M.S. Halpert, 1989. Journal of Climate, Precipitation patterns associated with the high index phase of the Southern Oscillation, 2:3:268-284.

Vega, A.J., K.G. Henderson and R.V. Rohli, 1995. Journal of Climate, Comparison of monthly and intramonthly indices for the Pacific/North American teleconnection pattern, 8:2097-2103.

Vega, A.J., R.V. Rohli and K.G. Henderson, in press. Climate Research, The Gulf of Mexico mid-tropospheric response to El Nino and La Nina forcing.

Wallace, J.M. and D.S. Gutzler, 1981. Monthly Weather Review, Teleconnections in the geopotential height field during the Northern Hemisphere winter, 109:784-812.

Extracellular Acid Phosphatase(s) Activity of the Protozoan Parasite *Perkinsus marinus*

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Recent studies have shown that acid phosphatase (AP) may have the ability to suppress the production of reactive oxygen intermediates in host hemocytes leading to increased infection rates in the host. This study characterized the biochemical behavior of AP extracted from *Perkinsus marinus* to elucidate the functional role of AP within the host-parasite relationship. The effect of temperature, substrate concentration, pH and buffers, and inhibitors on AP activity was determined. The highest activity was observed at 50°C, and activity increased with increasing substrate concentrations. The buffer that displayed the greatest activity was 0.1M acetate buffer at pH 4.0. In comparison, the highest activity in a 0.5M citrate buffer was observed at pH 4.4, in 0.5M McIlvaine buffer at pH 2.8, and in Potassium Hydrogen Phthalate buffer at pH 4.0. Sodium fluoride was a potent inhibitor of acid phosphatase activity. Okadaic acid significantly reduced AP activity, and nodularin was a weak inhibitor at low concentrations. EDTA had no significant effect on AP activity. These results suggest that AP in *Perkinsus marinus* may be a type PP2B phosphatase. Additional study of the purified enzyme may confirm these results and lead to the development of chemotherapeutics.

INTRODUCTION

Phagocytosis and production of reactive oxygen intermediates (ROI) is a main defense mechanism in molluscs. The hemolymph of molluscs is known to be involved in internal defense against invading organisms. When nonself organisms or molecules invade or are experimentally introduced into gastropods or pelecypods they are usually phagocytosed or encapsulated (Cheng and Roderick 1974).

The process of phagocytosis is initiated by the recognition of foreign particles by hemocytes. When vertebrate macrophage membranes are stimulated by non self particles or organisms, stimulation of NADPH oxidase and activation of the hexose monophosphate pathway occurs. This is accompanied by the production of toxic reactive oxygen intermediates (ROI). These ROIs are microbicidal (Volety and Chu 1994).

There are numerous ways that an invading organism may evade the defense mechanisms of the host organism. Certain protozoan parasites employ mechanisms such as active entry into host cells, entry into host cells without triggering the respiratory burst, and suppression and/or inhibition of ROI production by phagocytes (Volety and Chu 1994). A proposed mechanism for the suppression of ROI production is the presence of acid phosphatase in the parasite cells. Acid phosphatase of the promastigote *Leishmania donovani* is capable of inhibiting the production of superoxide anions by human neutrophils (Remaley et al. 1984). This might indicate a contribution of acid phosphatase to the survival of the parasite by interfering with host oxygen-dependent killing mechanisms.

For many years, the eastern oyster *Crassostrea virginica* has been a victim of the protozoan parasite *Perkinsus marinus*. This study was conducted to characterize AP activity in an attempt to better understand its role in the parasite's virulence. Understanding the physiologic and physiopathologic properties of *Perkinsus marinus* acid phosphatase might allow better knowledge about the hemocyte-parasite relationship of *P. marinus* and *C. virginica* and the possible development of chemotherapuetics.

MATERIALS AND METHODS

Perkinsus marinus meronts were cultured in 12 well culture plates (N=6) according to Gauthier and Vasta (1993). A cell viability assay was performed using trypan blue dye exclusion method. Determination of cell protein was carried out according to Lowry et al. (1951). The acid phosphatase activity assays were performed according to Andersch and Szczypinski (1947).

Table 1. Parameters and description of assays performed

Parameters Tested	Assay Components
Buffer System	Acetate, Citrate, McIlvaine, and Potassium Hydrogen Phthalate buffers pH 2.4-6.0
Temperature	6 temperatures in the range of 10 to 70°C
Substrate Concentration (p-Nitrophenyl phosphatase)	7 dilutions ranging from 0.25 to 10 ppm
Inhibitors	Inhibitors tested were NaF, EDTA, Nodularin, and Okadaic Acid (0.00M control)

RESULTS

The results from each assay are shown in the figures below. The acid phosphatase activity of the pH, temperature, and substrate concentration assays are expressed as units per milliliter. The activities for the inhibitor assays are expressed as a percent of the control solution.

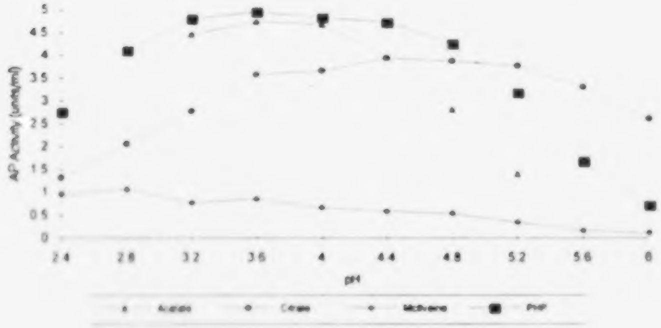

Figure 1. Effect of pH and buffer systems on AP activity of *Perkinsus marinus*

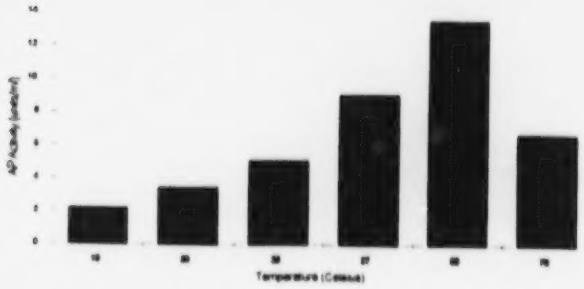

Figure 2. Effect of temperature on AP activity of *Perkinsus marinus*

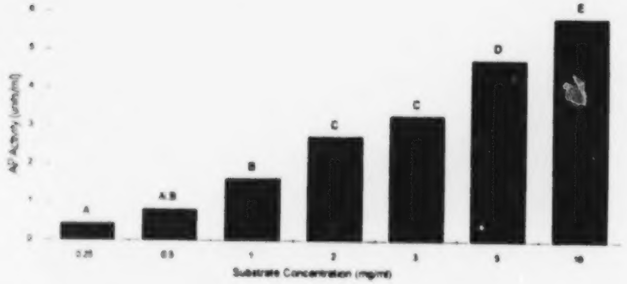

Figure 3. Effect of substrate concentration on AP activity of *Perkinsus marinus*

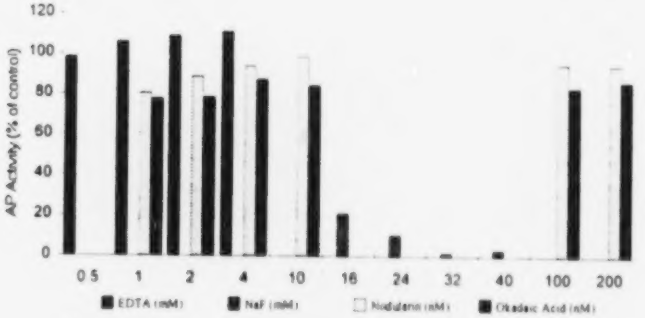

Figure 4. Effect of Inhibitors on AP activity of *Perkinsus marinus*

DISCUSSION AND CONCLUSIONS

The results from the temperature experiment are similar to the findings of Gottlieb and Dwyer (1981). They found that the optimal activity of membrane bound acid phosphatase of *Leishmania donovani* was 42°C. At higher temperatures, a decrease in lysosomal enzymes into the oyster serum has been observed (Chu and La Peyre 1993). With increased activity of acid phosphatase and decreased defense ability, the oyster may be more susceptible to infection at the higher temperatures. The decrease in activity at temperatures above 50°C may be explained by the denaturation of the enzyme.

The pH study yielded similar results of a study of membrane acid phosphatase conducted by Gottlieb and Dwyer (1981). The membrane phosphatase displayed an optimum at a pH of 5.0, while these tests showed an optimum between 3.6 and 4.8 for the three most effective buffers.

The rise in activity correlated with the rise in substrate concentration was expected. There was more substrate from which to liberate *p*-nitrophenol by the enzyme , so the higher concentrations produced higher activities. The inhibitor experiments will perhaps provide the best information for classification of the acid phosphatase.

Sodium fluoride was the only effective inhibitor of this acid phosphatase. All of the test treatment activities were significantly lower than the observed activity of the control. The addition of EDTA to extracellular acid phosphatase had no significant effect on the activity of the enzyme. EDTA is an inhibitor of enzymes which require the presence of divalent cations to be active. Since the phosphatase was not inhibited, its activity is probably not dependent on these cations.

Nodularin was only effective as an inhibitor at low concentrations. Nodularin is a potent inhibitor of PP1 and PP2A but did not effect the activity of extracellular acid phosphatase. Conversely, nodularin is a weak inhibitor of Ca^{+2}/calmouldin-dependent phosphatase PP2B. These reports are consistent with our results. Nodularin has been shown to be enzyme dependent and not substrate dependent, so there is no outside effect from the substrate used.

Okadaic acid has a specific and potent inhibitory activity against PP1 and PP2A (Honkanen et al. 1993). In our study, okadaic was a weak inhibitor of the phosphatase but still stronger than nodularin and EDTA inhibitors. Under experimental conditions reported by Honkanen et al. (1993), okadaic acid inhibits the activity of PP2A and PP3 more potently than PP1(order of potentcy PP2A>PP3>PP1).

According to the literature on protein inhibitors and our results, it seems that this acid phosphatase could be a member PP2B. Since nodularin weakly inhibited the acid phosphatase in these experiments, the extracellular phosphatase could be a member of PP2B. These are similar to the results obtained in this study which may lead to the conclusion that extracellular acid phosphatase from *P. marinus* may be a part of this class of proteins. Further studies of the purified enzyme are needed to verify these results.

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LITERATURE CITED

Andersch, M. A., and Szczypinski, A. J. 1947. Use of p-nitrophenyl phosphate substrate in determination of serum acid phosphatase. Am. J. Clin. Pathol. 17: 571.

Cheng, Thomas C., and Roderick, Gary E. 1974. Lysosomal and other enzymes in the hemolymph of *Crassostrea virginica* and *Mercenaria mercenaria*. Comp. Biochem. Physiol. 52B: 443-447.

Chu, Fu-Lin E., and La Peyre, Jerome F. 1993. *Perkinsus marinus* susceptibility and defense-related activities in eastern oysters *Crassostrea virginica*: temperature effects. Dis. Aquat. Org. 16: 223-224.

Gauthier, J. D., and Vasta, G. R. 1993. Continuous in vitro culture of the eastern oyster parasite *Perkinsus marinus*. J. Biol. Chem. 62: 321-323.

Gottlieb, Michael, and Dwyer, Dennis. 1981. *Leishmania donovani*: surface membrane acid phosphatase activity of promastigotes. Exper. Parasitol. 52: 117-128.

Hervio, D., Chagot, D., Godin, P., Grizel, H., and Mialhe, E. 1991. Localization and characterization of acid phosphatase activity in *Bonami ostreae* (Acetospora), an intrahemocytic protozoan parasite of the flat oyster *Ostrea edulis* (Bivalva). Dis. Aquat. Org. 12: 67-70.

Honkanen, Richard E., Codispoti, Burt A., Tse, Kathy, and Boynton, Alton L. 1993. Characterization of natural toxins with inhibitory activity against serine/threonine protein phosphatases. Toxican. MS 092: 1-12.

Lowry, O. H., Rosebrough, N. J., Farr, A. L., and Randall, R. J. 1951. Protein measurement with the Folin phenol reagent. J. Biol. Chem. 193: 265-275.

Remaley, A. T., Kuhns, D. B., Bradsford, R. E., Glew, R. H., and Kaplan, S. S. 1984. *Leishmanial* phosphate blocks neutrophil O^{2-} production. J. Biol. Chem. 259: 11173-11175.

Volety, Aswani K., and Chu, Fu-Lin E. 1994. Suppression of chemiluminescence of easter oyster (*Crassostrea virginica*) hemocytes by the protozoan parasite *Perkinsus marinus*. Devel. and Compar. Immunol. 19: 135-142

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Microhabitat Use By Fish Populations Within the Little Miami River

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ABSTRACT

Microhabitat (i.e. velocity, depth, cover, and substrate) use by lotic fish assemblages was examined within a fourth-order reach of the Little Miami River, a state-protected scenic waterway originating in Clark County, Ohio. Microhabitat availability and channel structure were mapped for a 270 m study area and fish samples were collected within a stratified random sampling design, where the strata were general habitat classifications (i.e. pool, run, and riffle). Samples were collected from July through November 1996. Fourteen species of fishes were observed within a broad range of microhabitat conditions. The Northern Creek Chub *Semotilus atromaculatus atromaculatus* (Mitchill), Common White Sucker *Catostomus commersoni commersoni* (Lacepede), Ohio Stoneroller Minnow *Campostoma anomalum anomalum* (Rafinesque), and Greenside Darter *Etheostoma blennioides blennioides* (Rafinesque; all species authors from Trautman 1981) were the most abundant species. Analysis of microhabitat use data revealed few strong correlations. Mean depth values for all observed species were limited to a 0.38 to 0.70 m range. While fishes utilized a broad range of mean velocities (0.00 to 0.53 m/sec), within species variation in actual velocity confounded the effort to define significant correlations. Likewise, cover and substrate observations appeared random. The obscurity of these data may be due to extreme shifts in microhabitat availability that occurred during the sampling period (e.g. major flooding, followed by extended drought). However, the failure to determine useful microhabitat trends is most likely due to an insufficient number of samples.

INTRODUCTION

Habitat use by fishes within lotic systems of the eastern United States is a concern that has received much attention in recent years (Grossman and Freeman 1987; Bain et al. 1988; Leonard and Orth 1988; Reiser et al. 1989; Aadland 1993; Vadas and Orth 1993; Grossman et al. 1995). The high species diversity that is typically observed in these warmwater streams (relative to western coldwater streams), combined with the erratic and often times unpredictable nature of hydrologic events, makes it difficult to assess the well-being of native fish populations (Reiser et al. 1989; Langton et al. 1996). Fisheries personnel from all backgrounds should then benefit from sampling regimes that minimize the variation within and between habitat surveys (Reiser et al. 1989). However, such protocols often require extensive support. It therefore becomes important to maximize sampling efforts, as time, resources, and manpower are frequently the most limiting factors within stream surveys (Paller 1995; Peterson and Rabeni 1995).

In this study, microhabitat use by fish communities was examined within a headwater reach of the Little Miami River, Clark County, Ohio. Microhabitat (i.e., depth, velocity, cover, and substrate) was chosen for two reasons. First, microhabitat has frequently been cited as the most significant factor or variable in accounting for fish distribution patterns within warmwater streams of the eastern U.S. (Grossman and Freeman 1987; Bain et al. 1988; Leonard and Orth 1988; Freeman et al. 1990; Aadland 1993). Second, microhabitat is a relatively simple feature to quantify within low-order streams; cover and substrate do present problems when calibrating an appropriate scale for their quantification, but some microhabitat studies have found depth and velocity to account for the majority of microhabitat variance, with little variation attributed to cover and/or substrate (Aadland 1993). Following their collection, microhabitat data were evaluated in the hope of identifying useful trends.

STUDY AREA

Microhabitat data were collected within a fourth-order reach of the Little Miami River (Figure 1). This reach is 270 m in length, with a drainage area of 133.4 km^2. Local geology is characterized by fairly even topography, underlain primarily by limestones and dolomites (i.e., Springfield and Cedarville Dolomites) of the Niagara group (Brown 1960), which are blanketed by large deposits of glacial till.

Land use within the area is predominantly agricultural, based largely upon the harvesting of corn and soybeans. Extensive channelization (particularly straightening) of the channel bed occurred between 1952 and 1958, when a joint effort between the Ohio Department of Natural Resources (Division of Wildlife) and local land owners was instituted to regulate discharge (Brown 1960). However, while optimizing discharge controls, such efforts typically result in the loss of habitat diversity and a consequent reduction in species diversity (Simpson et al. 1982).

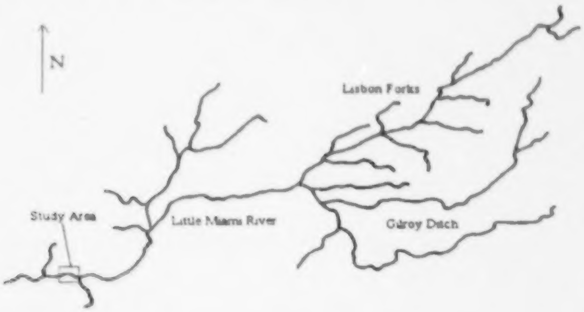

Figure 1. Map of the Upper Little Miami watershed (from U.S.G.S., Springfield, OH; 1:100,000).

METHODS

Surveying of the study area was completed during July 1996, using a modified deflection angle traverse method (Murphy and Willis 1996) to create a scale base map. This map featured habitat classifications (i.e., pools, runs, and riffles) and distinct structural components (e.g., fallen trees, undercut banks, gravel bars, etc.). Generalistic pool, run, and riffle designations were assigned according to Ritter et al. (1995), where pools were relatively deep, slow moving areas, runs were shallow, fast moving zones within the pool-riffle transition, and riffles were similar to runs but characterized by turbulent surface flows. A longitudinal profile was also established for the entire study area.

A stratified random sampling design was used to orchestrate field work (Bovee 1986; Murphy and Willis 1996), with pools, runs, and riffles as the strata. Sampling effort was partitioned among the three habitat classes according to their dominance within the system, while sampling within each strata was randomized.

Fishes were sampled with a Coffelt Mark-10 backpack electroshocker. All samples were set at 300V output, DC, using the Coffelt CPS wave signature and the diamond-ring electrode configuration. Shock intervals ranged from 38-135 seconds, depending primarily upon the complexity of the habitat being sampled; excessive cover generally mandated longer shock intervals. Shocked fishes were collected with dip nets, identified, and measured.

Microhabitat was recorded after each shocking event. Several depth readings were taken at each sample location using stadia rods and meter sticks, with their mean value representing available depth. Velocity readings were taken with a Global Water current meter and averaged for each sample. Substrate was estimated using a modified Brusven index (Bovee 1982) based upon dominant materials (fines, sand, small gravel, medium gravel, large gravel, small cobble, large cobble, boulder), and a relative roughness scale (very rough - very smooth). These two categories or "variables" were then converted to a single substrate value for each observation; dominant material and relative roughness each acted as a treatment in this conversion, creating "substrate scores," ranging from 0-11, based upon the theme: "How difficult is it to walk over this particular substrate?" (A score of 0 indicates a sandy, homogenous substrate. A score of 11 indicates a rocky stream bed, consisting of large particles mixed with smaller ones; a prime opportunity to twist a few ankles.) Cover was classified using the system described by Bovee (1982) and a relative shade designation (total shade - no shade). Cover was also converted to a thematic scale, where the size of local objects, the presence of root wads and/or undercut banks, and overhanging vegetation, along with relative shade, acted as the four treatments. This produced "cover scores," ranging from 0-15, where the highest scores represented the "most complete cover."

RESULTS & DISCUSSION

One-hundred seventy-four fish were collected during the 5 month study period, representing 14 species. The Northern Creek Chub *Semotilus atromaculatus atromaculatus* and Ohio Stoneroller Minnow *Campostoma anomalum anomalum* were the two most abundant species, with 58 and 53 specimens observed, respectively. Extreme standard deviations and coefficients of variation reflect diffuse microhabitat use trends (Table 1). Only depth use by the Northern Creek Chub and the Ohio Stoneroller Minnow indicated strong central tendencies.

A broad range of discharge events took place between June and November 1996. Excessive rainfall led to extreme flooding during most of June, with discharge reaching stages greater than 6 times the median daily streamflow for the past 41 years. However, severe drought throughout August and early September 1996 produced either an intermittent or stranded condition within many upper reaches of the Little Miami River. Therefore, a consequent loss of habitat diversity and/or availability may have occurred (Simpson et al. 1982; Bain et al. 1988). Discharge values observed during sampling events ranged from 0.19 to 0.41 m^3/sec.

Although microhabitat use trends were not readily apparent, a collective look at all species does suggest what might be a limiting microhabitat factor: mean depths emphasize the possibility of a minimum depth requirement for normal species distributions. The shallowest mean depths were occupied by Greenside and Rainbow Darters (which are both bottom-dwelling species), at 0.38 m. It may be that depths less than approximately 0.38 m are incapable of supporting healthy fish assemblages, in which case reduced or intermittent flows would have serious detrimental effects upon native fish populations (Simpson et al. 1982; Bain et al. 1988).

A number of biases should be addressed before reaching any definitive conclusions. Foremost is the assumption that fish communities are utilizing available habitat in a non-random fashion. Many of the species observed within the Little Miami River appear to be habitat generalists, using a broad range of depths and velocities. Indeed, the total absence of habitat specialists adds considerably to the task of modeling microhabitat use patterns (Fausch et al. 1988; Leonard and Orth 1988).

Sampling techniques undoubtedly introduced some bias to the results. Some fishes did have an opportunity to escape the field of the electroshocker before undergoing electrotaxis and/or narcosis. Likewise, habitats with high population densities often produced more specimens than could be netted by a three-man crew. Therefore, some fish were seen to "passively" escape capture (as they drifted downstream). Also, substrate and cover designations were largely subjective; while depth and velocity were measured quantitatively, substrate and cover were recorded using qualitative descriptions, the validity of which depended upon the opinion and experience of the recorder. Such methods are typically cited as being sufficient, as their purpose is not so much an accurate description as the noting of differences between a series of habitats (Wang et al. 1996). However, they remain a potential source of sampling error.

The fact that the data presented here do not define discrete microhabitat trends does not necessarily imply that such trends are non-existent with the Upper Little Miami River. On the other hand, it is entirely possible that microhabitat is not a dominant factor in regulating local fish populations. Such dependance may be counterproductive within highly variable, relatively unstable reaches like the one presented here; the loss of habitat diversity imposed by previous channelization activities (Brown 1960), combined with the severe flooding and drought cycles that are so typical of small, low-order streams (Ritter et al. 1995), could have created a condition within the Little Miami headwaters where microhabitat dependant species would be at a considerable disadvantage.

As the Upper Little Miami continues its return to a more natural, sinuous condition, new microhabitats will be created while older ones are simultaneously lost. The classic pool-run-riffle sequence is not well established within the study reach examined here. However, pool, run,

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Table 1. Microhabitat use results for all observed fishes. N = number of specimens observed, SD = standard deviation, and CV = coefficient of variation. (Note: Cover Scores and Substrate Scores are not included for species with less than 8 observations.)

Species	N	Variable	Mean	SD	CV
Northern Creek Chub	58	Depth (m)	0.56	0.05	7.96
Semotilus atromaculatus atromaculatus		Velocity (m/sec)	0.12	0.13	114.53
		Cover Score	7.36	5.50	74.65
		Substrate Score	7.19	3.17	44.10
Ohio Stoneroller Minnow	53	Depth (m)	0.56	0.04	6.78
Campostoma anomalum anomalum		Velocity (m/sec)	0.16	0.12	78.86
		Cover Score	4.96	3.87	77.95
		Substrate Score	6.62	2.19	33.14
Common White Sucker	13	Depth (m)	0.63	0.09	14.67
Catostomus commersoni commersoni		Velocity (m/sec)	0.17	0.16	95.40
		Cover Score	5.69	3.35	58.87
		Substrate Score	5.54	1.66	30.05
Greenside Darter	13	Depth (m)	0.38	0.15	39.78
Etheostoma blennioides blennioides		Velocity (m/sec)	0.37	0.27	71.38
		Cover Score	3.00	3.24	108.01
		Substrate Score	7.08	1.26	17.74
Common Shiner	10	Depth (m)	0.60	0.02	4.03
Notropis cornutus		Velocity (m/sec)	0.27	0.21	77.37
		Cover Score	8.30	4.72	56.81
		Substrate Score	8.20	2.66	32.42
Bluntnose Minnow	8	Depth (m)	0.41	0.13	30.79
Pimephales notatus		Velocity (m/sec)	0.38	0.19	49.26
		Cover Score	5.63	4.27	75.98
		Substrate Score	6.50	1.69	26.01
Northern Hog Sucker	4	Depth (m)	0.49	0.19	39.61
Hypentelium nigricans		Velocity (m/sec)	0.31	0.25	81.27
Carp	4	Depth (m)	0.70	0.10	13.52
Cyprinus carpio		Velocity (m/sec)	0	0	
Spotfin Shiner	3	Depth (m)	0.61	0	0
Notropis spilopterus		Velocity (m/sec)	0.53	0	0
Rainbow Darter	2	Depth (m)	0.38	0.07	18.61
Etheostoma caeruleum		Velocity (m/sec)	0.33	0.26	80.50
Central Striped Shiner	2	Depth (m)	0.61	0	0
Notropis chrysocephalus chrysocephalus		Velocity (m/sec)	0.53	0	0
Smallmouth Blackbass	2	Depth (m)	0.67	0.11	16.89
Micropterus dolomieui dolomieui		Velocity (m/sec)	0.06	0.09	141.42
Western Creek Chubsucker	1	Depth (m)	0.61		
Erimyzon oblongus claviformis		Velocity (m/sec)	0.53		
Rockbass	1	Depth (m)	0.59		
Ambloplites rupestris rupestris		Velocity (m/sec)	0.12		

and riffle habitats are unquestionably present, though arranged in a somewhat "haphazard" fashion. In other words, the headwaters of the Little Miami River are not currently in a state of equilibrium. Ultimately, if anthropogenic disturbances do not prevent them from doing so, these reaches will return to an equilibrium condition. But until then, erosional and depositional cycles will continue to occur in an erratic fashion (Ritter et al. 1995), imposing considerable stresses upon microhabitat sensitive species. It therefore becomes imperative that such species be identified, as their diminishment will inevitably degrade the quality of the entire lotic system (Aadland 1993).

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LITERATURE CITED

Aadland, L. P. 1993. Stream habitat types: their fish assemblages and relationship to flow. North American Journal of Fisheries Management 13:790-806.

Bain, M. B., J. T. Finn, and H. E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69:382-392.

Bovee, K. D. 1982. A guide to stream habitat analysis using the instream flow incremental methodology. U.S. Fish and Wildlife Service FWS/OBS-82/26.

Bovee, K. D. 1986. Development and evaluation of habitat suitability criteria for use in the instream flow incremental methodology. U.S. Fish and Wildlife Service Biological Report 86(7).

Brown, E. H. Jr. 1960. Little Miami River headwater-stream investigations. Ohio Department of Natural Resources, Division of Wildlife.

Fausch, K. D., C. L. Hawkes, and M. G. Parsons. 1988. Models that predict standing crop of stream fish from habitat variables: 1950-85. Gen. Tech. Rep. PNW-GTR-213. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 52 p.

Freeman, M. C., D. Vinolas, G. D. Grossman, and A. De Sostoa. 1990. Microhabitat use by *Blennius fluviatilis* in the Rio Matarrana, Spain. Freshwater Biology 24:335-345.

Grossman, G. D. and M. C. Freeman. 1987. Microhabitat use in a stream fish assemblage. Journal of the Zoological Society of London 212:151-176.

Grossman, G. D., J. Hill, and J. T. Petty. 1995. Observations on habitat structure, population regulation, and habitat use with respect to evolutionarily significant units: a landscape perspective for lotic systems. American Fisheries Society Symposium 17:381-391.

Langton, R. W., R. S. Steneck, V. Gotceitas, F. Juanes, and P. Lawton. 1996. The interface between fisheries research and habitat management. North American Journal of Fisheries Management 16:1-7.

Leonard, P. M. and D. J. Orth. 1988. Use of habitat guilds of fishes to determine instream flow requirements. North American Journal of Fisheries Management 8:399-409.

Murphy, B. R. and D. W. Willis. 1996. Fisheries techniques; 2nd edition. American Fisheries Society. Bethesda, Maryland. 732 p.

Paller, M. H. 1995. Relationships among number of fish species sampled, reach length surveyed, and sampling effort in South Carolina coastal plain streams. North American Journal of Fisheries Management 15:110-120.

Peterson, J. T. and C. F. Rabeni. 1995. Optimizing sampling effort for sampling warmwater stream fish communities. North American Journal of Fisheries Management 15:528-541.

Reiser, D. W., T. A. Wesche, and C. Estes. 1989. Status of instream flow legislation and practices in North America. Fisheries (Bethesda) 14(2):22-29.

Ritter, D. F., R. C. Kochel, and J. R. Miller. 1995. Process geomorphology; 3rd edition. Wm. C. Brown Publishers. Dubuque, Iowa. 546 p.

Simpson, P.W., J. R. Newman, M. A. Keirn, R. M. Matter, and P. A. Guthrie. 1982. Manual of stream channelization impacts on fish and wildlife. U. S. Fish and Wildlife Service; FWS/OBS-82/24.

Trautman, M. B. 1981. The fishes of Ohio. Ohio State University Press. Columbus, Ohio. 782 p.

Vadas, R. L. and D. J. Orth. 1993. A new technique for estimating the abundance and habitat use of stream fishes. Journal of Freshwater Ecology 8:305-317.

Wang, L., T. D. Simonson, and J. Lyons. 1996. Accuracy and precision of selected stream habitat estimates. North American Journal of Fisheries Management 16:340-347.

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Water Chemistry Habitat Assessment in Eastern Tiger Salamander Ponds

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Eastern Tiger Salamanders (*Ambystoma tigrinum tigrinum*) inhabit only two known locations in Virginia. One of these locations is in an area known as Maple Flats, a unique 55 square mile area of George Washington National Forest that includes nearly two dozen sinkhole pond depressions. A team of scientists from various disciplines has been assembled to study this region to estimate the range, habitat, and status of the tiger salamanders. Previous studies of streams and lakes in this area indicate a reduction of biomass of trout and other aquatic species due to anthropogenic acid deposition (acid rain). To assess the effects of acid rain on the salamander pond water, samples were collected monthly. Parameters monitored included pH, acid neutralizing capacity (ANC), base cation concentrations and strong acid anion concentrations. The water samples revealed a pH range of 4.3 to 6.6 and an ANC range of -69 to 44. The results of this study will be used to help U.S. Forest officials manage the habitat for this state listed endangered species.

BACKGROUND

The Maple Flats ponds complex extends over a 55 square mile area along the western foothills of the Blue Ridge Mountains near Stuarts Draft, Virginia (Latitude: 38° 58' 30" Longitude: 79° 59' 00"). It is the largest assemblage of sinkhole ponds in Virginia's Shenandoah Valley and has been referred to as one of the most significant botanical areas in the Mid-Atlantic region (Hayslett & Smith, 1994). The area encompasses more than two dozen sinkhole ponds and contains currently undisturbed natural communities in the ponds and the associated woodland environment.

The sinkhole complex lies on a densely forested alluvial plain which extends in an arc fan approximately three miles from the base of the Blue Ridge Mountains. The fan is about 100 feet thick and is primarily composed of Antietam Formation quartzite sandstone, which is a low solubility, acidic rock. Over thousands of years, pockets formed in the carbonate bearing rock formations of the dolomitic bedrock that lies under the alluvium. The sinkhole ponds resulted from the collapse of these pockets to create shallow depressions in the alluvium; typically 3-10 feet maximum depth with surface areas of 0.5-5 acres.

This dynamic complex ecosystem has suffered greatly from the effects of human impact. The most significant human influence was the manganese and iron mining that occurred in the late nineteenth and early twentieth centuries. Since the 1950s, there have been several timber sales and clear cuttings. It is reported that during these timber management activities, "some buffer protection" was given to the sinkhole ponds (Hunt, 1991). The roads constructed for the timber sales are closed now, but modern disturbances, including hunting, fishing, camping, illegal ATV activity, littering, dumping, and encroaching housing developments, continue to adversely affect the area.

In 1982, the USDA stated that the Forest Service must treat all severely neglected areas in the National Forest by the year 2000 (Bracy, 1982). To meet this regulation, a Restoration Program was initiated for the Maple Flats region. In order to evaluate possible treatment alternatives, a study was conducted to identify possible rare or endangered species in the complex, and many were found, including twenty-six species of plants and seven animal species (Hayslett & Smith, 1994). In June 1987, eastern tiger salamander larvae were discovered in several sinkhole ponds at Maple Flats (Buhlman, 1987). On October 1, 1987, the tiger salamander was officially listed as endangered by the Virginia Department of Natural Heritage (Mitchell, 1991). Maple Flats is one of only two confirmed locations in Virginia inhabited by eastern tiger salamanders.

EASTERN TIGER SALAMANDERS

Eastern tiger salamanders are one of the world's largest land dwelling salamanders. An adult can reach a total length of 254 mm, of which about half is its tail. It is generally dull black or brown with irregularly spaced yellow to olive dorsal blotches which extend from the snout to the tip of the tail. Although there is no difference in total body length between males and females, males show a proportionally longer tail (Terwilliger, 1991). The toes of the eastern tiger salamander are uniquely depressed and pointed. This serves as a distinguishing characteristic from all other members of its family which have round toes. Adult salamanders live in burrows near shallow ponds generally in pine stands.

Adults migrate to breeding sites nocturnally in the late winter. Clutches of about 350 eggs are laid in masses of 35-75 each and are attached to submerged twigs and grass. The eggs hatch in about 30 days, and larvae remain in the ponds about four months until they reach an average 12.5 mm long. Major threats to the tiger salamander population include unpredictable water levels in ponds, fish stocking, logging, and acid rain deposition. In amphibians, low pH adversely affects sperm motility, development time to hatchling body size, hatchling survival, and larval growth rate (Whiteman, et al., 1995). The most critical period is between January and July each year.

WATER CHEMISTRY

In and effort to preserve the tiger salamander as well as the unique ecosystem of Maple Flats, a team of scientists from various disciplines was assembled to study the region. This research group was asked to collect and analyze samples from twelve representative ponds monthly for one year beginning in October 1995. Water chemistry analyses were performed to (1) find the principle solute concentrations in the ponds and observe any variations throughout the year, (2) determine the anthropogenic input to the ponds, (3) assess the impact of the water composition on the tiger salamander populations and (4) relate the water chemistry to soils and bedrock geology.

The following parameters were analyzed in the pond water samples. Initially, pH was measured to establish the acidity of each sample. Then the acid neutralizing capacity (ANC) was determined to establish the degree of buffering ability of the water. The following equation defines the ANC:

$$\text{ANC } (\mu\text{eq/L}) = [\text{Ca}^{2+}] + [\text{Mg}^{2+}] + [\text{Na}^{+}] + [\text{K}^{+}] - [\text{Cl}^{-}] - [\text{NO}_3^{-}] - [\text{SO}_4^{2-}] \qquad (1)$$

Zero and negative ANC values indicate an acidic sample with no buffering capacity. Chloride, nitrate, and sulfate were the only strong acid anions found in the water. Low levels of chloride are naturally present in the pond water, but may increase due to road salt, farm run off, or other human activities. Nitrate levels are usually near zero, but higher concentrations may be found in areas with large amounts of animal excrement or fertilizer. Sulfate is the principle acid anion of acid rain. High sulfate concentrations are often found in acidic samples. Sodium, potassium, magnesium, and calcium concentrations were measured to relate base cationic content to the solubility of the rock formations that influence the source of the water sample. Low concentrations of aluminum occur in natural waters. At low pH, minerals containing aluminum are solubilized which cause levels to reach toxic proportions. In addition to the pH, ANC, base cations, and strong acid anions, the temperature and depth of each pond were measured monthly.

RESULTS

All of the sinkhole ponds have a low pH; average values do not exceed pH 6 (Table 1). Water in equilibrium with CO_2 in the atmosphere has a pH ~ 5.6 (Schindler, 1988). A small amount of natural sulfuric and nitric acid lowers this value to pH 5.0 (Charlson & Redke, 1982). The Shenandoah Valley receives an average annual rainfall of 37-42 inches (Bracy, 1982), with an average pH of 4.2 (NADP, 1987), which is about ten times more acidic than unpolluted rainwater. Bicarbonate, HCO_3^-, is the major acid neutralizing ion available in natural waters. It is released when minerals such as limestone, $CaCO_3$, react with dissolved CO_2 and water.

$$CaCO_3 + CO_2 + H_2O \longrightarrow Ca + HCO_3^- \qquad (2)$$

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A combination of low ANC and a high amounts of acid from precipitation depresses pH. The lowest annual values for ANC and pH were found primarily in winter and spring. This occurred concurrent with the hatching of tiger salamander larvae, which is a particularly sensitive stage in the salamander's life cycle.

Figures 1 and 2 graphically depict monthly pH and ANC values for three ponds that represent the general groupings existing in the Maple Flats region. Pond 2 is a member of a group that generally shows positive ANC values and rarely pH values below 5.0. Pond 18 is a member of a group whose ponds seldom show positive ANC values and usually have pH values below 5.0. Pond 17 is a member of a group that experiences a wide fluctuation in pH and ANC. Please note that Pond 2 and Pond 18 were dry in July of 1996, and Pond 2 was also dry in August of the same year. Although lines are connected on the graphs, this is not necessarily representative of true values for these months. Water levels were low in Pond 17 during these months as well. This led to increased concentrations of all ionic species which explains the peaks observed for these months in the figures. Adult tiger salamanders and larvae have been found in ponds 2, 12, 13 and 17.

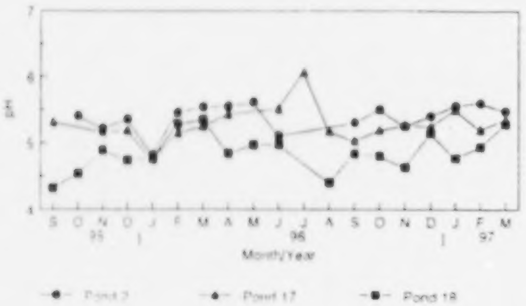

Figure 1. Representative pH Values for Maple Flats Ponds 2, 17 and 18

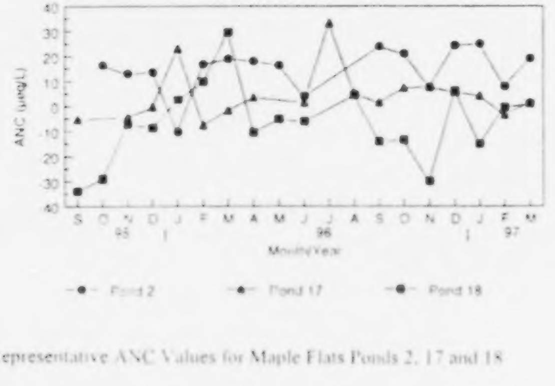

Figure 2. Representative ANC Values for Maple Flats Ponds 2, 17 and 18

The base cations, sodium, potassium, magnesium, and calcium, are so named because they provide a positive influence on ANC (Equation 1). The presence of these ions in water generally results from dissolution of minerals in the surrounding soils and bedrock geology. Low concentrations found for these metals provide strong evidence that the water in these ponds generally has experienced a short geological history. Special attention was paid to Ca^{2+}, which is essential to respiration and ionic balance in gilled organisms. The majority of the ponds have very low Ca^{2+} concentrations (Table 1).

Table 1: Average Values of Parameters Monitored from 9/95 to 2/97

Pond	pH	ANC	Na^+	K^+	Mg^{2+}	Ca^{2+}	Cl^-	NO_3^-	SO_4^{2-}	Al^{3+}	Ca^{2+}/H^+
2	5.39	14.2	19.1	17.0	25.8	21.2	19.0	1.9	18.5	66	5.5
5	4.67	-27.4	18.5	16.7	19.7	21.5	18.7	0.9	34.3	104	1.2
11	5.41	10.1	18.0	13.2	16.1	12.4	18.8	0.9	12.5	44	3.7
12	5.31	7.2	19.9	11.3	14.7	10.3	16.2	0.9	11.7	41	3.2
13	5.35	6.5	19.5	18.8	22.7	17.6	21.2	1.2	20.2	67	4.3
16	5.25	16.9	21.3	15.4	24.6	16.9	21.8	1.0	18.6	81	3.3
17	5.29	1.8	20.9	18.6	23.1	16.0	20.8	1.6	34.7	60	3.2
18	4.86	-11.0	24.8	16.7	30.6	23.3	32.9	0.5	13.3	161	1.5
21	5.18	0.4	22.6	17.2	14.4	8.8	19.3	0.5	15.9	48	2.0
50	5.19	7.6	20.4	17.7	18.4	18.8	21.3	0.8	19.9	40	3.7
70	5.97	19.5	18.0	15.7	19.9	25.5	17.6	0.7	32.3	41	31.0
90	5.91	16.4	18.4	15.6	20.4	23.3	19.2	0.4	31.7	24	24.2

Some concern has been raised about the ratio of calcium ion to hydronium ion in acidic surface waters. When pH decreases along with the concentration of Ca^{2+}, reduction in biomass of aquatic species occurs. Typically, a ratio of six or greater is considered acceptable. The average values of Ca^{2+}/H^+ ratio rarely exceed six, with the exception of the man-made ponds, 70 and 90 (Table 1). Figure 3 is a graphic representation of monthly Ca^{2+}/H^+ ratios for ponds 2, 17, and 18. The elevated Pond 17 value in July 1996 can again be explained by low water levels increasing the ionic concentration.

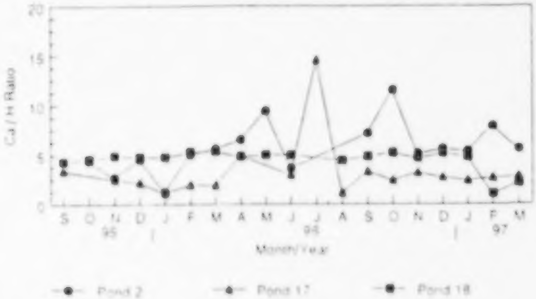

Figure 3: Representative Ca/H Values for Maple Flats Ponds 2, 17 and 18

The strong acid anions, chloride, nitrate, and sulfate, have negative effects on the ANC (Equation 1). Chloride is naturally present in small amounts proportional to the solubilization of minerals in the substrate around the ponds. Small chloride concentrations are further evidence of lack of mineral solute content in the water. Nitrate is derived from acid rain. In an area that receives approximately 40 inches of 4.2 pH precipitation annually, one might anticipate high concentrations of nitrate in the sinkhole pond water. Contrary to this expectation, nitrate levels are low due to its consumption by growing plants. Concentrations of nitrate are high only after storm events or snow melts causing significant run-off. Sulfate is the principle anion of acid rain. The ponds at Maple Flats typically have sulfate levels less than half of that of streams in the Blue Ridge region (Webb, et al., 1989). This suggests a high degree of sulfate retention in the soils surrounding the ponds.

Aluminum levels are inversely proportional to pH. Although aluminum is fairly prevalent in the earth's crust, it is generally insoluble at a neutral pH. When pH levels decrease, aluminum is solubilized and is extremely toxic to gilled aquatic life. The Maple Flats ponds rarely approach the tolerance limit of most aquatic species to aluminum (150 ppb) because the water is not actually in contact with the minerals long enough to release significant amounts of

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solubilized aluminum, and organic compounds in the ponds complex aluminum and remove it from the water. Thus, toxic levels of aluminum in the pond water are not an immediate threat to the lives of the tiger salamanders.

CONCLUSION

The set of water chemistry values amassed by this research group will be used as a baseline with which changing parameters in the ponds can be compared. Considering the acidity and amount of rainfall which the Shenandoah Valley receives, as well as the low solubility of the surrounding geology, thus a lack of buffering in the ponds, the water chemistry of the Maple Flats ponds will inevitably degrade until they can no longer support aquatic life. Throughout the investigation of the Maple Flats ponds complex, much of the sulfate and nitrate from acid precipitation was retained in the watershed. In the future, the watershed will reach a saturation point at which anions will no longer be retained. Consequently, the pH of the ponds will fall drastically. The end result will be the deaths of all gilled aquatic species living in the ponds.

Amassing further knowledge about the sinkhole ponds and the Maple Flats region will enable the Forest Service to detect and counteract threatening conditions in the area. With only the monthly samplings, the influence of episodic storm events has not yet been deduced. The monthly samplings are now being supplemented by daily sampling at two specific ponds, one is known to support a tiger salamander colony, and the other does not. This will provide information regarding the effects of short term storm events on the ponds. In the future, it may be helpful to have an estimate of tiger salamander biomass associated with each pond inhabited by a salamander population. A correlation could then be drawn between the water chemistry data and the specific effect on the salamander population.

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REFERENCES

Bracy, K., Maple Flats Watershed Improvement Plan, (1982) Environmental Assessment of George Washington National Forest, U.S. Government Printing Office, Washington, D.C.

Buhlman, Kurt, A., Summary of Activities and Report of Findings, Contract #00-3383-7-445, prepared for the George Washington National Forest, December 10, 1987.

Charlson, R.J. and Rodke, H., Nature (London), Vol. 295 (1982) pp. 683.

Hayslett, M.S. & Smith, L.R., Establishment Record for the Maple Flats Ponds Research Natural Area Within the George Washington National Forest, Augusta County, Virginia, (1994) U.S. Government Printing Office, Washington, D.C.

Hunt, J.A., Timber Narrative: Maple Flats Area, (1991) U.S. Government Printing Office, Washington, D.C.

Mitchell, J.C., Amphibians and Reptiles, (1991) pp. 411-423 In K. Terwilliger, Virginia's Endangered Species, McDonald and Woodward Publishing Co., Blacksburg, VA.

NADP, NADP Annual Data Summary on Precipitation, Chemistry in the United States, 1985, National Acid Deposition Program, 1987, U.S. Government Printing Office, Washington, D.C.

Schindler, D.W., "Effects of Acid Rain on Freshwater Ecosystems", Science, Vol. 239 (1988) pp. 149-157.

Terwilliger, K., Virginia's Endangered Species, (1991) McDonald and Woodward Publishing Co., Blacksburg, VA.

Webb, J.R., Cosby, B.J., Galloway, J.N., Hornberger, G.M. & Ryan, P.F., Acidification of Native Brook Trout Streams of Virginia, VTSSS, Project # F-72, Dept. Environmental Sciences, University of Virginia, Charlottesville, VA, March, 1989.

Whiteman, H.H., Howard, R.D., & Whitten, K.A., Canadian Journal of Zoology, Effects of pH on Embryo Tolerance and Adult Behavior in the Tiger Salamander, *Ambystoma tigrinum tigrinum*, Vol. 73, (1995) pp. 1529-1537.

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The Derivation of United States Temperature and Precipitation Regions

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The goal of this study is to precisely define precipitation and temperature regions for the conterminous United States. A secondary goal is the identification of long-term regional trends in the climatic variables to determine regional climate change. Results indicate the derivation of plausible climate regions for both atmospheric parameters. Long-term regional trends were identified on an annual and seasonal basis. The most notable long-term changes relate to significant increases in precipitation across the US, especially during autumn and a significant increase in Southwestern US temperature.

INTRODUCTION

Recent climatological research has focused on automated classification techniques to provide spatial and temporal records of complex data arrays (Yarnal, 1993). Many of these techniques involve eigenvector analysis to determine primary surface patterns (Henderson and Vega, 1996) or dominant modes of atmospheric variation (Wallace and Gutzler, 1981). Current literature is replete with traditional eigenvector techniques and applications for classification (White et al., 1991), alternative classification methods such as harmonic analysis (Finkelstein and Truppi, 1991) and correlation techniques (Sumner, 1983). No matter the technique employed, climate classifications and regionalizations remain vital to a proper understanding of climate variability and its influence upon the surface environment (Yarnal, 1993).

Of the many eigenvector techniques, the most prevalent with regard to climatology is Principal Components Analysis (PCA). This is largely due to the simplicity and reliability of the procedure. Karl and Koscielny (1982) use rotated PCA to identify drought regions within the conterminous United States. Walsh et al. (1982) use a similar methodology to determine precipitation regions in the United States. Both studies incorporate statewide averages and select station data interpolated to a grid to derive regions. While such methods are common, the resulting regional demarcations are highly generalized and somewhat spatially incomplete.

This analysis seeks to precisely define precipitation and temperature regions for the conterminous United States. A secondary goal is to identify trends and significant patterns in the regional time-series to determine regional climate change. Ultimately, the goal is to enhance understanding of the regional response to large-scale climate fluctuations.

DATA AND METHODOLOGY

Mean monthly climate division precipitation and temperature totals are used for the contiguous United States. Monthly totals are used in their entirety for the annual analysis and grouped into standard meteorological seasons (winter=DJF) for the seasonal analysis. Data were extracted for all 344 United States climate divisions for the time period 1895-1991. Data were obtained from the National Climatic Information Disc Volume 1.

Climate division data are intended to represent relatively homogenous precipitation and temperature regions. In actuality, huge disparities exist in the number and size of the divisions within each state. PCA is used to effectively reduce the 344 climate division in addition to identifying physical homogeneity. Climate division data is highly desirable for the statistical techniques used as the data are aerially weighted and corrected for bias.

Data were standardized by month (mean=0; standard deviation=1) and merged into annual and seasonal arrays. PCA using a Pearson correlation matrix was used to isolate discrete regions of covariation. Varimax rotation techniques were employed to better determine the resulting solutions. Component retention was determined through a combination of the Kaiser-Guttman eigenvalue 1 criterion and a scree plot (Henderson and Vega, 1996). Component loadings were plotted to determine the spatial resolution of the eigenvectors utilizing a 0.45 eigenvector isoline cutoff for the precipitation variable and a 0.5 cutoff for the temperature variable. This procedure was followed in order to precisely define the associated regions with little transitory overlap. Once the final regions were produced spatially, a time-series of the precipitation and temperature anomalies was created to temporally isolate distinct regions of a particular phenomenon. A clustering procedure was used which combines the actual precipitation and temperature anomalies for each climate division included within a particular region.

ANALYSIS

For the precipitation variable, a total of nine components were retained for every season except summer, in which eight components were held for rotation. The unrotated components explain between 53 and 70% of the total variance in the annual-autumn time-series. For temperature, five principal components were retained for rotation with regard to the annual, spring, and autumn analysis, four for the winter analysis, and seven for summer. The total explained variance accounted for in the unrotated components varied between 84 and 88%. Loadings representing the spatial configuration of the components for all annual and seasonal precipitation and temperature regions are presented in Figure 1. It is apparent that the resulting precipitation regions are less cohesive than those for temperature. This is to be expected due to temporal and spatial discontinuities associated with the precipitation variable (Babin, 1995). Of special note are the climate divisions which did not correlate with any of the resulting precipitation regions (hatched areas). It is suspected that these areas are truly transitional.

The most striking feature associated with the precipitation analysis is the alignment of the eastern regions with known extratropical cyclone paths as identified by Zishka and Smith (1980). Such an alignment is evident in recent literature (Karl and Koscielny, 1982; Walsh et al., 1982) suggesting that migratory baroclinic wave forcing is the dominant precipitation generating mechanism for the eastern portion of the US, especially during the cool season.

Each regions anomaly time-series was tested for trend by correlating the derived precipitation anomaly by year. Results indicate many significant trends. PC's 1 through 6 of the annual time-series all display significant (alpha=0.05) increases in precipitation through time. Of the six regions, five (PC's 1-3, 5 and 6) display qualitatively substantial increases in variability. The shift in variability is important as this may cause considerable environmental stress in addition to biasing the linear regression procedure used to denote long-term change.

On a seasonal basis, long-term change is less apparent. For the winter season, only one region displays a significant trend through time, the Northwestern Plains (PC9). Here a significant decrease in precipitation occurred. For the spring season, three regions show significant increases in precipitation over the study period (PC1 at alpha=0.10). For the summer season, only one regional time-series displays a significant change through time, PC5. This component which represents the Northwest shows a significant increase in precipitation but displays a fairly constant level of variability throughout the time-series. The significant increases during the autumn season dominate the seasonal analysis as every region except PC4 and PC8 display significant trends. Further, surprisingly constant variability is evident in all of the regions with significant trend. This finding suggests that changes apparent during the autumn season are driving significant changes evident in the annual analysis as no other season displays trends which consistently match those of the annual time-series.

The derived temperature regions differ from those for precipitation in that they are primarily zonally symmetric and fewer in number, ranging from four winter regions to seven in summer. Complete spatial resolution is accomplished through the eigenvector procedure stemming from the continuous nature of the temperature parameter. An examination of the interannual temperature variability reveals more variability than precipitation. This is likely tied to the inherent colinearity of the temperature parameter in addition to the continuous link to atmospheric flow variations. Trend analysis reveals few significant annual or seasonal trends. The only significant trend in the annual record occurs in the Southwest (PC5). Here, a significant temperature increase is evident. The statistic

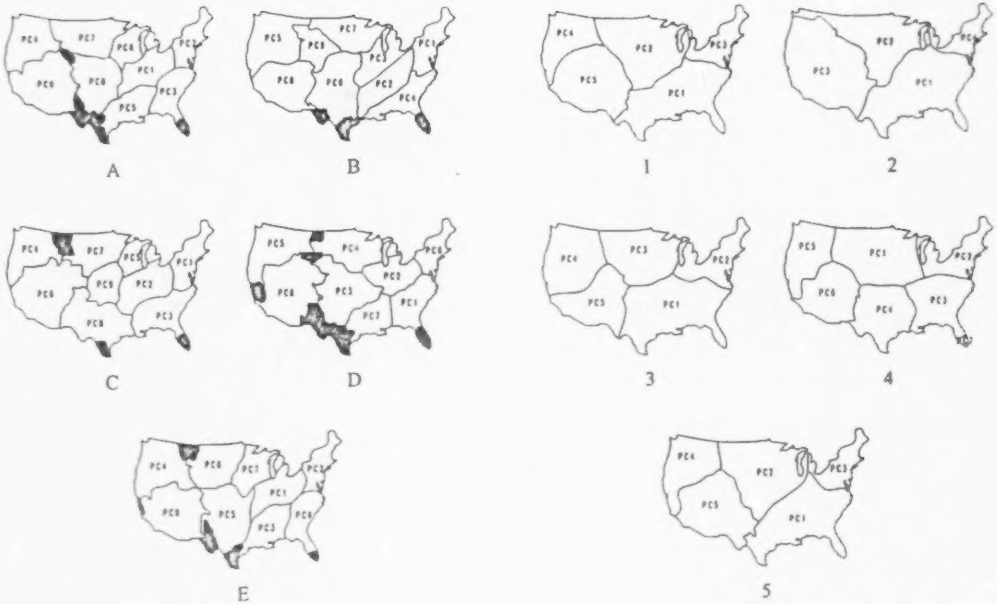

Figure 1. United States Annual - Autumn Precipitation (A - E) and Temperature (1 - 5) Regions.

may be biased by the extreme variability apparent from the early teens into the late 1930s. This is revealed in the qualitatively significant drop in variability across the study period. The time-series for this region, as well as many others, displays a somewhat cyclical pattern as early record cooling is followed by a high degree of warmth culminating in the late 1950s when a cool period ensued until the early 1980s followed by subsequent warming. The cooling which occurred following the late 1950s is likely due to the change in longwave flow amplitude documented by Leathers et al. (1991).

Statistical analysis of the winter season temperature anomalies reveals no significant long-term trends. The spring season analysis shows that the Upper Plains (PC3) significantly warmed over the temporal period. Although variability remains rather constant through the study period, a recent explosion of high variability and mainly positive anomalies dominates the temporal record. The summer period is interesting in that four of the associated regions show significant trends. All of these regions show significance at the 0.50 alpha level except the Southwest (PC6; alpha=0.10). The Upper Plains (PC1), the Southwest (PC6), and South Florida (PC7) all display a warming trend while the Southeast (PC3) indicates significant cooling over the study period. Substantial changes in variability are notable in association with the Upper Plains and Southwest (PC6) which depict decreasing variability through time, matching the annual record. The autumn time-series analysis reveals no significant temporal trends.

CONCLUSIONS

This study attempted to regionalize precipitation and temperature for the conterminous United States. PCA was used to effectively reduce climate division data and create physically based homogeneous climate regions. Results and comparisons with relevant literature indicate that the annual-autumn regions are climatologically plausible for both parameters. Further, significant long-term trends were identified in the associated regional time-series. For precipitation, substantial increases in precipitation were evident. It is believed that significant precipitation changes evident during autumn are in part responsible for the annual changes. For temperature, fewer annual and seasonal changes were noted. However, substantial increases through time are apparent especially with regard to the Southwestern US.

REFERENCES

Babin, S.M., 1995. Journal of Climate, Sensitivity of average runoff to spatial variability and temporal correlation of rainfall, 8:2104-2108.

Finkelstein, P.L. and L.E. Truppi, 1991. Journal of Climate, Spatial distribution of precipitation seasonality in the United States, 4:373-383.

Henderson, K.G. and A.J. Vega, 1996. Physical Geography, Regional precipitation variability in the Southern United States, 17:2:93-112.

Karl, T.R. and A.J. Koscielny, 1982. Journal of Climatology, Drought in the United States: 1895-1981, 3:313-329.

Leathers, D.J., B. Yarnal and M.A. Palecki, 1991. Journal of Climate, The Pacific/North American teleconnection pattern and the United States climate. Part I: Regional temperature and precipitation associations, 4:517-528.

Vega, A.J. and K.G. Henderson, 1996. The Pennsylvania Geographer, On the use of eigenvector techniques in climatological analysis, XXXIV:1:50-73.

Wallace, J.M. and D.S. Gutzler, 1981. Monthly Weather Review, teleconnections in the geopotential height field during the Northern Hemisphere winter, 109:784-812.

Walsh, J.E., M.B. Richman and D.A. Allen, 1982. Monthly Weather Review, Spatial coherence of monthly precipitation in the United States, 110:272-286.

White, D., M.B. Richman and B. Yarnal, 1991. International Journal of Climatology, Climate regionalization and rotation of principal components, 11:1-25.

Yarnal, B., 1993. Synoptic Climatology in Environmental Analysis: A Primer, Belhaven Press, London, 187pp.

Zishka, K.M. and P.J. Smith, 1980. Monthly Weather Review, The climatology of cyclones and anticyclones over North American and surrounding ocean environs for January and July, 1950-77, 108:4_387-401.

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Cloud Masking of Normalized Difference Vegetation Index (NDVI) Images

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Analysis of satellite Advanced Very High Resolution Radiometer (AVHRR) data can be complicated by the presence of clouds. Therefore, it is necessary to effectively remove cloud contaminated pixels from an image before it can be used to calculate Normalized Difference Vegetation Index (NDVI). This study focuses on the use of a threshold technique to cloud mask the satellite images. A separate aspect of this study also looked briefly at the effects of two compositing techniques. It was concluded that the compositing process for both methods was highly affected by the quality of the cloud mask that was previously performed.

INTRODUCTION

The Advanced Very High Resolution Radiometer (AVHRR) on board the NOAA 14 satellite can be used for determination of vegetation indices. This satellite is in a polar orbit that allows it to complete one orbit in 101 minutes [3]. The orbit of NOAA 14 is heliosynchronous, which causes the satellite to pass over a spot on the earth at a slightly different time each day [3].

The AVHRR on NOAA 14 measures the visible radiation ($.58$ - $.68\mu m$) on channel one, near infrared ($.725$ - $1.10\mu m$ and 3.55 - $3.93\mu m$) on channels two and three respectively, and the infrared radiation (10.3 - $11.3\mu m$ and 11.3 - $12.5\mu m$) on channels four and five respectively.

By using the information in channels one and two, and the following formula, the Normalized Difference Vegetation Index (NDVI) can be calculated.

$$NDVI = (ch2 - ch1) / (ch1 + ch2) \qquad (1)$$

This index gives scientists a measure of how much chlorophyll is in the area of interest (AOI).

However, analysis of the AVHRR data can be complicated by the presence of clouds. Large thick clouds can completely obscure the ground cover, while smaller thinner clouds more subtly alter the radiation emitted over a given area of land. In fact, cloud cover can appreciably lower NDVI values [5]. Therefore, it is necessary to effectively remove cloud contaminated pixels before the data can be used to calculate NDVI. This study used a number of different thresholding methods to cloud mask the satellite images. After the data was cloud masked, composite NDVI images were created. This process will also be discussed.

DATA ACQUISITION

The AVHRR data was directly downloaded from NOAA 14 using Smartrack 1.2dQ. This software received the data as a High Resolution Picture Transmission (HRPT), and then put the data through level 1b processing, which appends calibration data and earth location to the data [4].

The data was then transferred to ERDAS Imagine 8.2, which resampled the data so that it only contained the AOI. In this case the AOI was the Southern Great Plains Cloud and Radiation Testbed (SGPCART) site. Then an initial cloud contaminated NDVI image was created. The images used in the cloud masking study were from January 1996 to the present.

CLOUD MASKING

Several different thresholding methods were applied to the data to eliminate the effect of clouds. These techniques include a channel four test, a channel one test, a negative NDVI test, and a channel four NDVI test. The tests were run in conjunction with each other and separately to determine their validity. For all of the tests, data points that failed the test were assigned a value of zero, elsewhere the NDVI values were reported.

The channel four test eliminated clouds based on their temperature. Since clouds are higher in the atmosphere than the land under them, they are generally colder [1], so this test removed everything below a certain temperature or threshold value. The threshold value had to be determined by individual examination of each image. Threshold values around 100 were used for summer images, and values around 85 were used during the winter.

The channel one test eliminated clouds based on their reflectivity. Since clouds are composed mostly of water vapor they have a higher albedo than the surrounding land surfaces [1]. Some exceptions to this rule include water surfaces and salt plains. The threshold value had to be determined by individual examination of each image. Threshold values of approximately 15 were used for the summer images and values of approximately 9 were used for the winter ones. This method has a tendency to remove the lakes from an image, especially for the winter when lakes are cold. The salt plain is also removed.

Another cloud masking method was the test for negative NDVI. This method did not require a threshold as it simply removed everything from the image that had a negative NDVI. This test had a tendency to remove lakes and the salt plains as well as the thicker clouds.

The last three methods used to cloud mask the data used both channel four and NDVI values. These tests are based on the theory that for vegetated land areas, a larger NDVI corresponds to a cooler temperature due to increased evaporation [2]. This test yeilds the opposite for clouds, which generally have a smaller NDVI for cooler temperatures [2].

By plotting the NDVI versus the channel four values it is possible to see that the relationship between NDVI and channel four varies depending on the image. In the images, a cluster of points with relatively high temperatures and NDVI are associated with land. In the colder images the land points show more variation in temperature than in NDVI. This causes the land cluster to spread out horizontally. In the warmer images the points spread up and back. This is because there is a large variation in NDVI. Furthermore, as the NDVI of the land increases the temperature decreases, for reasons already stated.

In the plot from image 96015a14 (Fig 1), there are two clusters with low NDVI. These clusters represent two distinct clouds in the image. There is also a third clump that is above these two clusters because it has a higher NDVI. This clump represents a third, thinner cloud image. As expected for a cloud, the colder points have a lower NDVI, and the warmer points have higher NDVI values.

For all of the following equations, NDVI is the NDVI value of a pixel, and ch4 is the channel four value of the pixel. The first cloud masking technique uses the following equation, and all values that satisfy the equation are designated as a cloud.

$$[\mathrm{NDVI}] < (\mathrm{threshold})\,[(\mathrm{ch4}) - b]. \qquad (2)$$

where b is the maximum channel four value for the entire image. The threshold is given by the equation

$$(\text{threshold}) = n / (a - b), \qquad (3)$$

where a is the minimum channel four value for the image and n is an NDVI value.

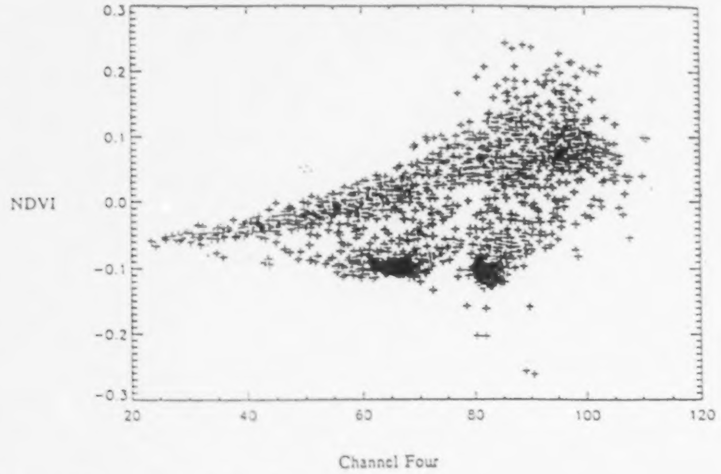

Figure 1: NDVI vs Channel Four for Image 96015a14

This technique was tried on the summer image 96211a14 with n equal to the maximum NDVI value for the image. In this case it may have removed a small amount of land pixels and did not completely remove the warm, high NDVI cloud pixels.

The second NDVI channel four cloud masking technique uses the following equation, where the values that satisfy the equation are clouds.

$$[\text{NDVI}] < (\text{threshold})\,[(\text{ch4}) - b]^2, \qquad (4)$$

where b is the maximum channel four value for the image, and the threshold is given by the equation

$$(\text{threshold}) = n / (a - b)^2, \qquad (5)$$

where a is the maximum channel four value for the entire image, and n is the maximum NDVI value for the entire image.

This test has the tendency not to remove cloud pixels that are warmer with high NDVI values. This can be compensated for by combining the test with others, such as a channel four threshold test. The values for a, b, and n can be altered depending on the image.

In the final channel four NDVI test the equation that must be satisfied to classify pixels as clouds is

$$[NDVI] < \frac{-n \cdot [(ch4) - a] ** 3}{[b - a] ** 3} + n, \qquad (6)$$

where n is the maximum NDVI value for the image, a is the minimum channel four value of the image, and b is another channel four value.

The test was tried on the summer image 96211a14 with b equal to 100. Almost no land pixels were masked and most cloud pixels were. A few warm, high NDVI clouds were still left unmasked. Of the three NDVI channel four masks this appeared to be the most effective.

COMPOSITING

Two methods of NDVI compositing where tried for this study. One involved the direct substitution of values, and the other averaged and then substituted values. Both methods were greatly affect by the quality of the cloud mask applied to the image. The combined channel four, channel one, and negative NDVI mask that was used for these trials was ineffective and there was a lot of noise in the resultant composite.

However, the averaging method was less affected by the presence of clouds. Presumably, it would also lessen the affect of random noise, by lessening the effect of a dramatic change in vegetation cover. Unfortunately, dramatic changes in vegetation cover caused by farming and natural processes, such as fire, might also be lessened by this process.

CONCLUSIONS

The algorithms for the compositing methods were sound. However, the resultant composites were affected by the quality of the cloud masking techniques. This effect was more pronounced in the direct substitution method. Therefore, in order to have a good composite, it is necessary to improve the cloud masking techniques.

It may be possible to significantly improve the quality of the mask produced by the channel four NDVI test with more study. For example, the method used to derive the thresholds could be improved by removing the guess work involved in picking the variables. Furthermore, when a combination of the tests is applied the resulting cloud mask can be improved.

REFERENCES

[1] Gallegos, Sonia C., Hawkins, Jeffery D., and Cheng, Chiu Fu. A New Automated Method of Cloud Masking for Advanced Very High Resolution Radiometer Full-Resolution Data Over the Ocean. Journal of Geophysical Research, 1993, pp. 8505-8516.

[2] Gutman, G. Garik, Ignatov, Aleksandr, M., and Olson, Steve. Towards Better Quality of AVHRR Composite Images Over Land: Reduction of Cloud Contamination, Remote Sens. Environ., 1994, pp. 134-148.

[3] Matra Marconi Space. Earth Observation Spacecraft Directory, 1992, pp. 45-46.

[4] NOAA POD Guide Section 1.1, http://www2.ncdc.gov/POD/c1/sect1-1.html.

[5] Schultz, P. A., and Halpert, M. S.. Global Analysis of the Relationships Among a Vegetation Index, Precipitation and Land Surface Temperature, International Journal of Remote Sensing, 1995, pp. 2755-2777.

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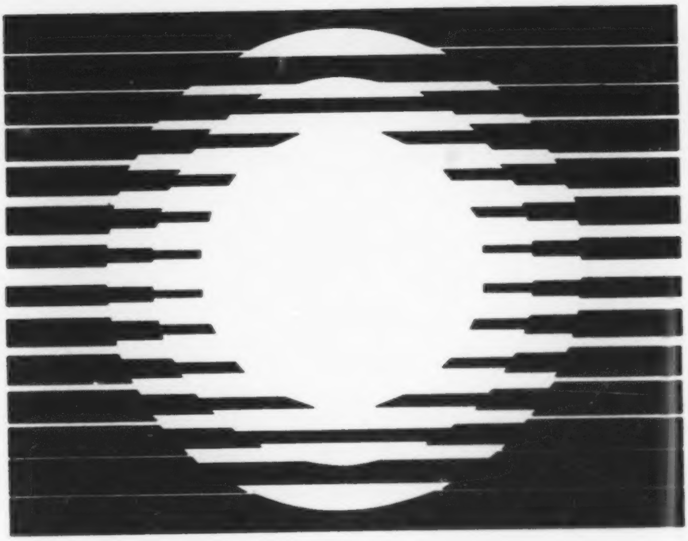

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ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

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Volume IV

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VOLUME IV

THE UNIVERSITY OF NORTH CAROLINA at ASHEVILLE

JULY, 1997

Foreword for the
Proceedings of the Eleventh National Conference on Undergraduate Research
University of North Carolina at Asheville
April 24-26, 1997

The University of Texas at Austin was pleased to host the 1997 National Conference on Undergraduate Research, affirming its commitment to excellence in undergraduate education and to the research experience in particular. Over 2100 students and faculty attended some 1500+ oral, poster and performing or visual arts presentations scheduled over April 24-26. A special feature of NCUR '97 was a series of more than 30 presentations by faculty members from all disciplines demonstrating the integration of research and teaching with the new technologies. These presentations were capped by a performance on Saturday night of "Ears and Feet," a concert of new interdisciplinary work by student and faculty composers, choreographers, dancers and performers from the UT College of Fine Arts. Electro-acoustic music and modern dance explored interactivity of disciplines and technologies by allowing dancers' movements to control electronic music and robotic lighting by way of a touch-sensitive computer dance floor.

President Robert M. Berdahl opened the conference quoting a Chinese proverb: "I hear and I forget. I see and I remember. I do and I understand." Berdahl praised the research experience as the most practical and potent method to provide students the perspective of inquiry, innovation and exploration as they prepare "for a future that is not so much known to be uncertain, but instead, certainly unknown." That facts and methodologies become obsolete in a world in which developments and advances occur with dizzying rapidity points to the importance of incorporating research activity into the undergraduate experience.

Dr. Berdahl also praised the student-faculty relationships that are fostered by the research process, congratulating the faculty mentor for serving the educational needs of the talented and motivated students by participating in the adventure of exploration and discovery, of cooperation and collaboration which characterize academic life.

Five distinguished plenary speakers addressed conference participants throughout the three days. Dr. Steven Weinberg, Nobel laureate in physics and professor at the University of Texas at Austin, challenged listeners to consider the future of science by posing the questions "The End of Science?". Dr. Robert Williams, Director of the Space Telescope Science Institute, dazzled the audience with the most recent images from the Hubble Space Telescope. From the vastness of space to the minute complexity of genetic research, Dr. Steven McKnight of the UT Southwestern Medical Center at Dallas introduced conference participants to the fascinating work being done in gene regulation and cell differentiation. Friday night's fete "Texas Culture Swing" featured, in addition to an outstanding sampler of culinary and musical styles of the Lone Star state, a mini-plenary address on the multifaceted aspect of Texas border cultures by Dr. Rolando Hinojosa-Smith, distinguished author and professor of Creative Writing. NCUR 97 closed with a resounding standing ovation upon conclusion of "The Challenge of Leadership" by Sarah Weddington, J.D., former Texas legislator and White House assistant, now author, lecturer and adjunct professor.

The University of Texas at Austin is proud of the privilege to share our campus for these few days with the distinguished group of students and faculty whose work is presented here in published form. We congratulate you for your accomplishments and encourage you to continue to participate in the challenge of research.

Susan Wells Howard, Chair, NCUR '97

PREFACE

The 407 papers published in these five volumes are representative of the approximately 1825 papers and posters presented at the celebration of undergraduate research that was NCUR '97'. The faculty, staff and students of the University of Texas at Austin are to be commended for making NCUR '97' such an enriching experience. The student authors deserve recognition for their hard work and for their persistence in seeing their research through to its final publication.

Special thanks are extended to Dr. Susan Howard, Ms. Kelly Johnson and other members of the NCUR '97' staff. Their help during the days of the Conference was invaluable. Many thanks also to the members of the National Board, who reviewed a large number of papers submitted to the *Proceedings* under time constraints. Their continued efforts to standardize has raised the *Proceedings* quality. This project would have not been successful without their assistance.

I would also like to thank the UNCA Editorial Board, who put in many long hours reviewing, checking and organizing papers, and Tracy Walker, and Adam Bradley, who did all the cutting and pasting necessary for these volumes. I owe a special debt of gratitude to Katherine Whatley, Tracy Walker and Mila Cleverdon for their support, encouragement, and mentorship during the entire process of organizing the *Proceedings*.

To all the students who submitted papers to the *Proceedings* go thanks for their participation and congratulations for their achievements. Your enthusiasm and achievement will serve as role models for the next group of student researchers - whom we look forward to meeting at the Twelfth National Conference on Undergraduate Research at Salisbury State University, Salisbury Maryland.

Robert D. Yearout
UNC at Asheville
1 July, 1997

PROCEEDINGS OF THE ELEVENTH NATIONAL CONFERENCE ON UNDERGRADUATE RESEARCH

1997

CONTENTS

VOLUME I

FOREWORD iii

PREFACE iv

ARTS AND HUMANITIES

Collaborative Art: A Movement in the Twentieth Century 1
Kristen Jo Kerr (Jane-Allen Mckinney)

Nature and the Natural in the Paintings and Prints of Helen Frankenthaler 6
Danielle G. MacCartney (Debora Rindge)

A Comparison of Frank Lloyd Wright and Michael Graves: Furniture Influenced by Architecture 9
Nieya C. Wallace (Jane-Allen McKinney)

Art Education: Art is Underrated as an Instrument for Teaching Essential Learning and Cognition Skills 14
Jennimarie L. Ward (Jane-Allen McKinney)

Toontown: The Disney Tradition Continues 18
Jennifer Lugg (Dianne S. Macleod)

Political Ideologies of Harlaxton Gardens, Harlaxton, Lincolnshire, England 23
Nicole L. Stutzman (Shirley Schwarz)

Reminders of Death and Lessons for Life: Vanitas and Memento Mori Paintings of the Spanish Golden Age (1556-1700) 27
Wendy Singer (Susan V. Webster)

Visualizing the Human Form: Art and Anatomy in Eighteenth-Century England 31
Erin M. Loos (Philip Wilson)

The American Canon: Great Male Playwrights and Their Female Characters 34
Michelle McGovern (Mark Pizzato)

Henry Purcell's Dido and Aeneas: A 1689 Composition Endures Controversy 39
Stacy M. Dieckman (Patricia Kazarow)

Determining the Authorship of the Toccata and Fugue in D Minor, BWV 565 44
Aaron Juhl (Patricia Kazarow)

Plains Attire: The Individual Expression of Culture, the Cultural Expression of Identity 48
Sherri A. Mainord (Anne Guernsey Allen)

Victim vs. Participant: A Comparison of Dmitri Shostakovich's Lady MacBeth of Mtsensk and Katerina Ismailova 53
Heather Miller (Charles McKnight)

New Possibilities in Composition Through Computer Technology 56
Christopher Watts (Daniel Koppelman)

The Conception of "Poet" in the Work of Bei Dao 61
Jennifer L. Berry (Martin Backstrom)

Bei Dao's Poet 66
Jennifer L. Berry (Martin Backstrom)

"There Is No Loneliness Like Theirs": James Wright's "A Blessing" and C.K. Williams' "On Learning of a Friend's Illness" Examined 71
Kirsten C. Bender (William Aarnes)

Embrace of Dionysus The Presence of African Art In D.H. Lawrence's Women in Love 76
Kristin A. Frey (Eric Chandler)

A Poststructural Analysis of Richard Wright's "Big Black Good Man" 80
James S. Guignard Jr. (Jill Sessoms)

William Shakespeare's Othello: The Moor of Venice A Case Study in the Thermodynamics of Evil 85
Roger A. Harris (Linda K. Barlow)

Wilde's Christ: Exemplifying Aesthetic Morality 89
Elizabeth M. Hendershot (Daniel Born)

Pearl's Scarlet Soul: The Influence of Spenser's Una on Hawthorne's Ideal Vision of Daughters 93
Tracy Ann Kennedy (John C. Bean)

Agrarianism in the American South: From the Vanderbilt Agrarians to Wendell Berry, A Shift from Regional Myth to Practicable Ideal 98
Robin Kidd (John Cawelti and David Hamilton)

Margaret Fuller's Women in the Nineteenth Century: An Appeal for the Inclusive Self 103
Jeanne Kolker (Sara McAplin)

The Paradox of the Crucifixion Allegory in Ben Franklin's "The Kite Experiment" 107
Sandra Argroves Watson (Steven L. Hamelman)

The Doorway to Wildness: Four Poems by Muriel Rukeyser and Adrienne Rich 112
Trace V. Wilson (Richard Chess, Michael Gillum, and Jeff Rackham)

The Relationship Between Cognitive Growth, Journal Writing, and the Development of Critical Thinking 117
Lynn Herink and Anna Long (Larry Nichols)

Images of Health in Health Magazines 122
Travis Bebout (Sarina Chen)

Blissfully Rude: The Diatribe of ACT-UP 127
Mark S. Buchanan (Suzanne E. Lindsey)

Eyewitness vs. Pseudo Reality: A Comparative Analysis of Student's Accounts and the Media Reports of a University Disturbance 132
Ben L. Daniels (Sarina Chen)

Light in the Crevice Never Seen: The Indigenous Voice and the Rhetoric of Resistance Literature 137
Blayne M. Higa (Catherine A. Collins)

Marketer's Use of Semiotics and Symbolic Representation of Children's Packaging 142
Reagan Turok and Heidi Redeker (Lois Smith)

Same-Sex Marriage Politics: The Politicizing of Sexual Orientation 147
Kari Wagener (Phillip Voight)

"Do As Little As Possible" The Transformation of Film Noir's Myths in Chinatown 151
Karen Demski (Chris Hassold)

Outside Looking In: Sacred Space of Taos Pueblo 157
Brenda L. Hanson (Anne E. Allen)

Directed By and Starring Cindy: Sherman's Performance Photography 161
Jennifer Lemmer (Cris Hassold)

Reinterpreting Roman Morality 166
Ryan Pesch (Marleen Flory)

Edna St. Vincent Millay: A Feminine Perception of Love 170
Mandy C. Carlson (Lysbeth Em Benkert and Jay Ruud)

The Romantic Paganism of Niccolo Ugo Foscolo: Infancy, Greece, Venus, Exile, Pain, and Death in the Foscolian Artistic Sensibility 174
Mark Anthony Espinosa (Andrea Baldi)

Subject Pronoun Usage in Mexican Spanish in South Texas 179
Javier M. Morin and Carla Chapa (Sandra Baumel-Schreffler)

I, Tituba, Symbol of the Antilles 183
Debbie Officer (Margarite Fernandez-Olmos)

A Profound Cultural Exchange: The Mexican Muralist Movement and the Harlem Renaissance and its Modernist Descendants 187
Alice Psirakis (Raysa Amador)

The Issue of Status in Puerto Rico: Internal Strife in the Search for Status 192
Mandy Robinson (Paul Simon and Maria Dolores Goddard)

Multinational vs. Global Organizations: A Case Study of the Corporate Culture of IKEA 197
Katherine J. Ross and Saturnia Alcala (Peter Hackbert)

The Creation of Christianity: Exploring the Role of Women in the Development of the Ancient Church 202
Jennifer L. Borden and Kevin S. Minoli (John R. Lanci)

For Better or For Worse: The Case For Gay Marriage 205
Kathrine Ehrlich (Laura Purdy)

The Mother-Daughter Relationship of Harriet Taylor Mill and Helen Taylor 210
Amy M. Kuhl (Jo Ellen Jacobs)

Pragmatic Faith in John Dewey and Fyodor Dostoevsky 215
William D. McCracken (Stuart E. Rosenbaum)

Epistemological Conditions: How Plato Anticipates Gettier 220
Andrew T. Cronan (A.M. Weisberger)

Adversity and Sacrifices: The Examination of Two Lives 224
Patience Adibe (Harriette Pipes McAdoo)

The Acquisition of Knowledge According to the Theory of Jean Piaget 229
Donna M. Cain (Ralph Carlson, Dalinda Rodriguez, Raymond Welch, and Keith Turner)

A Descriptive Survey of the Three Contemporary Approaches to Fluency Disorders 234
Peter Golleck (Raymond Welch, Barbara Johnson , Teri Mata-Pistokache, Timothy Meline, and Keri Parchman-Gonzalex)

Cosmos and Chaos: An Analysis of Themes and Issues in Doris Lessing's The Fifth Child 238
Anna C. Long (Hamida Bosmajian)

Toni Morrison's Sula: The Pharmakos of Her Community 243
Joseph Van Mieghem (Hamida Bosmajian)

BEST COPY AVAILABLE

The Search for Innocence in the Art of Jean Cocteau 249
Erin Nicole Parisi (Alexandra Wettlaufer and Jonathan Bober)

Preferences of Positive Reinforcers Among Elementary Students 253
Kelly Schutte (Lian-Hwang Chiu)

Implementation of Civil Rights Policy in Education 257
Autumn Stewart (Carter A. Wilson)

Jewish Resistance to the Nazi Occupation of Lithuania and Belarus during World War II 260
Phillip C. Alloy (L. Wilcox)

Peddling Public Assistance: The Children's Bureau and the Aid to Dependent Children Program in the Social Security Act of 1935 263
Katherine E. Anselmo (Helen Wheatley)

A Case Study of the Tax Reform Initiative by Marylanders 268
Juanita Maria Banks (Abdul Karim Bangura)

Famous and Forgotten: The Life and Death of the Dubuque Dial, 1934-1935. 272
Katherine Dietrich (Michael Anderson)

The Stonor Letters and the Wars of the Roses: Violence and Politics in Fifteenth-Century England 276
Michelle Dowd (Richard Kaeuper)

Thomas Becket and King Henry II A Medieval Drama with a Contemporary Application 281
Lorie Fratz (George Sochan)

The Mushroom of Feeling: American Public Reaction to the Atomic Bomb, 1945. 285
Jason C. Gaskill (Larry Lipin)

Henry Laurens: The Making of a Revolutionary 289
James Hutchinson (Bruce Greenawalt)

Beyond the Imperialist V Anti-Imperialist Dichotomy: American Intellectuals and Fin De Siecle Expansionism 294
Robert James Kijewski, Jr. (David Worbel)

"Being Madame is a Miserable Job" The Letters of Liselotte von der Pfalz, 1672-1722 299
Christie King (Caroline Castiglione)

Fencing out the Foreigner: Influences on the Eighteenth Legislature of Wyoming and its Exclusion of Foreign Physicians 304
Susan Macki (Eric Kolher)

A Woman's Place: Female Tavern and Inn Keepers in Early Pennsylvania 310
Sarah E. Morgan (Larry Eldridge)

The Debates and Arguments Leading to the Passage of the Seventeenth Amendment 314
Tara M.E. Yencha (Deborah A. Rosen)

Jane Addams: Women-Based Political Actor as Role Model 320
Oona Besman (Susan Harrison)

Lesbian Perspectives on Love, Sex and Relationships: Adult vs. Youth 325
Angelica Victoria Hernandez (Mary L. Alpaugh)

Women's Body Image: Effects of Media Imagery and Anorexia Nervosa 330
Grace Lager (Susan Harrison)

Testing the Effects of Sample Composition and Context on Radiocarbon Dating from Mammoth Cave, Kentucky 335
Sarah McCloskey (Kenneth B. Tankersley)

Three-Dimensional Mapping of the Bluff Greathouse Archaeological Site 339
Natasha Psenicka (Lawrence B. Conyers)

Scholarly Sightseeing in Rome, Ravenna, and North Africa: The Differences in Early Christian Centrally Planned Vaulted Structures 344
Benjamin D. deLee (Christine Colley)

Self-Perceptions and Representations of Hawaiian Identity, Ke Kanaka and Ke Kane Ikaika 349
Cheryl Nohealani Olivieri (Margarite Fernandez-Olmos)

Mexican Catholicism: The Syncretic Result of the Spanish and Indigenous Religions in Contemporary Mexico 352
Helena E. Colyandro (Susan Deans-Smith)

Rocky Road: The Long Journey to Educational Freedom in Prince Edward County 357
Randy A. Jones (George Bagby and Lowell Frye)

VOLUME II

SOCIAL SCIENCES

Preclassic Maya Pottery From Colha, Belize 362
Sharon Hankins (Fred Valdez, Jr.)

Deciphering the Secrets of Skeletal Remains from Hellenistic Abdera, Greece 367
Thomas P. Bolioli and Tara M. Kirkpatrick (Anagnosti P. Agelarakis)

Japanese Unknown Women Under the Japan's Alliance Capitalism: The Complementarity of the Pre-Existing Structures and the Changing in Identity 373
Yumi Kobayashi (Jeffrey Broadbent)

Window Into the Past: Diachronic Aspects of Three Ancient Human Skeletal Populations from the Khao Wong Prachan Valley in Central Thailand 377
Anna Konstantatos (Anagnosti P. Agelarakis)

Whole Vessels from Kichpanha, Belize: Implications of Increasing Social Complexity 382
David A. McDow (Fred Valdez, Jr.)

Form and Function of Late Preclassic Maya Pottery 387
Angela Milliman (Fred Valdez, Jr.)

Southern Plains Powwow Culture: Exploring the Identity of the Drum 392
Cindy Stout (Sue Tuohy)

The Sexual Oppression of Women in South Korea 397
Tuesday M. Tamburri (Leslie Miller-Bernal)

Evaluation of a Summer Orientation Course for New College Students: Critical Reading and Reasoning 403
Hernan E. Diaz (Sharon L. Pugh)

The Association of Peer Acceptance and Social Behavior in Early Childhood 406
T. Gayle McLemore (Leslie Phillipsen)

The History of the Civil Rights Movement in Prince Edward County, VA (1951-1964) 411
Steven L. Turner (Susan H. Bagby)

Qualitative Research on the Teaching Methodology of Genetics 348: A Hands on Approach 416
Tia Fluegge (Sandra Tutwiler and Presley Martin)

Spatial Distribution and Socio-Economic Profile of Asian Indians 421
Aaron Otto (Jayati Ghosh)

Intra-Asian Direct Investment and Indian Economic Liberalization 426
Susanne Peters (Jayati Ghosh)

The Spatial Distribution of the Hispanic Population in the United States: An Analysis at Various Geographic Scales 431
Stephanie M. Sheetz (Robert Douglas)

A Quantitative Study of Communication Apprehension and Self-Esteem 436
Mattie Marie Butler (Abdul Karim Bangura)

Attraction Factors Involved in Internet Relationships 441
Karen Chain, Christopher Gill, and Dawn Kujawski (Dean Thomlison)

Wartime Benevolence: A Portrait of Northern Philanthropy During the Civil War 446
Kevin Davis (Bruce S. Greenawalt)

Media and the Construction of Identity: Young Women's use of "Friends" 451
Kristi L. Eaves (David B. McLennan)

Dress and Nonverbal Communications 456
Barbara Heinemann (Joanne B. Eicher)

Confronting Learning Disabilities: A Proactive Approach for Parents 461
Holly Kapp (George Sochan)

Public Perceptions of Television Versus Newspaper Credibility: A Local Study 465
Andrea Lawson (Mark D. West)

The Evidentiary Impact of the Likelihood Ration and Assessment of Diagnosticity 470
Nir Liberboim (Jonathan Jay Koehler)

Solitary Confinement: A Study of Prisoners' Access to the News Media 475
Michael O'Sullivan (Ann Marie Major)

The Conveyance of Socioemotional Cues in Computer-Mediated Communication: A Content Analysis of Internet Relay Chat 480
Kimberly K. Schaefer (Denise Bostdorff)

You Eat What You Are: An Investigation of Key Environmental Variables on Food Choice 485
Laurel Y. Shanaman (James Brancato)

The Nurse-Patient Continuum: A Nursing Model 489
Jackie Boak, Elizabeth Dickerson, Melissa Jackson, Teri O'Quinn, and Cathleen Fabiani (Margaret Erickson)

Assessing the Effects of HIV/AIDS Peer Education on High School and College Freshmen 493
Cara Catalino, Erin Clune, Megan Gordon, and Marie Neilan (Patricia A. Bailey and Donna R. Carpenter)

Relationships of Self-Perception of Balance, Technological Measures of Balance, and Fall Events Among Individuals with Parkinson's Disease 496
Kativa L. Leal (Nancy E. Dayhoff)

Depression: Prevalence, Causes, Manifestations, and Repercussions Associated with Elderly Disability 501
Nicole Lovell (Clyde B. Killian)

Medical Costs and Correlates of Gunshot Wounds in Travis County, 1995 506
Jennifer L. Moren (L. Michelle Issel)

Family Caregivers' Perceptions of Pallidotomy Surgery: Expectations, Satisfaction, and Health Dysfunction 511
Polly K. O'Brien (Jane Backer)

Living on the Health Care Drawing Board: An Analysis of the Availability of Health Care to Low-Income Families in Los Angeles 515
William Ortiz (Leslie Howard and Cheryl Swift)

Fathers, Food, and Fun: A Nutrition Education Program for Low-Income Urban Fathers and their Children 520
Donald C. Sweet, Lisa Gemlo, and Jennifer Ruffing (Debra Palmer Keenan)

Accounting for the Effects of Hurricane Hugo 523
Tulani Giscombe (Mary Jones Phillips)

Changes in Smokeless Tabacco Utilization Patters Among School-Aged Children 526
Mark A. Robinson (Don Lisnerski, Bob Yearout, and Cheryl McClary)

Detecting Hidden Periodicities in Business Cycles of Fifteen Countries Using Fourier Analysis 530
Peter Hlavaty (Edward Gamber and James DeVault)

Effects of Foster Care on Perceptions of Family and Family Functioning 534
Judy Meyer (Beverly Curry)

BEST COPY AVAILABLE

Retailer Country Bias Cues: An Experimental Approach 538
Erin C. Miller (Sherry L. Lotz)

Matching Cultural Value Orientations to Ad Appeals: Exploring the Role of Individualism-Collectivism in the USA Versus Mexico 543
Michael Mosley (James M. Munch and Gary D. Gregory)

Vertical Integration and Profitability 548
Cecelia Ruth Buchanan (Stephen Schmidt)

NAFTA and Jobs in the United States 553
Kristina Carrico (Rutilio Martinez)

Gender Differences in Investment Expectations 558
Teresa D. Harrison (Rosemary T. Cunningham)

Do Dollars Make a Difference? The Relationship Between Expenditures and Test Scores in Pennsylvania's Public Schools 563
Jonathan M. Klick (Charles Zech)

The Income Distribution Effects of IMF Balance of Payments Stabilization Tools: A Case Study of Monterrey, Mexico 569
Charlotte Opal (Perry Patterson, Michael Lawlor, and Dan Hammond)

Tests of the Induced Innovation Hypothesis in Indian Agriculture 574
Anthony Walsh (Kailash Khandke)

A Qualitative Study of the 1994 Voter Turnout in Prince George's County Executive Election 579
Kirk A. Gordon (Abdul Karim Bangura)

A Test of the Efficacy of the University of Maryland College Park Affirmative Action Program 584
Shamica Monique Jackson (Abdul Karim Bangura)

From Critique to Consensus: Stephen White's Pursuit of a Postmodern Politics 589
Ingrid A. Jendrzejewski (David Gugin)

A Quantitative Study of the High School Attrition in Prince George's County, Maryland 594
Dorothy Lyons-Wilson (Abdul Karim Bangura)

Race in the Balance: Case Study of Escambia Treating Company 599
LaRuby May (Carolyn Johnston)

Aid in Transition: Explaining Post Cold-War Trends in House Foreign Aid Voting 604
Scott R. Meinke (John R. Baker)

A Quantitative Study of the Essence of Federalism: Who Does it Benefit: 609
Kim Odoms (Abdul Karim Bangura)

The Concepts of Community and Individualism in Twentieth-Century Presidential Nomination Acceptance Speeches and Inaugural Addresses 614
Stephen V. Potenza (James E. Underwood)

A Comparative Study of the Levels of Political Socialization of Children in Two New Hampshire Towns 619
Kathleen M. Ridolfo (Clark Hubbard)

A Qualitative Study of Minority-Majority African-American Congressional Districts and African-American Representation in Congress 623
Marvin M. Silver (Abdul Karim Bangura)

A Quantitative Study of the Longevity of Vietnam-Era Disabled Veterans 628
Joseph L. Singleton, Jr (Abdul Karim Bangura)

The 1996 Albanian Elections: Corruption? Or a Catalyst for Democracy? 632
Christopher Thomas Johnson (Karen Vogel)

The Role of the International Law of the Non-Navigational Uses in International Watercourses in Resolving the Disputes Over Access to Freshwater in the Middle East 637
Jason Woolwine (Gary Prevost)

Trends in the Eisenhower Administration: A study of Inflation, Unemployment, and Presidential Popularity 642
Shadya Y. Yazback (James Lindeen)

Strategizing Advocacy: Theoretical Frameworks in Grass Roots Social Organization 646
Tamie M. Aceves (Manuel Carlos)

Peering into the Success of Peer Feedback: Understanding how Feedback Works in Elementary-Aged Writers 651
Laura Angyal (Matthew Olson)

The Impact of Acculturation Type, Stress, and Social Support Among Mexican-American Adolescents 655
Elsa C. Arroyos (Enedina Garcia-Vazquez)

Physiological Responses to Racist Stressors Among African-American College Students 660
Jamar Barnes, John A. Oliver, and Foye Smith (Vernessa R. Clark)

Gender Differences in Perceptions of Martial Infidelity: Sexual Versus Emotional Cheating 664
Anne-Marie Bartos and Allison D'Auteuil (Ralph J. McKenna)

Childhood and Adolescent Abuse, Fear of Negative Evaluation, and Social Interaction Self Statements: A Correlational Analysis 670
Patti Beth (Barbara Beaver)

Coping Strategies Among African-American and Caucasian Female College Students 675
Ayannah A. Brower, Afiya Ricks, and Foye A. Smith (Vernessa R. Clark)

The Effects of the Administration of Methysergide and Ritanserin, Two Serotonin Antagonists, on the Behavioral Repertoire of Zebra Finches (Taeniopygia guttata) 679
Megan B. Bruther (Wendy L. Hill)

Context and Quality of Social Interaction of Children with Severe Language Delays in a Full Inclusion Preschool Program 684
Amy Buchanan and Krista DeZerega (Lawrence V. Harper and Karen McCluskey)

Characteristics Associated with Premature Drop Out in Client-Centered Play Therapy 689
Valerie A. Campbell, and David B. Baker (Sue Bratton and Jennifer Cleveland)

Helping Behavior Rates and Demographics: A Comparative Analysis 694
Jennifer D. Carlson-Weiberg (Nancy Steblay)

Parents' Marital Status, Father-Daughter Intimacy and Young Adult Females' Dating Relationships 698
Kristen J. Clark (Korrel Kanoy)

Investigating Physiological Responses to Sexual Harassment 703
Shaunta K. Clark, Carina De Fazio, Jamar D. Barnes, and Foye A. Smith (Vernessa R. Clark)

Peace Builders Case Study: Combating Violence Through the Exercise of Positive Choices in an Elementary School in California 707
Charlotte M. Contreras (Manual Carlos)

The Psychobiological Effects of Narcolepsy: Its Causes and Treatments 711
Sara Cronin (Charles Kutscher)

Racial Similarity, Cost to Helper, and Sex as Determinants of Helping Behavior 717
Heather A. Dooner and Margaret M. Blake (Patricia Oswald)

Sex Role Type and Effectiveness of Women Speakers at a Religious Presentation 722
Catherine E. Dundas (Lynn New)

Alpha-Ganzfeld: An Experimental Study on Alpha Rhythms Under the Ganzfeld Condition 727
Darin Dutcher and Joshua Johnson (Dorothee Dietrich and Matt Olson)

The Relationship Between the Extent to Which Adolescents are Taught Not to Trust Strangers During Childhood and Interpersonal Skills 732
Laurie Harrier (Francis Terrell)

The Relationships Among Eating Attitudes, Loneliness, and Self-Monitoring 737
Patricia L. Hart (Cynthia Crown)

Readability of Websites with Various Foreground/Background Color Combinations, Font Types and Word Styles 742
Alyson L. Hill (Lauren F.V. Scharff)

The Relationship Between the Protestant and Catholic Religions and Guilt 747
Caramin C. Johnson (Emily Hause)

Locus of Control and Superstitious Behavior: A Visit to the Putting Green 751
Mark W. Jones (Ralph J. McKenna)

Effects of Long-Term Ad Lib. Feeding on the Weight and Health of Differentially-Reared Laboratory Rats 756
Gary L. Lawrence & Kimberly M. Murrell (Karen E. Brakke & Jeanne M. Stahl)

Drug State Dependent Performance of Rats on a Hampton Court Maze 761
Shawana N. Lewis and Gary L. Lawrence (Karen E. Brakke and Jeanne M. Stahl)

Child Abandonment in St. Petersburg, Russia: Effect of Early Intervention 766
Natalya M. Lvoff (H. Banis)

Parent and Adolescent Relationships as Predictors of Post Divorce Functioning 770
Marisa Manzi, Joan Garten (Michelle Wierson)

Doing Field Research in an Electronic Environment 775
Tracee S. Matlock (Manuel Carlos)

Irrelevant Speech Eliminates the Word-Length Effect 779
Rebecca Mazzorana (Ian Neath and Aimee Surprenant)

Activational Effects of Testosterone On Sound-Guided Spatial Navigation 782
Eric J. Moseley (Mark C. Zrull)

Effects of Employment on College Students' Academic Performance and School Involvement 787
Laura A. Schwarber (Cynthia L. Crown)

Gender Differences In Coping Strategies and Cardiovascular Responses to Stress 791
Eric Shaw and Foye Smith (Vernessa R. Clark)

An Extension of the "Two-Baskets' Theory of Self-Cognitions to Native Americans 794
Mandy D. Smith (David Trafimow)

The Relationship Between Self-Esteem and Extraversion 797
Wendy S. Peterson (Cynthia Crown)

1722

Chicano Gangs in California: Analytical Analysis of the Structure and Dynamics of Chicano Gangs from Street Corner to Prison Cell 801
Brenda J. Pobre (Ruben Mendoza and Manuel Carlos)

The Relationship Between Parents' and Adolescents' Values 807
Heather Reynolds, Corinne Auman, Ilona Teleki, and Laura Batz (Maureen Vandermass-Peeler)

Attitudes of College Students Toward Using Animals in Research 813
Katina V. Robinson and Lisa Harris (Karen E. Brakke and Jeanne M. Stahl)

Transitive Inference in Undergraduate College Students 818
Rhea Watson (Julianna Lancaster and John Batson)

Conflicts of Interest in the Early Stages of Intimate Relationships 822
Susan Russell (Renate Klein)

Social Adjustment of Children and Adolescents with Juvenile Rheumatoid Arthritis: Parent Report 826
Stacie M. Arthur (Robert B. Noll)

The Relationship Between Nicotine and Alcohol Dependence: Treatment Implications: 831
Meenakshi Garg (Barbara J. Mason)

Social Isolation of Nursing Home Residents and Their Perceived Health 833
Jennnifer Langford (Jerry Pankhurst)

The Effects of Minority Influence on Group Polarization 838
Kelly Murphy (Jennifer J. Dose and Jeff Ratliff-Crain)

Scottish Soccer Violence and Religion 843
Megan O'Neill (Len Berkey)

A Content Analysis of Children's Television Commercials 848
Rachel D. Sgaglio (Michelle E. Barton)

A Critical Analysis of Current State Responses to the Problem of Child Maltreatment 852
Elise L. Siddell, Eileen T. West and Emma S. Gavino (Madeline Lovell)

The Assessment of College Students' Perceptions and Attitudes Towards Academic Dishonesty 857
Sarah Acton, Jennifer Thetford (Irene Staik and John Burling)

Changing Pedagogy: Using a Computer Simulator to Teach Ethnographic Methods 862
Gregory R. Blaza (Manuel L. Carlos)

The Influence of Pretrial Publicity on Juror Decision-Making: A Meta-Analysis 866
Jasmina Besirevic (Nancy Steblay)

North America by Bus: A Study of Interaction and Personal Space 871
Lisa Marie Bosner (Natalie Rosel)

The Assessment of College Students' Attitudes Toward the Social Aspects of Their Own Aging 876
April M. Chambers and H. Perry Swindall (John Burling and Irene Staik)

Exploring the "GenderedPerspective" in Early Adolescents' Interpretations of Popular Music 881
Anastasia M. Pharris-Ciurej and Kristine M. Ward(Jodi O'Brien)

An Examination of Gift Giving in Post-Modern Society 886
Megan Kathleen Donovan (Martha Huggins)

1723

Learning to Hate Yourself: How Homophobia Teaches Girls to Devalue Women 889
Jennifer L. Engle (Harriet Adams)

The Effect of the "Year of the Woman" on the 103rd Congress 894
Emily C. James (Nadia Rubaii-Barrett)

Popularity: The Crisis and Culture of Adolescent Girls 899
Cinnamon Reiheld (Harriet Adams)

Production Scheduling of Flexible Manufacturing Cells 904
Jeffrey D. Erickson (Bijayananda Naik)

Physical Attributions of Racial Sterotypes 908
Lori Dixon (B. Runi Mukherji)

Proceedings — NCUR XI (1997)

Volume III

Mathematical and Engineering

Groundwater Nitrate Removal for the Main San Gabriel Basin, California 911
Chad Blais, Katina Burl, Adam Nazaroff, Peter Tonthat, Vinh Truong and Justine Yu (Julie Wei)

Occupant Dynamics in Stationary and Moving Vehicles Subjected to Vertical Impacts: An Experimental Study 915
Peter D. Layson (Toufic M. Hakim and Orion P. Keifer)

SubzeroCam: Design of a World Wide Web-Based Digital Camera for Sunrayce 97 920
James A. Johnson (Richard R. Schultz)

Using Java for Computational Electromagnetic Scattering 925
Jared Martin (Lyle Long)

Flat Oceans and Satellite Radar Anomalies 930
David L. Mickler (Chester J. Koblinsky)

Cyberprint: Creating Alternative Medical Visualization Tools Using Architectural Metaphors 936
Jim Agutter (Julio Bermudez)

Sustainable Building: Planning and Design of a Family Residence and Education Center Using Local Building Materials 940
Geoffrey B. Grace (Rebecca Fish Ewan)

An Analysis of Ancient Maya Obsidian Artifacts from Belize 946
Rissa M. Trachman (Fred Valdez, Jr.)

Effects of Detention Time on Sedimentation Performance 951
Ben Ehrhart (A.R. Jarrett)

Characterization of Waste Sites in Greater Newark Area Using Geographic Information Systems (GIS) 956
Jelena Balorda (Sima Bagheri)

Electrochemical AC Impedance Technique to Investigate the Inhibition Efficiency of an Inhibitor for Steel Rebar in Concrete 960
Octavio Cervantes, Elaine Lopez & Rudolph Martinez (Behzad Bavarian)

Prototype Designs of Concrete-Filled Steel Tube Composite Building Frames 965
Katherine Fetterer (Jerome F. Hajjar)

Removal of Ammonia from Contaminated Air Stream by Biofiltration 970
Annie W. Chou (Ruihong Zhang)

Comparison of Analysis Methods for Non-Classical Structures with Added Viscoelastic Damping 975
James P. Horne (Douglas K. Nims)

Field Testing of Stone Masonry Arch Bridge #143 in Chester County, PA 978
Allyson Karper (Thomas Boothby)

Determining Suitability of Irrigation in Developing Countries 983
Carl McGloughlin (Roger Ruggles)

Development of a Generic, Robust, and Reliable Networking Protocol for a Motorola Microcontroller 988
Mary Frances J. Austin (Charles Bennett)

Ideal Case Modeling of Optical Preamplifer Receivers at the 10Gb/s Data Rate 993
Deborah S. Hart (Y.K. Park, Lucent Technologies, Lightwave Subsystems)

Nonlinear Filtering and Enhancement of Digital Ultrasound Imagery 998
Melissa L. Kurtz (Richard R. Schultz)

Mathematical Modeling of a Fuzzy V-Chip 1002
Daniel J. Landherr (Marian S. Stachowicz)

Effect of Thin Film Disk Texture on Magnetic Recording Head-Medium Clearance Measurements 1007
Daniel Yau (Chorng H. Chang)

A Self-Evaluation Tool for Life-Cycle Cost Analysis 1012
Fabiola Gaytan and Pablo Santos (John Wilson)

Excessive Noise Levels Enhance Special Effects, Are You Aware? 1017
K. Osborne (D. Lisnerski and R. Yearout)

Surface Estimation of Machined Parts 1022
Gustavo Perez (Prasad Gavankar)

The Use of the GRAFCET Approach to Automation of PLC Programming & Control 1027
Janice R. Sansberry (Shueh-Ji Lee)

Counting Arrangements of 2's and -1's 1031
Robert S. Sielken (Donald Bailey)

Magic Squares as Matrices 1036
April Warn (Donald Bailey)

The Structural Design and Electronic Control System for a Large Segmented Space Reflector Test-bed 1041
Anibal Jaimes and Efrain Velazquez (Helen R. Boussalis, Maj Mirmirani and Khosrow Rad)

The Effects of Stretching and Aging on the Tensile Properties of A1-Cu-Li (2195) Alloy 1046
Michael C. Abernathy and Clarence Adkins (Reza Mirshams and Zhixian Li)

Resolvents of m-Accretive Operators in Banach Spaces 1050
Eric Lehr (David Kerr)

Numerical Model for Ice Melting in a Rectangular Enclosure with Density Extremum Effects 1055
Makeda Smith (Khoudir Medjani)

Nanofabrication and Resistance Testing of Metal Coated Silicon Microcontact Arrays 1060
Jeffrey A. Yap (Jack M. Blakely)

The Effect of Razor Notching Techniques on the Fracture Toughness of Polymeric Materials 1063
Dora C. Arevalo (Carlos R. Corleto)

Assessment of In-Plane Strength of Carbon/Epoxy Laminates 1067
Jill Hahl (Ronald Bucinell and Alan Nettles)

The Design and Development of a Phantom Model for Hyperthermia Cancer Treatment 1071
Jennifer Lelas (Ann Anderson)

International Virtual Design Studio: Design of a Vehicle Without Wheels or Wheel-like Contact with the Floor 1075
Carmen McMurtry (Ronald B. Bucinell)

Heat Transfer Enchancement on a Printed Circuit Board 1079
Gretchen R. Voegler (Ann M. Anderson)

BEST COPY AVAILABLE

A Study of Data Issues in the GIS Environment 1084
Jesus Acosta and Lori Alvarado (Ann Q. Gates)

Quick Write vs. Quick Run: Implementation Methods for Goal Definition 1088
Kellie Alexander and Yolanda McCullough (Scott Anderson)

A Study of Environments for Successful Component Reuse in System Development 1093
Debbie Bowles (Mary Lynn Manns)

Digital Simulation of the Acoustic Guitar: A Physical Model Abstraction 1098
Adam D. Bradley (Wayne Lang)

A Parallel Solution of a Second Order Elliptic System 1103
Andre Da Breau and Lwanga M. Phillip (Okon H. Akpan)

Formulation of a Parallel Recursive Substructuring Method for Finite Element and Finite Difference Solutions 1108
Derek O. Bruff (Hayden S. Porter, Jr.)

Comparing a Particle-System Based Simulation to Other Methods in Modeling Special Effects 1113
Joshua Buckner and Ryan Mitchell (Gerald N. Pitts)

An Examination of Mentoring Methodologies in Object Technology 1118
Janet E. Cody-Mehaffey (Mary Lynn Manns)

3D Special Effects: Modeling Reflective Surfaces In Real-Time 1123
Daniel P. Cornell (Gerald Pitts)

Formal Methods for Software Specifications: A Case Study 1128
Michelle Dillinger (Ken Abernethy)

Truth Maintenance Techniques for Verification of Knowledge Bases 1134
Mark R. Finn (Neli P. Zlatareva)

Computer Assisted Data Reduction: Optimizing the Astrophysicist 1139
Dan Greenspan (Karen Magee-Sauer, Michael Mumma)

Hierarchical Planning with Definite Clause Grammars 1143
Tarik Vance-Harris (R. Raymond Lang)

Algorithm Animation: Programming on the World Wide Web Using Java 1148
Stephanie Hitchcock (Kevin Treu)

Formal Methods for Software Specification 1153
Amanda Hoffman (Ken Abernethy)

RSL, A Language for Distributed Parallel Solution of Sparse Matrix Systems 1157
Chad Huneycutt (Hayden Porter)

A Parallel Solution of a Parabolic System on a SIMD Processor 1162
Adrain Ironside and Ramaiz Mansoor (Okon H. Akpan)

Evolutionary Confusion: When and How to Apply the Genetic Algorithm 1167
Michael G. Jones (Gerald Pitts)

Visualization of a Global Atmospheric Model with Iris Explorer 1171
Elizabeth C. McAliley (Hayden Porter)

Experimental Evaluation and Comparisons of Algorithms for Incremental Graph Biconnectivity 1176
Ramgopal Mettu and Yuke Zhao (Vijaya Ramachandran)

An Implementation of Particle Systems for Special Effects 1181
Ryan Mitchell and Joshua Buckner (Gerald N. Pitts)

Parallel Programming: A Disparate Architectures Approach 1186
Jason Pounds (Maurice Eggen)

A Traceability Tool: Linking Knowledge Programs 1191
Francisco Saenz and Tom Watson (Ann Q. Gates)

Commonsense Knowledge Representation for Russian Folktales 1196
Damon Stewart (R. Raymond Lang)

Godel's Incompleteness Theorem and Turing's Solution to the Halting Problem: Linking the Foundations of Mathematics and Computer Science 1201
Philip Rash (David B. Teague)

Java Security 1206
Hnatyshin Vasil (Bob Neveln)

DARWIN: Software to Identify Dolphins in Digital Images 1211
Daniel J. Wilkin (John H. Stewman)

Wavelength Division Multiplexing Coupler Based on Talbot Self-Imaging in Planar Optical Waveguides 1215
Cadet Diana Kuykendall and Cadet Christopher L. Reitsma
(Tristan J. Tayag, David M. Mackie, Lorna J. Harrison,
Gary W. Euliss, and Richard P. Leavitt)

VOLUME IV

BIOLOGY

In Search of Aspects of the Human Condition in Antiquity: The Case of A Hellenistic Population from Abdera, Greece 1220
Pia Economou (Anagnosti Agelarakis)

Abnormalities in Occlusal Surface Wear and Enamel Integrity in Tehuelche Dentition 1224
Alberto Silva (Silvia Dahinten and Daniel de Lamo)

Design of the Acetylcholinesterase Enzyme Using Brownian Dynamics Simulation: A Novel Therapeutic Approach to Alzheimer's Disease 1229
Brent A. Hanks (Walt Potter, Kerry Burns and Vicente Villa)

Postanesthesia Nausea and Vomiting 1234
Aaron Shaw III (Paul Loubser)

A Study of the Risk Factors for Cerebrovascular Accidents in African-Americans 1239
Tera R. Hurt (Dennis E. Daniels)

The Effect of Training Position on Leg Flexor Power in Untrained Males and Females 1244
Dawnelle Diedrich and Ryan H. Robinson (Anthony Caterisano)

Measurement of Anaerobic Power in Elite Wheelchair Athletes: Absolute Load Optimization of the Wingate Test Using the Monark 881 Arm Crank Ergometer 1247
Stephen E. Mercer (Pamela J. H. Beehler)

The Effects of the Raised Mutation of Sexual Behavior in Drosophila Melanogaster Females 1252
Jeannine Caesar and Joshua Bradner (Scott P. McRobert)

The Influence of Menstrual Cycle Phases on the Chaotic Behavior of Electrocardiograms in College-Age Women 1257
Maria M. Mountis, Meghan Ginty and Sharee Livingston (James J. Watrous)

Pollinated Maize Ovaries are Resistant to Infection by the Smut Fungus Ustilago maydis 1262
Margaret Carfioli (Karen Snetselaar)

Genetic Characterization of the AXR5 Gene 1267
Ibrahim Carvan, Donovan Chance, Joseph Mazzie, Rina Pineda and Shabnam Shah (Lawrence Hobbie)

The Competitive Relationship between the Perennial Cardaria draba and the Annual Lepidium virginicum 1272
Maria Conley (Steven Carroll)

Self-Incompatibility: a Model for Pollen- and Pollen Tube-Mediated Signal Transduction in Petunia inflata 1276
Chandreyee Das (Teh-hui Kao)

Investigating Temperature Sensitive Mutants of Ustilago maydis 1282
Janet Gervaiss, Jason Lotkowski (K. Snetselaar and M. McCann)

Partial Purification and Properties of Putrescine Oxidase from Candida albicans 1287
Uma Gunasekaran, Johnny Thomas, and Louis McDonald (Muthukumaran Gunasekaran and Elias K. Manavathu)

Role of Host Plants in Egg Hatching of the Soybean Cyst Nematode 1292
Renee Poupard and Lou Casta (Paul M. Tefft)

Coat Protein Analysis of Tomato Mosaic Virus (ToMV) 1297
Victor Huber, Nicole Kimmes and Jesse Barthel (N. Bharathan)

Feeding Behavior of the Tropical Stick Insect Extatosoma tiaratum: A Study in Palatability of Thirty-one North American Plants 1302
Karla J. Johannes (James Poff)

Monitoring the Release of Acid Phosphatase in Pitcher Plant Fluid after Feeding with Insects 1305
Matthew Jones (Diane Melroy)

Elucidating Mechanisms of Pulmonary Fibrosis: Intracellular and Extracellular Events when the Platelet-derived Growth Factor Receptor System is Up-regulated by Air Pollution Particles and Interleukin 1-beta (IL-1ß) 1309
Patricia O. O'Brien, Annette Badgett and James C. Bonner (Sandra Gilchrist)

Determination of RNA Binding Domains of the Nucleocapsid Protein of Tomato Spotted Wilt Virus 1314
Patricia M. Stickler (Sandra Gilchrist and Tom German)

Characterization of an Auxin-Resistant Mutant of Arabidopsis thaliana 1319
Shabnam Shah, Ibrahim Carvan, Donovan Chance, Joseph Mazzie and Rina Pineda (Lawrence Hobbie)

Comparison of Microbial Consortia and Environmental Condition of Two Granite Outcrop Plant Communities 1324
Keri Randolph and Lisa M. Knauff (Sandra T. Bowden)

Characteristics and Purification of Agkistrodon controtrix laticinctus Venom 1328
Xavier G. Aranda, Elda Sanchez (John C. Perez)

The Purification and Characterization of Crotalus Viridis Oreganus Venom 1332
Gloria R. Chapa and Elda Sanchez (John C. Perez)

The Purification and Characterization of Agkistrodon piscivorus leucostoma Venom 1337
Celia Garcia and Elda Sanchez (John C. Perez)

Purification and Characterization of Crotalus viridis lutosus Venom 1342
Maria Susana Ramirez and Elda Sanchez (John C. Perez)

The Use of Electrophoretic Titration Curves as a Tool in Predicting the Separation of Crude Crotalus atrox Venom by High Performance Liquid Chromatography 1347
Maria Elisa Perez-Johnson (John C. Perez)

Development of a Rapid Detection Method for Determining Bacterial Guild Structure in Mining-Impacted Freshwater Sediments 1352
Todd Christensen (Frank Rosenzweig)

Purification and Biochemical Characterization of Antibacterial Antibiotics Produced by Soil Streptomyces 1356
Victoria C. Heverly (Robert W. Morris and Richard T. St. John)

The Microbial Activity in Saltmarsh Tidal Creek Waters Determined by Oxygen Metabolism 1360
Kenneth C. Hayes and Alan J. Lewitus (Eric T. Koepfler)

Efficiency of Latex Gloves as Barriers to bacterial and Viral Pathogens 1365
Erica Jo Hughes (Robert McLean and Carolyn Benjamin)

Oyster Reef Impact on Microbial Food Web Dynamics in Tidal Pools in North Inlet Estuary 1369
LeRoy F. Humphries, Alan J. Lewitus, Leah L. Gregory and Bonnie M. Willis (Eric T. Koepfler)

BEST COPY AVAILABLE

The Molecular Evolution of HLA-A 1374
Kristie A. Mather (Carrie Grimsley and Carole Ober)

Restriction Endonuclease Analysis of Plasmid DNA from Methicillin Resistant Staphylococcus aureus 1379
Janey Phelps (Betsy Wilson)

Macrorestriction Patterns and Genome Sizes of Two Strains of Bdellovibrio 1384
Theresa Scognamiglio (John J. Tudor)

Effects of Specific and Non-Specific Transport ATPase Inhibitors on Gill and Rectal Gland Tissues of the Little Skate, Raja erinacea 1389
Tanisha Wilkins (Gregg Kormanik)

Effects of Wood Frog (Rana sylvatica) Predation on Spotted Salamander (Ambystoma maculatum) Oviposition Site Selection 1392
Joyce E. Cacka (James W. Petranka)

Consequences of Opportunistic Predation by a Primary Consumer (Rana) on a Predator (Ambystoma) 1397
Andrea Rushlow (James W. Petranka)

The Role of Visual Cues in Determining Recognition Behaviors in Poecilia Latipinna and Poecilia Velifera x Poecilia Latipinna 1402
Joshua Bradner and Jeannine Caesar (Scott P. McRobert)

The Effect of the Lipid Content of the Diet of Blue Crabs, Callinectes sapidus, on Osmoregulation 1407
Sarah E. Hazzard (Lee Ann Clements)

Short-Term Effects of UV-B Radiation on Salt Marsh Vegetation 1412
Christopher D. Raleigh (Eva Koch & Laura Murry)

The Study of the Oxidation of CZT with H_2O_2 Using XPS 1417
Brandy Granderson (De Tang Shi, W. Eugene Collins and Muthukumaran Gunasekaran)

The Effects of Precocene 2 on The Predatory Insect Tenodera aridifolia sinensis Saussure 1422
Emily C. Whiteley (Diane Melroy)

Interspecific Interference and Resource Partitioning Among Males of Three Dragonfly Species (Odonata: Libellulidae) 1427
Michael Wolyniak (Vicky McMillan)

Habitat Selection by American Kestrels (Falco sparverius) Wintering in Northwestern Ohio 1432
Tami L. Parker (J. Eric Juterbock)

The Role of Calcium in Wound-Induced Cell Proliferation 1437
Quoc-Huong Tran (Paul J. Sammak)

Isochore Related Amino Acid Substitutional Biases 1442
Allen J. York (Dan E. Krane)

Effects of Thallium on Inositol Polyphosphate Receptors and Nitric Oxide Synthase in Rat Cerebellum 1447
Chadrick Anderson and Tanya Wright (Chellu S. Chetty and Muthukumaran Gunasekaran)

Initiation of Expression and Cell-Specific Localization of Nitric Oxide Synthase (NOS) in Pre-Implantation Mouse Uterus 1452
Preeti Gupta (Yvette M. Huet-Hudson)

Characterization of Urethral Blockage in a New Mutant Diabetic/Obese Mouse 1456
Michael Villarroel (John G. Vandenbergh)

One-Dimensional and Two-Dimensional SDS-PAGE of Total Protein in the fungus Ustilago maydis 1459
John G. Devlin (Karen Snetselaar and Michael McCann)

Regulation of Superoxide Dismutase Synthesis in Candida albicans 1464
Uma Gunasekaran, Anita Austin and Louis McDonald
(Muthukumaran Gunasekaran, Elias Manavathu and C.S. Chetty)

Antifungal Resistance in Opportunistic Fungi: Isolation and Characterization of Amphotericin B-Resistant Mutants 1469
Uma Gunasekaran, Anjana Challa, Dinita Scurry and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

In Vitro Susceptibility of Clinical Isolates of Opportunistic Fungi to Antifungal Agents 1474
Uma Gunasekaran, Tanya Wright and Louise McDonald
(Muthukumaran Gunasekaran and Elias K. Manavathu)

Aye-Aye Gruel Presentation Preference 1479
Heather Ann Lynch (Joan H. Eisemann)

Modification of the Binary TBP-DNA Complex by Pluramycins 1483
Sameer Ambady (Lawrence Hurley)

Characterization of a Mutant dnaA-dnaN Gene Region that Suppresses a Temperature Sensitive Defect in the dnaX Gene of Salmonella typhimurium 1487
Farhang Amini (James R. Walker)

Conservation of Proto-Oncogenes, Tumor Suppressor Genes, and V (D) J Recombinase Genes Across Species 1492
Lucy A. Aplan (Rob Young)

An Analysis of Lipid Bilayer Studies of Single Ion Channels using M2 as an Example 1496
Erin E. Grimm (Carl Helrich)

Metal Regulated Gene Expression in Pseudomonas fluorescens 1501
Marsha L. Kukuk (Silvia Rossbach)

The Development of a PCR-Based Test to Identify the Red Factor Coat Color Genotype in Horses by RFLP Analysis 1506
Staci Murguia (Ann T. Bowling)

Differentiation and Classification of Bdellovibrio bacteriovorus using Random Amplified Polymorphic DNA (RAPD) Analysis 1509
Bao-Dan T. Nguyen (John T. Tudor)

QTL Mapping of a Genetic Marker for Longevity in Drosophila melanogaster 1513
Amy Resler (Jim Curtsinger)

Stability of Heterochromatin in Voles from Chernobyl 1518
Lara Wiggins (Robert J. Baker)

Isolation and Functional Analysis of three Non-Human Primate CXCR4 Genes 1521
Brigitta Zoltay, Jay Vasudevan and Greg Shaeffer (David Camerini)

Volume V

PHYSICAL SCIENCES

Modification of an Interference Pattern Through Particle Statistics: Experimental Study 1526
Niranjan Sharma (Willard Fadner)

Nuclear Structure of the Stable Tellurium Nuclei 1531
Brian Champine, Peter Burkett, Christopher Davoren, Stephen Etzkorn, William Faulkner, Bernard Meehan, and Mark Skubis (Jeffrey R. Vanhoy and Sally F. Hicks)

Pulse Propagation in a 1-D Physical Lattice 1536
Jonathan Tuminaro and Joseph Winkler (H. David Sheets)

An Investigation to Measure Mechanical Strain in Structures using Optical Fiber Interferometry 1540
Satyender Mahajan (Zolili Ndlela)

CO Adsorption on Cobalt Particles Supported on Chromia - An FTIR Study 1544
Caribee Collier and Agegnehu Tsega (Murty A. Akundi and A.N. Murty)

Solar Cells Using Organic Pigment Nanoparticles 1549
D.J. Hilton and E.W. Forsythe (B.R. Hsieh and Y.Gao)

Calculating O_3 9.6 μm Absorption as a Function of Atmospheric O_2 1553
Hilary L. Justh (James F. Kasting)

Electromagnetic Field Profiles Inside Biomaterials 1558
Pedro L. Melendez, Dimaries Nieves, Ramon A. Rivera (Idalia Ramos and Fredy Zypman)

Thermal Modeling of the Marcy Anorthosite Massif, Adirondack Highlands, New York: Implications for Depth of Emplacement 1563
Kevin M. Myer (J. Alcock)

Ultra Sensitive Diode Laser Based Monitors for Toxic Environmental Gas NO_2 1568
Jessica Owens (G.N. Rao and M.N. Reddy)

Sample Heating and its Effects on Diffusion Depth 1573
J. Reed Patterson (Peter A. Barnes)

The Hyperpolarizabilities of Phthalocyanines 1578
Tiffiani R. Williams (Beatriz H. Cardelino)

Simulated Super Resolved Imaging of Compact Radio Sources 1583
Erika Barth (David Hough)

A Study of the Lobe-Dominated Superluminal Quasar 3C263 1588
Philip J. Beyer (David Hough)

Global Imaging of the Cusp Region of the Earth's Magnetosphere 1593
John W. Colson (J.D. Perez)

3D Circuit Networks Simulate Biomaterials 1596
Edsel Ruiz, Pedro Melendez (Idalia Ramos and Fredy Zypman)

A Two-Year Climatology of Radiation Budget and Cloud Properties for the ARM SGP Site 1601
Stephen G. Strum (Thomas P. Ackerman)

Nonlinear Optical Properties of Halogenated Porphyrin 1606
Angela Benloss (Beatriz H. Cardelino, Craig E. Moore)

A Novel Method for Investigating Phase Disturbances 1611
Rex L. Blair Jr. (Thomas R. Moore)

An X-ray and Optical Study of Galaxies in Pairs 1616
Sarah Cousineau (Mark Henriksen)

Optically Driven Pendulum 1621
David Coy and Michael Molnar (Randall Peters and LTC Thomas Moore)

Surface Morphology of CdZn Te Crystals Grown by Physical Vapor Transport 1626
Montiquilla Davis (Arnold Burger, Henry Chen, Kuo-Tong Chen and Muthukumaran Gunasekaran)

Avalanche Segregation of Granular Media 1631
James Koeppe and Michael Enz (James Kakalios)

Magnetic Susceptibility (MS) and Visual Spectral Reflectance (VIS) Measurements: Paleoclimate Estimates for Pleistocene Europe 1636
James R. Marlatt (Brooks B. Ellwood)

Diamond Film Coatings on Titanium Alloy Using Chemical Vapor Deposition 1641
Andrea Nelson (John T. Tarvin and Yogesh K. Vohra)

Purification and Crystal Growth of Lead Iodide 1646
Danielle Robinson (Kuo-Tong Chen, Arnold Burger, Henry Chen and Muthukumaran Gunasekaran)

Recalibration of the Wilson-Bappu Effect Using the Singlely Ionized Magnesium k and h Lines 1651
Frederick Scoville (Jose Mena-Werth)

Analysis of X-ray Sources in Galaxy Clusters 1656
Dean Smith (Mark Henriksen)

Using FTIR-Reflection Absorbance Spectroscopy to Study the Structure of Thin Ice Films 1659
Jennifer L. Spillman, Govind Mallick and Robert M. deGroot (Marin S. Robinson)

CHEMISTRY

Large DNA Fragment Sizing by Flow Cytometry 1664
Angela R. Cameron (Jeffrey T. Petty)

Enchancement of Asymmetric Induction in the Aqueous Diels-Alder Reaction of (L)-Menthyl Acrylate with Cyclopentadiene by β-Cyclodextrin 1669
Kristen Daniell, Terry E. McIntyre, Poh Ai Ling (Moses Lee)

Effect of Lipid Peroxidation Products, 4-hydroxy-2-trans-Nonenal and Malondialdehyde, on Erythrocyte Membranes 1674
Michael Green, Ram Subramaniam (Allan Butterfield)

The Synthesis and Decomposition of Single Source CVD Precursors 1679
Tadd Kippeny (D.S. Amenta, J.W. Gilje, and T.C. DeVore)

Thermal Remediation of Model Chloropesticides Utilizing Reactions with Sodium Salts 1684
James W. Parrett, Jr. (Thomas C. DeVore)

Determining the Effect of Substitutions on the Hyperpolarizabilities of Tricyanoquinoline-Dimethanes 1689
Jamarcy L. McDaniel (Beatriz Cardelino)

Better Magnetic Resonance Imaging Contrast Agents for Tumor Detection 1694
Leah C. Saunders (Thomas R. Cundari)

Computational Analysis of the Electronics of Substituents on Aromatic Systems 1699
Lumelle A. Schmiedekamp (Judy L. Ozment)

Isolation of a Compound Responsible for the Biochemical Control of Dimorphism in Candida Albicans 1704
Joseph J. Tasto (Kate J. Graham)

Adsorption Behavior of NO and CO on Pd/Al_2O_3: An FT-IR and Mass Spectrometric Study 1707
Chad D. Marten and Barry W. Smith (Dilip K. Paul)

Structural Studies of a Modified Oligonucleotide using 2-D NMR Techniques 1712
Thanh Ta, Shannon Teeters and Brigette Semler (Dale G. Ray III, Mark McDougall, Jim Holecek, Lorraine Rellick)

Effects of Additives, pH, and Buffers on the Chemiluminescence of Phenyl Acridinium Ester 1717
Carolyn Snider, John Rollag (D.S. Hage)

Dynamic Surface Tension and Surface Adhesion Detection for the Rapid Analysis of Surfactants 1722
Dana Alloway (Robert Synovec and Kristen Skogerboe)

Interactions of the Domains of Myosin's Regulatory Light Chain with the Heavy Chain: A Photocross-linking Study 1727
Lisa Nguyen (Jennifer J. Olney and Christine R. Cremo)

Thermodynamic Melting Point Studies of a Native and Modified Thirteen Base Pair Oligonucleotide containing 5-Nitroindole using UV Spectrometry 1732
Jamie Doone and Chad Willis (Lorraine Rellick, Dale G. Ray, Jim Holecek, and Mark G. McDougall)

Chitosan-Porphyrin Films for NLO Applications and Optical Devices 1736
Celeste A. Roney (Rosalie A. Richards, Subhash C. Bhatia, Albert N. Thompson, Jr., and Beatriz H. Cardelino)

Biochemical Characterization of Amino Acid Uptake in Potential Vacuolar Mutants of Neurospora crassa 1741
Zeljka Basic and Jonathan Z. Tayco (Kelly Kennan)

Preparation of $Co(PYAN)^{+3}$ and Progress Toward the Separation of its Optical Isomers 1745
Lori Bigler (Susan C. Jackels)

Attempted Synthesis of a Precursor of an Anti-tumor Marine Alkaloid: Shermilamine B 1750
William Buitrago (Yvette Jackson and Michael Lyon)

Determination of the Vanadate-Mediated NAD(P)H or NADH Oxidation Mechanism in Biological Systems 1755
Carlos J. Olivo-Delgado (Ileana Nieves-Martinez and Ronald P. Mason)

Mobius Kekulenes: Semiempirical and ab initio Hartree-Fock Calculations of Their Structures and Properties 1760
Patricia L. Frisch (Robert W. Zoellner)

Synthesis of (-)-(S)-4b, (S)-8b, (S)-8c, (S)-8d Diisopropyl 4b,8b,8c,8d -tetrahydrodibenzo[a,f]cyclopropa[c,d]pentalene-8b,8c-dicarboxylate: A Project on Absolute Asymmetric Induction 1765
Kimberly Johnson and Jacob E. Simpson, Jr. (Moses Lee)

The Polymerization of Dicyclopentadiene for use in the Undergraduate Organic Laboratory Utilizing Computational Methods 1769
Jason Logan (James W. Hershberger)

Examination of the Decarboxylation of Ketoisovalerate Using Pyruvate Decarboxylase from Saccharomyces cerevisiae 1773
Michael B. Meek (Betty H. Stewart)

Synthesis, Purification, and Activity of Glutaryl-CoA Analogs 1777
Shannon L. McKinney, Carrie L. Donley, Gregory K. Sewall, Patricia L. Kultgen (Colleen M. Byron)

The Synthesis of Rigidin -- A Tetrasubstituted Pyrrole 1782
R. Jordan Shuford (Keith Krumpe and John Gupton)

Molecular Modeling of Vanadium-Oxo Complexes 1787
Laura L. Sisterhen (Thomas R. Cundari)

Characterization of Liquid Crystalline Thermoset Networks 1792
Jeffrey M. Valentine (Christopher K. Ober)

Faraday Rotation of a Photogenerated Organic Triplet Molecule in Polyvinyl Alcohol Films 1797
Paul Trotto (David Hall and David Dwyer)

HPLC Analysis of Eicosanoids in Response to Valproic Acid (VPA), Endotoxins (LPS) and Tumor Necrosis Factor (TNF) 1802
Matthew Thomas McKevitt (J.R. Stephens)

Preparation of an Iron Complex of $Pyo_2[18]dieneN_6$ 1807
Shane O'Mahony (Susan C. Jackels)

The Plasma Etching of Metals and Metal Compounds 1811
Gordon Shaw (Judity Halstead)

ENVIRONMENTAL SCIENCES

Pipelines and Potential Disaster: An Introduction to Cathodic Protection 1816
Joy J. Burwell (Brian Hale and Verne Lehmberg)

Twin City Water Quality Initiative Program 1821
Valerie Kuntz (Kenneth Brooks)

Lead Contamination of Canned Food Products from Argentina 1825
Margaret M. Ryan (Richard P. Maas)

Don't Die with TDI: Dynamic Calibration of MDA Isologgers for Toluene Diisocyanate 1830
Clare E. Smith (Herschel A. Elliott and V. Dharmarajan)

The Effect of Carbon Content on the Redox Potential and Fermentation Products of Wetland Soils 1835
Wendy Rash and David Cahan (Kevin K. Moorhead and Keith E. Krumpe)

The Invasion of Carrotwood (Cupaniopsis anacardioides): A Study Comparing the Impact of an Exotic Species on two Islands in Sarasota, Florida 1840
Lisa Downey (Sandra Gilchrist, John B. Morrill and Terry Palls)

Urban Forests and Wildlife: A Web Document 1845
Katrina M. Simon (John Bishop)

Effects of Stratification on Germination of Two Oak Species in Southeastern Arizona 1849
Kimberly Suedkamp (Guy R. McPherson)

Seasonal Fluctuations in Central Greenland Ice Sheet Radar Altimeter Return Characteristics 1853
Philip Dennison (Richard Alley)

Results of a Microseismic Survey of the Front Range of Colorado 1857
Noah Daniel Hughes (Anne Sheehan)

Atmospheric Teleconnections and United States Regional Climates 1862
Dana M. McCracken (Anthony J. Vega)

Extracellular Acid Phosphatase(s) Activity of the Protozoan Parasite Perkinsus Marinus 1866
Christine M. Forsythe (Aswini K. Volety, and Fu-Lin E. Chu)

Microhabitat use by Fish Populations within the Little Miami River 1871
Daniel J. McGarvey (Horton H. Hobbs III and John B. Ritter)

Water Chemistry Habitat Assessment in Eastern Tiger Salamander Ponds 1876
Sara E. Wirtz (Daniel M. Downey)

The Derivation of United States Temperature and Precipitation Regions 1881
Donna M. Fiscus (Anthony J. Vega)

Cloud Masing of Normalized Difference Vegetation Index (NDVI) Images 1885
Heidi Zeleznik (Barry Lesht)

Proceedings — NCUR XI (1997)

IN SEARCH OF ASPECTS OF THE HUMAN CONDITION IN ANTIQUITY: THE CASE OF A HELLENISTIC POPULATION FROM ABDERA, GREECE

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This paper presents important dental information involving a Hellenistic (3rd century B.C. B.C.E.) skeletal population from Abdera, Greece. It is part of a larger interdisciplinary archaeo-anthropological research project carried out by Dr. A. P. Agelarakis of the Department of Anthropology at Adelphi University. This collection consists of the skeletal remains of 51 individuals, 36 of which have preserved dentitions.

The goal of this project was to evaluate dental anthropological data in a laboratory study in order to determine the significance of the occurrence of dental morphology and pathologies, aspects of dietary patterns, and of related manifestations and dental changes which add significant information to the decipherment of aspects of the human condition in the past.

Methods used included background literature research, tabulation of data from the original excavation site, and analysis of information from past research concerning the collection.

Research results include valuable contributions regarding conditions of early life stress which affected the livelihood of these people, organismal growth processes, and the ecology and distribution of dental pathologies. This information provides insight and adds to our understandings about our ancestors pertinent for both present and future scientists and scholars alike.

INTRODUCTION

This study is part of a larger ongoing interdisciplinary project which began in 1984 as a collaborative endeavor between the Greek Archaeological Service and Dr. A. P. Agelarakis of Adelphi University. This paper presents results of physical anthropological and paleo-pathological laboratory analyses in reference to dental surfaces and of their hard supporting tissues recovered from a Hellenistic population dated to the 3rd century B.C./B.C.E. excavated from the site of Abdera, in the coastal plains of Thrace in Greece. Abdera, one of the richest ancient cities of Greece, is located near the mouth of the Nestos river diagonally opposite to the island of Thasos, in the northeastern area of Greece. It was first founded in the 7th century B.C./B.C.E. by the Clazomenaens of Greek Asia Minor seeking refuge from the invading monarchic forces of the Persian Empire (Herodotos: History).

Abdera is also the birth place of great philosophers, Democritus and Protagoras. Democritus is known for developing the atomic theory, which had been introduced by his mentor the philosopher Leucippus, also probably born in Abdera. Protagoras is known as the "first thinker" to call himself a Sophist and the first to teach for fee. He is best remembered by his expression " Man is the measure of all things ".

SAMPLE SIZE, METHODS AND SCOPE OF PAPER

This skeletal collection consisted of fifty-one individuals, thirty-six (68%) of which had preserved dentitions. The skeletal collection included twenty-three males, eighteen (78%) with preserved dentitions, nineteen females, thirteen (68.4%) with preserved dentitions, three individuals which were classified as borderline females, two (66.6%) of which had preserved dentitions, and six individuals which could not be identified as either male or female due to fragmented remains out of which only three (50%) had preserved some fragmented dentitions. The age groups in this collection included individuals within Infancy II, age assessed between 8-12 years, to Senilis, the oldest individual being a male, age assessed at approximately 55-65 years (Agelarakis, database).

The dentitions provide vital information as part of the preserved osseous human record, for deciphering issues of skeletal biology and growth processes, aspects of dietary patterns, range and variation of dental diseases, aspects of dental hygiene and genetic morphological characteristics as variations of dental morphological expressions.

Pertinent studies revolved around tabulations of existing data (Agelarakis, 1994; database and manuscript) through manipulations of the database in order to derive assessments which would carry statistical implications concerning the dental record for understanding interpretations about the human condition during Hellenistic times in Abdera.

RESEARCH RESULTS

Based on the analyses of existing records on the dental remains (Agelarakis, 1994; database and manuscript), it has been determined that out of the eighteen males that had preserved dentitions, eight (44%) were affected by carious cavities. From the females, of the thirteen with preserved dentitions it was determined eight (61.5%) revealed carious cavities, and out of the six individuals in which sex assessment could not be determined, two (33%) showed carious lesions. Carious cavities are the result of infectious conditions affecting and degrading dental hard tissues (Mandel, 1978). The carious process in enamel consists of a diffuse demineralization within the bulk of the lesion that affects crystals in all regions of enamel. However, varying patterns of differential dissolution are often observed thus explaining the different sizes and severity of carious lesions (Ten Cate, 1994). Out of the eighteen individuals with carious cavities, involving both males and females, nine were found to be between 35-55 years of age. The other nine were found primarily to be in the 25-35 age range.

As reflected by the paleo-pathological database, jaws and teeth revealed the presence of periodontal disease. This disease usually begins due to a lack of oral hygiene coupled by the nature of dietary intake and degree of food preparation (Agelarakis, personal communication). It involves the inflammatory and subsequent infectious implications for the gingival components, the clinical and anatomical surfaces of dentitions, as well as the hard tissues of the alveolar bone (Ten Cate, 1994). Evidence of the disease was derived through two assessments: 1) flattened inter-dental septae, compounded with resorbtion of the alveolar bone; and 2) the presence of calculus deposits on the supra-gingival dental surfaces that were formed ante mortem (Agelarakis, 1994; database). It was assessed that sixteen males (88%), sixteen females (88%), two with indetermined sex assessment (33%), and one borderline female (33.3%), possessed characteristics of periodontal disease. Resorption of inter-dental alveolar septae ranged from slight to severe.

Linear enamel hypoplastic (LEH) defects were considered the product of malnutrition and constitutional metabolic disturbances as well as the result of hereditary information (Pindborg, 1982). LEH is further defined as permanent markers of stress that are directly related to metabolic deficiencies. These deficiencies are cases of temporary cessations of growth during periods of stress that occurred during an individual's life, specifically while teeth form inside the alveolar bone of the jaw, whether deciduous or permanent. It was tabulated that six males (26%), had characteristics of LEH ranging from slight, sometimes immeasurable due to calculus build-up, to severe. Only two females (11%), showed slight hypoplasias on their mandibular surfaces. Two (33%) out of the six indetermined individuals showed slight defects, as well as, one from the borderline female category (Agelarakis, 1994; database and manuscript).

Morphology of the dentitions refers to the studies of the surfaces of dental components and of their epigenetic, congenital, and developmental variation, as well as, of their overall shape and size determined by an individual's particular collection of genes or genotype, and on the body's reaction to environmental stimuli (Hillson, 1986). Examples of morphology found in this collection (Agelarakis, 1994; database) included enamel pearls, traits of Carabelli, and varieties of reasons which resulted in mandibular and maxillary excessive dental crowding (Agelarakis, 1994; database). Enamel pearls are small nodules of enamel developing from embryonic enamel tissue usually occurring in a particular proportion of the mandibular second molar (Hillson, 1986). Evidence of enamel pearls were found in only two males (9%), age assessed between the ages of 25-35 years. The trait of Carabelli which is an expression of non-metric variation of epigenetic nature can be found in the form of a cusp, tubercle, groove, or pit at the mesiopalatal cusp of the first maxillary permanent molars (Rogers, 1988), although it might also appear with diminishing frequencies on the second permanent and third permanent maxillary molar (Agelarakis, personal communication). The trait was recorded only among one male, one female and two of indeterminate sex (Agelarakis, 1994; database). All four individuals expressed the trait in a different form, the male in terms of a cusp, the female which had four molars implicated, two in the form of a tubercle, and two in the form of a groove. The two individuals unable to be sex assessed revealed Carabelli forms of the cusp and the tubercle patterns respectively. Out of the thirty-six individuals dental crowding was observed in two males and one female.

DISCUSSION AND CONCLUSION

The data from this research provides scientists and scholars today with opportunities to better comprehend aspects of the life conditions of this population. This information is significant because it gives us a greater understanding as to the habitual conditions of not only the individuals, but of their population and culture. It is extremely important for reconstructions of the paleo-archaeological record to further understand multiple aspects of the environmental conditions, specifically that this population had to endure, to survive. Through the examination of the dental remains a significant amount of information can determine why, and how certain individuals were affected by dental pathologies and non-pathological conditions, and why others were not. As well as how efficiently did those affected with these conditions survive during Hellenistic times.

Based on the results pertaining to carious cavities, it was determined that 35% of the individuals preserving dental remains were affected due to relatively high amounts of starches and sugars in their diets. The high prevalence of periodontal disease and large amounts of calculus build-up allows us to conclude that they experienced insufficiencies in maintaining high standards of oral hygiene, which would have prevented such high prevalence of periodontal disease. We can also assess from the rest of the archaeological record that this population had a very high standard of living in addition to a dietary intake of extremely well prepared food (Agelarakis, personal communication).

Results involving linear enamel hypoplastic activity inferred that there was a low prevalence for this condition, and that in early childhood the majority of the individuals were not affected. This suggests that people living in Abdera had a lower incidence of childhood stresses that affected them in comparison to later archeological populations in Abdera (ibid.).

Even though the results determined through this study only reflect on a relatively small sample of the Hellenistic population found in Abdera, it is nevertheless a random representative sample and it provides pertinent information for present and future scholars in deciphering aspects of the human condition from the past. However, further research endeavors need to take place in order to better elucidate and understand facets of their daily lives. This might even give today's scientists and scholars the opportunity to better see our own lives in a diachronic context of the human condition.

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REFERENCES

Agelarakis, A.P., database and manuscript, 1994.

Brand, Richard W. and Isselhard, Donald E., Anatomy of Orofacial Structures, 5th edition, Mosby, NY, 1994.

Butler, P.M. and Joysey, K.A., Development, Function and evolution of Teeth, Academic Press Inc., London, 1978.

Hillson, Simon, Teeth, Cambridge University Press, Cambridge, 1986.

Mandel, I. D., Dental Caries, American Scientist, Vol 67, 1978.

Pindborg, J.J., "Aetiology of Developmental Enamel Effects not related to fluorosis." Int. Dental Journal, Volume 32, 1982.

Rogers, Spencer L., Testimony of Teeth, "Forensic Aspects of Human Dentitions", Thomas Publishing, 1988.

Ten Cate, A. R., Oral Histology: Developmental, Structure, and Function, 4th edition, Mosby, St. Louis, 1994.

Abnormalities in Occlusal Surface Wear and Enamel Integrity In Tehuelche Dentition

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ABSTRACT

The Tehuelches, an aboriginal tribe of the central eastern coast of Argentina, were hunter-gatherers first described by European settlers in the mid 1700's. Recent archaeological findings of Tehuelche burial sites have inspired current anthropological studies, with their abnormal dentition disintegration as a formidable mystery. The three-fold objective of this research project was to (1) utilize five quantitative standards to establish a dental attrition profile, (2) investigate the merits of a micro abrasion theory as the etiological agent of accelerated dental attrition, (3) determine if any significant differences exist between individual teeth relative to the observed standards. The data suggests that complimentary teeth #'s 14 and 19 possessed the greatest levels of dental attrition. The mineral composition of sampled soil was 68% quartz, and only 9% of the teeth possessed clinical calculus; both of these factors suggesting the presence of a cleansing agent. Significant differences between teeth #'s 14,16 and 17,19 were evident in all five quantitative standards. This statistical information will lay the foundation for a possible method of age at death determination, thus complimenting current anthropological methods.

INTRODUCTION

The Tehuelches were an aboriginal tribe of southeastern Argentina, first described by European settlers in the mid 1700's. They were hunter-gatherers, their diet consisting mainly of the nau and hoione (*Lama guanicoe* and *Pterocnemia pennata*, respectively). Two anthropological phenomena of the Tehuelches are of peculiar interest - their unusually tall stature (about 1.9m for males) and the pronounced disintegration of their dentition. Dentition can provide a multitude of anthropological information such as age-at-death, dietary characteristics, oral and systemic health, disease, and genetic affiliation (Kelly and Larsen, 1991). The degree of occlusal surface wear (OSW), for instance, allows one to determine to a certain degree of precision (analogous to that of cranial suture closure) the age-at-death of an individual. Occlusal surface wear, when coupled with other observations such as pulp chamber exposure (PCE), presence of topical or lateral fractures, and peripheral enamel integrity (PEI), can provide a broader dental attrition profile that may be used for dietary reconstructions and for analyzing variances in cariogenic oral flora populations (Tieszen, 1988).

The purpose of this project was to (1) create a Tehuelche dental attrition profile, (2) utilize the abnormal characteristics of this profile to provide a possible cause for accelerated attrition, and (3) establish possible relationships between individual teeth so as to lay the statistical foundation for a highly specific age-at-death determination method. The dental attrition profile consisted of observations in OSW, fractures, PCE, and PED. The etiology of the abnormalities associated with Tehuelche dentition was analyzed with a microabrasion theory as the current predominant theory. Finally, using non-parametric statistical analysis, relationships between teeth were analyzed.

MATERIALS & METHODS

Specimens. Eleven adult Tehuelche specimens (9 males, 2 females) and their 140 individual teeth were observed. Eight of the eleven were from a private collection (C. Brunette, Rawson) and the remaining three were excavated from a burial site in Trelew and Pt. Madryn. Radiocarbon analysis of the later three estimated a mean age of 1149 +/- 200 years.

Standards. Individual teeth were numbered according to the conventional numbering system of 1-32. Only the left arcade (9-16, 17-24) was examined, except for the absence of teeth where the right antimere was examined. Occlusal surface wear (OSW) was determined in accordance with the osteological standards of Smith (1984) (for canines, incisors, and premolars) and Scott (1979) (molars), which provided a progressive score relative to the degree of OSW (1-8 and 0-10, respectively). Using the Scott system, molars were divided into 4 exact quadrants and the mean of the 4 scores determined the overall OSW. Fractures, either topical or lateral, were observed. Pulp chamber exposure was scored on a progressive scale of 1-4, labeled as (1) no PCE, (2) commencing, (3) evident, and (4) well defined. Intermediate values demonstrated transient conditions. Quantitative analysis of PED was determined using an electronic caliper. Enamel condition was categorized as (1) intact, (2) uniform, non-disrupted, (3) disrupted (4) fragmented, (5) absent, and (6) absent, loss below cemantoenamel junction.

Soil Samples. Three random soil samples of burial site stratus were extracted and analyzed, and percent composition of mineral content determined (100X).
Statistics. The Kruskall-Wallis Test for non-parametric variance (where k>2) was used to detect any statistically significant differences (P<0.05) between individual standards.

RESULTS

Standards. The occlusal surface wear data was presented as the mean +/- SEM. Individual dentition standard results are allocated in Table 1. Individual dentition relative to the Scott scale is shown in Figure 1. Fractures on primary and tertiary molars were analyzed (Figure 2). The degree of molar PCE is shown on Figure 3. Molar PEI and their respective categories are shown in Figure 4.
Soil Samples. The three random soil samples contained roughly 68% quartz, 20% feldspar, and the remaining trace minerals were composed mainly of volcanic glass.
Statistical analysis. The Kruskal-Wallis Test determined that there exists significant differences in all applied standards between the primary (T_{14}, T_{19}) and tertiary (T_{16}, T_{17}) molars (Zar, 1984). No statistical differences were found in the other two classes (incisors/canines and premolars, data not shown).

DISCUSSION

Our initial goal was to establish the dental attrition profile and thus provide the basis on which any anthropological inferences to Tehuelche dentition . The numerical analysis of all applied standards demonstrate a dental attrition profile that most notably isolates primary molars as the most deteriorated teeth, whereas tertiary molars seem to be immune to the adverse conditions causing this level of attrition (Figure 4). Occlusal surface wear, the hallmark of dental attrition profiles, was at a score of 34 for T_{14} and 36 for T_{19} indicating these teeth as anatomically useless. The accelerated primary molar PCE associated with massive OSW becomes a liability predisposing an individual to microbial infection, whereas the overall enamel integrity disruption can promote adverse contact wear with teeth that are proximal to it. The microabrasion theory seems to be an appropriate approach in determining the etiology of the accelerated attrition. From the results of the soil samples, one can note that the mineral composition of that stratus of soil was about 68% quartz, which scores a 7 on the Moh's scale. Note that apatite scores a 3. Although enamel is composed mainly of hydroxyapatite and its strength is derived intrastructually rather than as a function of its mineral components, the Moh's scale demonstrates the vast differences in strength between the main mineral component of enamel and that of an abrasive. The culmination of chronic microabrasions coupled with acute destruction caused by the ingestion of animal bones might be a key factor in the Tehuelche dental attrition profile.

The statistical analysis of the profile demonstrates that significant differences exist between the most deteriorated and the most spared dentition, thus establishing the fundamental basis from which to construct an age-at-death determination method specific to Tehuelche dentition. If tertiary molars are said to erupt at age 15 +/- 2 years (Hanihara, 1961), then the differential characteristics between primary and tertiary molars can possibly be used to supplement and compliment current anthropological methods (Walker et al. 1991).

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REFERENCES

Kelly, M. A., and C.S. Larsen (editors) Advances in Dental Anthropology. Wiley-Liss, New York, 1991

Hanihara, K. Criteria for Classification of Crown Characters of the Human Deciduous Dentition. *Zinriugaku Zassi* 69:27-45, 1961

Smith, B.H. Patterns of Molar Wear in Hunter-Gatherers and Agriculturalists. *American Journal of Physical Anthropology.* 63:39-56, 1984

Scott, E.C. Dental Wear Scoring Technique. *American Journal of Physical Anthropology.* 51:213-218, 1979

Tieszen, M.F. A Review of Dental Microwear and Diet in Modern Mammals. *Scanning Microscopy.* 2:1149-1166, 1988

Walker, P.G. Dean, and P. Shapiro Estimating Age of Tooth Wear in Archaeological Populations. In Advances in Dental Anthropology, edited by M. Kelly and C.S. Larsen, pp. 169-178. Wiley-Liss, New York, 1991

Zar, J.H. Biostatistical Analysis. Prentice-Hall, Englewood Cliffs, New Jersey, 1984

Table 1: Standards for incisors, canines, and premolars

Tooth #	OSW (+/- SEM)	PCE	PEI (CAT)
T9	19, 2.4	3.2	4.0, 2.2
T24	24.7, 4.8	2.6	1.8, 3.1
T10	22.3, 3.5	3.0	3.8, 2.5
T23	22.6, 4.2	3.1	2.5, 3.3
T11	22.9, 4.1	2.7	4.3, 3.6
T22	26.1, 3.1	2.8	3.1, 3.1
T12	24.3, 5.6	2.5	4.0, 2.7
T21	22.7, 5.5	2.3	5.0, 2.3
T13	24.2, 6.3	2.6	3.7, 3.2
T20	22.5, 4.5	2.3	4.7, 2.3

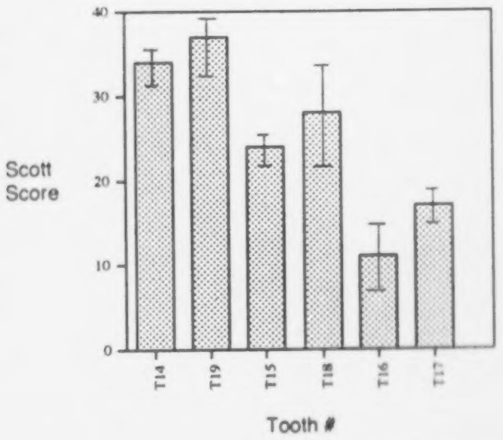

Figure 1: Occlusal surface wear; molars. Each bar represents the mean +/- the standard error of the mean (SEM) of respective Scott scores. Note the differential occlusal surface wear between primary and tertiary molars.

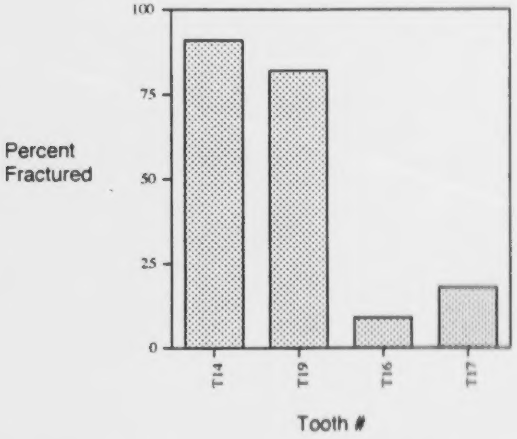

Figure 2 : Presence of fractures. Each bar represents the percent of individual teeth that exhibit fractures. Differential percent of fractures between primary and tertiary molars suggests pre-mortem abnormalities.

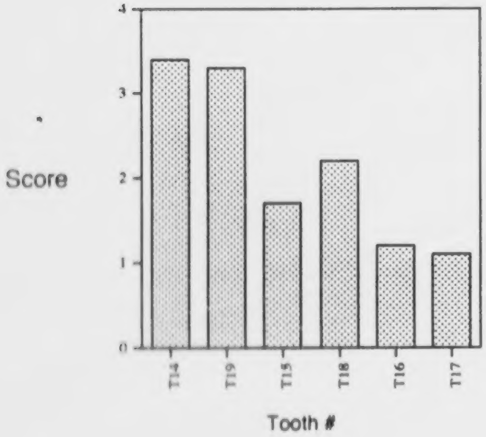

Figure 3 : Degree of Pulp Chamber Exposure in molars. Bars represent the mean value of X amount of samples. Note that T14 and T19 are within the 3-4 range (evident to well defined exposure) whereas T16 and T17 are about 1 (intact enamel).

1745

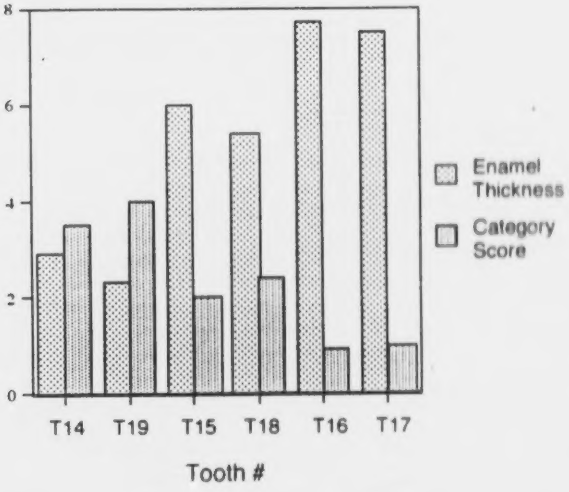

Figure 4 : Peripheral Enamel Integrity and Degree of Disruption ; Molars. Bars represent the mean peripheral enamel thickness (in mm) and the mean category score depicting enamel integrity, respectively. Note the inverse relationship between these two factors and the vast differences between primary and tertiary molars.

Design of the Acetylcholinesterase
Enzyme Using Brownian Dynamics Simulation
A Novel Therapeutic Approach to Alzheimer's Disease

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The computational technique of Brownian dynamics simulation was used to investigate the electrostatic and kinetic properties of wild-type and mutant *Torpedo californica* acetylcholinesterase (AChE) under normal and abnormal physiological conditions. This method was implemented by writing a Brownian dynamics program in Borland Pascal 7.0 protected mode. By calculating the electrostatic force field of AChE and simulating the diffusion-controlled reaction of this enzyme with its natural substrate, acetylcholine (ACh), the efficiency constant (k_{cat}/K_m) of the wild-type and mutant forms of AChE could be determined. These calculations have been used to find surface residue mutations that will depress the catalytic activity of this enzyme, thereby offering possible therapeutic alternatives to the treatment of Alzheimer's disease (AD). Simulations have been performed on wild-type, D285A, D285K, E278A, and E278K AChE mutants in low and high dielectric environments. The computed rate constants compare well with experiment and the results show that 1) the abnormally hydrophobic environment of this enzyme in AD is capable of enhancing AChE activity and promoting AD pathogenesis, 2) the E278K mutation is a promising candidate for experimental site-directed mutagenesis studies, and 3) Brownian dynamics simulation coupled with the modern personal computer is capable of offering a strategic methodology to the technique of site-directed mutagenesis and proposing target amino acids for the genetic therapy of human diseases associated with diffusion-controlled enzymes.

BACKGROUND

acetylcholinesterase

The acetylcholinesterase enzyme (AChE) is a 537 amino acid polypeptide that is anchored to the postsynaptic neural membranes in the central nervous system (CNS) and at neuromuscular junctions by a glycosylphosphatidylinositol linkage. The primary physiological role of AChE is to catalyze the hydrolysis of the acetylcholine (ACh) neurotransmitter at cholinergic synapses, resulting in the termination of impulse transmission. This catalytic role is thought to occur at a diffusion-controlled rate which is consistent with rapid neural propagation (Voet and Voet, 1995).

The determination of the three-dimensional structure of the electric ray *Torpedo californica* AChE dimer by Sussman et al. (1991) has shown that the enzyme's monomer is comprised of a 12-stranded mixed β-sheet surrounded by 14 α-helices and that these subunits associate through both a disulfide linkage and hydrophobic interactions. The most prominent structural characteristic of AChE is a deep (~20Å), narrow gorge that leads to the enzyme's catalytic triad of Ser^{200}, His^{440}, and Glu^{327} at its base. The gorge walls are lined with 14 highly conserved aromatic amino acids which have been implicated in guiding the positively charged ACh substrate toward the active site through low-affinity cation-π interactions. The amino acid charge distribution of AChE has been found to create a negative electrostatic field which contributes to its high enzymatic activity. Antosiewicsz et al. (1995) have found that this electrostatic steering effect is capable of guiding the ACh substrate toward the entrance of the AChE active site gorge and increasing the catalytic rate of this enzyme by an order of magnitude.

Alzheimer's disease

Despite decades of intense research efforts, an effective treatment for Azheimer's disease (AD) does not exist and it remains the fourth leading cause of death in the United States today, affecting more than four million Americans and costing society an estimated $100 billion dollars a year (Davis and Powchik, 1995) Many studies have shown that the levels of the ACh neurotransmitter in the cerebral cortex and hippocampus of patients suffering from AD are abnormally low (Rose, 1981) Other pathological markers of AD include senile plaques and neurofibrillary tangles (NFTs) in this same tissue Further work has shown that the distribution of AChE in the cerebral cortex of AD patients is limited to these lesions and that this enzyme's activity is significantly altered under these abnormal physiological conditions (Schatz et al , 1990)

Both senile plaques and NFTs are primarily composed of β-amyloid protein (βAP) fibrils, which have been found to be fragments of an integral membrane glycoprotein termed the amyloid precursor protein (APP) (Hardy and Allsop, 1991) APP processing can occur via two separate pathways a normal secretory route or a pathogenic endosomal/lysosomal route which results in increased βAP deposition (Golde et al , 1992) Nitsch et al (1992) presented an elegant study which showed that ACh activation of muscarinic ACh receptors (mAChR) stimulates the normal secretion of APP through a phospholipase C second messenger system This stimulation, in turn, reduces the degradation of APP through the amyloidogenic endosomal/lysosomal pathway Thus, if the catalytic activity of AChE could be inhibited, elevated levels of the ACh neurotransmitter would be present to bind to mAChRs on neural membranes, thereby resulting in decreased βAP production and reduced brain lesion formation

This work seeks to fulfill four goals 1) to write a Brownian dynamics program which accurately calculates bimolecular enzymatic rate constants, 2) to study the mechanism by which the electrostatic field of AChE contributes to its biological function, 3) to determine if the abnormally hydrophobic physiological environment of AChE in AD is capable of enhancing this enzyme's catalytic activity, and 4) to suggest a mutation which will depress the activity of AChE by altering this enzyme's electrostatic field

METHODS

electrostatics

The enzyme-solvent system was modeled using the 2 8 Å-resolution x-ray crystal structure of the *Torpedo californica* AChE monomer immersed in a homogeneous dielectric continuum (Sussman et al , 1991) Partial atomic charges were assigned according to the OPLS parameter set at neutral pH, generating a net charge of -10e The Coulombic electrostatic force field of the AChE monomer was calculated by centering the enzyme in a 64^3 grid lattice with 4 Å spacing and using the following equation to compute the electrostatic force at each point on the grid

$$F(r) = \frac{e^2}{\varepsilon} \sum_{i=1}^{N} \frac{q_i \mathbf{d}_i}{d_i^3} (1 + \kappa d_i) e^{(-\kappa d_i)} \qquad (1)$$

where e is the charge on an electron, ε is the dielectric constant of the system, N is the number of atoms in the enzyme, q_i is the charge of the ith enzyme atom, d_i is the distance between the ith enzyme atom and the grid point, and κ is the Debye-Huckel ion screening parameter which approximately accounts for the perturbance of solvent ions on charge-charge interactions between the enzyme and its substrate (Allison et al , 1988) This ion screening parameter is defined as

$$\kappa = \sqrt{\frac{2N_A \rho e^2 I}{\varepsilon_o \varepsilon \mathbf{k}_B T}} \qquad (2)$$

where N_A is Avagadro's number, ρ is the density of the solvent, I is the ionic strength of the solvent, ε_o is the permittivity of vacuum, k_B is Boltzmann's constant, and T is the absolute temperature of the system

Brownian dynamics

Diffusion-controlled rate constants were obtained by simulating the reaction of AChE with an ensemble of ACh substrate molecules using the theory of Brownian dynamics This was accomplished by dividing the space around AChE with a spherical surface of radius b and another with a larger radius q, such that all electrostatic interactions beyond b were centrosymmetric (Allison et al , 1985) The diffusional trajectory of an ACh molecule was calculated by randomly placing it on the *b* sphere and using the following Ermak-McCammon algorithm to compute subsequent motion

$$r = r^{o} + \frac{D_{rel}F(r)\Delta t}{\mathbf{k}_{B}T} + S \qquad (3)$$

where r^{o} and r is the location of ACh before and after a trajectory step is taken, D_{rel} is the relative diffusion constant, Δt is the length of a trajectory time step, and S represents a stochastic force due to collisions with solvent molecules having the statistical properties of a Gaussian distribution with zero mean and variance equal to $2D_{rel}\delta_{ij}\Delta t$, where δ_{ij} is the Kronecker delta (Ermak and McCammon, 1978). The electrostatic force on the substrate was calculated by interpolating the pre-calculated force values of the nearest grid points on the lattice by using a three-dimensional Taylor's expansion and solving the derivatives with the method of finite differences. Numerous trajectories were computed to yield a reaction probability of β, which was utilized in the following expression to solve for the diffusion-controlled rate constant

$$k = k_{D}(b)\beta\left[1 - (1 - \beta)\Omega\right]^{-1} \qquad (4)$$

where Ω is probability of a substrate diffusing past the *q* sphere and then returning and $k_{D}(b)$ is the steady-state rate constant at which the ACh molecules penetrate the *b* sphere (Northrup et al., 1984). The following expression has been derived to describe this term

$$k_{D}(b) = 4\pi D_{rel}\left(\int_{b}^{\infty}\frac{e^{U/\mathbf{k}_{B}T}}{r^{2}}\,dr\right)^{-1} \qquad (5)$$

model system

Molecular modeling was used to determine that the hydrodynamic radius of the AChE monomer and ACh were ~30 Å and 4.23 Å, respectively. However, to approximate the active site wall fluctuations of AChE, the substrate was modeled as a positively charged sphere with a radius of 2 Å. Protein atoms were modeled as 1.5 Å spheres. In addition, the *b* and *q* spherical radii were assigned values of 128 Å and 295 Å, respectively. Reaction criteria were satisfied when the substrate sphere diffused within 15 Å of the OG atom of the Ser^{200} catalytic residue. A variable time step algorithm was used with Δt values ranging from 1.25 fs to 800 ps as the substrate approached the outer *q* sphere.

Simulations were performed using 8000 trajectories at a temperature of 300 K, an ionic strength of 5 mM, a solvent density of 996.5 kg/m^{3}, and dielectrics of 78 and 60. All calculations were performed on a Packard Bell personal computer equipped with a 75 MHz Intel Pentium processor. Studies were conducted on the Asp^{285} and Glu^{278} sites, which represent the closest acidic residues to the entrance of the active site (Figure 1).

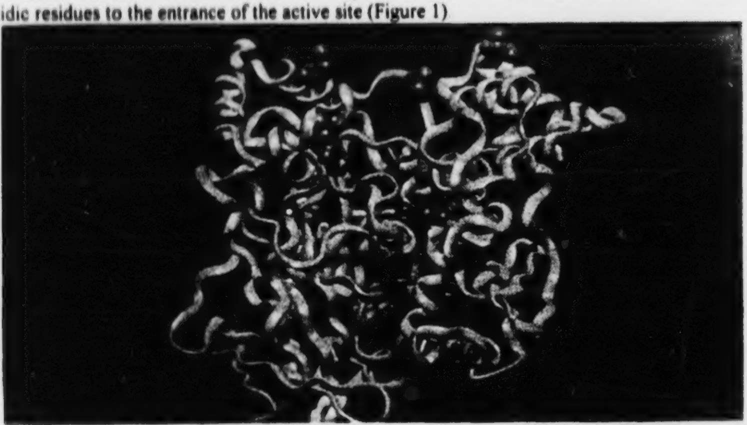

Figure 1. Ribbon Structure of the AChE Monomer. The Asp^{285} and Glu^{278} residues are the center and upper-right modeled amino acids near the active site entrance.

RESULTS

wild-type

The computed rate constant of wild-type AChE at an aqueous dielectric of 78 compares well with the experimental rate constant of 1.6 x 10^9 $M^{-1}s^{-1}$ found for the electric eel *Electrophorus electricus* AChE enzyme under similar conditions (Table 1, Nolte et al., 1980). These simulation results reveal that the abnormally low dielectric medium significantly enhanced the catalytic rate of AChE by a factor of 3.6. Furthermore, the electrostatic force field calculated in this work illustrates the expected gradient emerging from the active site gorge and extending along the enzyme's surface (Figure 2, contours = 5×10^{-12} N). This effectively enlarges the active site target area, resulting in increased enzyme-substrate association.

Table 1 Effect of Dielectric on Activity of wt AChE

Dielectric	Rate Constant $M^{-1}s^{-1}$	Standard Error
78	1.3 x 10^9	± 0.267 x 10^9
60	4.7 x 10^9	± 0.615 x 10^9

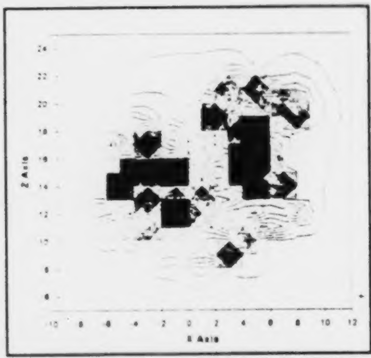

Figure 2 Electrostatic Force Field of wild-type AChE (ε=78). The catalytic Ser^{200} residue is located at (1,15) on the graph

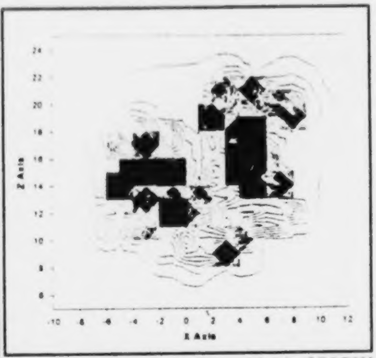

Figure 3 Electrostatic Force Field of E278K AChE (ε=78). The active site gorge lies between z=14 and z=20

glutamic acid-278

Simulations of the E278A mutant produced a K_{mod} value that compares favorably to the K_{mod} found by Shafferman et al. (1994) for human AChE (Table 2). The calculated K_{mod} of 3.36 at a dielectric of 60 compared to the 2.24 value at a dielectric of 78 indicates that the E278K mutation has a larger effect on the kinetics of AChE under hydrophobic conditions. The elevated K_{mod} values and suppressed rate constants for this mutant can be further explained by analyzing its electrostatic force field. Figure 3 shows a new region of positive charge at (-1,17), which is the location of the Glu^{278} residue. This positively charged mutation seems to reduce electrostatic attraction between the enzyme and the substrate as it diffuses near the gorge orifice.

Table 2 Effect of E278 Mutations on Rate Constant of AChE. K_{mod} (modification constant) is defined in this work as the ratio of the wild-type rate constant to the mutant rate constant

Enzyme	Dielectric	Rate Constant ($M^{-1}s^{-1}$)	Standard Error	Calculated K_{mod}	Experimental K_{mod}
E278A	78	6.7 x 10^8	±0.272x10^8	1.94	2.18
E278K	78	5.8 x 10^8	±0.750x10^8	2.24	------
E278K	60	1.4 x 10^9	±0.403x10^9	3.36	------

aspartic acid-285

Mutating AChE at the 285 position failed to significantly affect its activity (Table 3). In addition, the K_{mod} value calculated by neutralizing the Asp^{285} residue is statistically similar to the low experimental K_{mod} found by Shafferman et al. (1994). However, it should be noted that the K_{mod} value for the D285K mutation is larger in the low dielectric medium than in aqueous solution ($\varepsilon=78$), implying that the electrostatic field of AChE plays a larger role in its enzymatic mechanism under hydrophobic conditions

Table 3 Effect of D285 Mutations on Rate Constant of AChE

Enzyme	Dielectric	Rate Constant ($M^{-1}s^{-1}$)	Standard Error	Calculated K_{mod}	Experimental K_{mod}
D285A	78	1.8×10^9	$\pm 0.296 \times 10^9$	0.72	1.12
D285K	78	1.1×10^9	$\pm 0.112 \times 10^9$	1.18	------
D285K	60	2.4×10^9	$\pm 0.511 \times 10^9$	2.04	------

CONCLUSIONS

The reduced rate constants for the E278K mutant in this work are consistent with the work of Shafferman et al (1994) and Antosiewicz et al (1996) who found that the neutralization of this amino acid resulted in the largest decrease in AChE enzymatic activity out of all acidic surface residues The E278K mutation is therefore a promising candidate for experimental site-directed mutagenesis and circular dichroism studies These results also suggest that the abnormal physiological environment of AChE in AD is capable of enhancing this enzyme's surrounding electrostatic field and, in turn, increasing ACh breakdown and subsequent βAP deposition

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REFERENCES

Allison, S , Bacquet, R , and McCammon, J (1988) Biopolymers, Vol 27, pg 251-269, Simulation of the Diffusion-Controlled Reaction Between Superoxide and Superoxide Dismutase II Detailed Models

Antosiewicz, J , McCammon, J , Wlodek, S , and Gilson, M (1995) Biochemistry, Vol 34, pg 4211-4219, Simulation of Charge-Mutant Acetylcholinesterases

Antosiewicz, J , Wlodek, S , McCammon, J (1996) Biopolymers, Vol 39, pg 85-94, Acetylcholinesterase Role of the Enzyme's Charge Distribution in Steering Charged Ligands Toward the Active Site

Davis, K and Powchik, P (1995) The Lancet, Vol 345, pg 625-630, Tacrine

Ermak, D and McCammon, J (1978) J Chem Phys , Vol 69, pg 1352-1360, Brownian Dynamics with Hydrodynamic Interactions

Golde, T , Estus, S , Younkin, L , Selkoe, D , and Younkin, S (1992) Science, Vol 255, pg 728-730, Processing of the Amyloid Protein Precursor to Potentially Amyloidogenic Derivatives

Hardy, J and Allsop, D (1991) Trends in Pharm Sci , Vol 12, pg 383-388, Amyloid Deposition as the Central Event in the Aetiology of Alzheimer's Disease

Nitsch, R , Slack, B , Wurtman, R., and Growdon, J (1992) Science, Vol 258, pg 304-307, Release of Alzheimer Amyloid Precursor Derivatives Stimulated by Activation of Muscarinic Acetylcholine Receptors

Nolte, H , Rosenberry, T., and Neumann, E (1980) Biochemistry, Vol 19, pg 3705-3711, Effective Charge on Acetylcholinesterase Active Sites Determined from the Ionic Strength Dependence of Association Rate Constants with Cationic Ligands

Northrup, S., Allison, S., and McCammon, J. (1984) J Chem Phys , Vol 80, pg 1517-1524, Brownian Dynamics Simulation of Diffusion-Influenced Bimolecular Reactions

Rose, F (1981) Metabolic Disorders of the Nervous System, Pitman, London, pg 411

Schatz, C , Geula, C , and Mesulam, M (1990) Neurosci Lttrs , Vol 117, pg 56-61, Competitive Substrate Inhibition in the Histochemistry of Cholinesterase Activity in AD

Shafferman, A , Ordentlich, A , Barak, D , Kronman, C , Ber, R , Bino, T , Ariel, N , Osman, R , and Velan, B (1994) EMBO, Vol 13, pg 3448-3455, Electrostatic attraction by surface charge does not contribute to the catalytic efficiency of acetylcholinesterase

Sussman, J , Harel, M , Frolow, F , Oefner, C , Goldman, A., Toker, L , and Silman, I (1991) Science, Vol 253, pg 872-878, Atomic Structure of Acetylcholinesterase from *Torpedo californica* A Prototypic Acetylcholine-Binding Protein

Voet, D and Voet, J (1995) Biochemistry, 2nd Edition, John Wiley & Sons, Inc , New York, pg 1298-1299

Postanesthesia Nausea and Vomiting

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Since the inception of the field of anesthesiology, post-anesthesia nausea and vomiting (PANV) has been an important and common complication resulting from general anesthetics. PANV adversely affects patients' anesthetic experiences in numerous ways and is linked to an increase in health care costs. In the United States alone, it is estimated that between $250,000 and 1.5 million dollars in revenue is lost each year treating patients with PANV. The purpose of this study is to assess the incidence of PANV in patients undergoing general anesthesia in The Methodist Hospital, located in the Texas Medical Center. The study includes data from 150 patients in The Methodist Hospital and is limited to those who underwent surgical procedures that were four hours or shorter in duration. Data collected from patients who are considered to be in the high risk category (those undergoing laparoscopic procedures, women who are menstruating, those who have a history of PANV, etc.) were examined so as to reveal any correlations between their incidence of PANV and the occurrence of PANV in patients who are not in the high risk category. The results of this study are currently being analyzed for statistical significance using logistic regression analysis.

BACKGROUND

Nausea and Vomiting

Nausea is an unpleasant sensation associated with an impending vomiting episode. Vomiting, or emesis, is a forceful removal of gastric contents that is induced by powerful and sustained contractions of the abdominal muscles and is characterized by a descent of the diaphragm and the opening of the gastric cardia. Vomiting is a complex process that can be divided into three distinct phases: pre-ejection, ejection, and post-ejection (Watcha, 1992, 162). The pre-ejection phase involves symptoms that include excessive salivation and swallowing, tachycardia, and nausea. The ejection phase comprises the actual vomiting and retching, which is associated with rhythmic inspiratory movements of the diaphragm and abdominal muscles. During this process the mouth and the glottis remain closed and the contents of the stomach vacillate between the stomach and the esophagus. The post-ejection phase is characterized by a return of the autonomic and visceral phases to a placid state, and usually includes some degree of nausea. The entire emesis process is extremely complex and is controlled by the emetic center of the medulla, which involves the gastrointestinal, respiratory, and abdominal musculature.

The dangers associated with post-anesthesia nausea and vomiting are many. Persistent nausea and vomiting episodes can lead to dehydration and an electrolyte imbalance, which necessitates the use of expensive medications and causes prolonged hospital stays, both of which increase hospital bills and decrease hospital efficiency. Many surgical patients who are asked to answer questions several weeks after surgery, cite PANV as the most uncomfortable and inconvenient aspect of their hospital stay. Patients expect a certain amount of postoperative pain; they expect to dislike the hospital food; and they expect to deal with the lack of privacy that has become synonymous with hospital experiences. They repeatedly and emphatically state, however, that they were not prepared to deal with PANV.

Patient Variables

When conducting an analysis of the causes of PANV it is important to distinguish between and fully consider the relevant patient-related variables and the relevant surgery-related variables. The patient variables that were considered in this study include: age, gender, obesity, patient history, and anxiety. Children between the ages of 8 and 14 will almost invariably experience some sort of nausea and or vomiting after a procedure that involves general anesthesia. Interestingly, however, after adolescence the likelihood of developing PANV increases with age. In addition, patients' gender is also important when considering whether or not to prophylactically treat for PANV. Most studies report that women are much more likely to develop PANV than men are. Hormonal differences are cited as the main reason for this observation (Watcha, 1992, 195). Obesity is another one of the most prevalent patient-related PANV variables. It is linked to postoperative nausea and vomiting due to the absorbent nature of adipose tissue (fat cells), which take in and hold anesthetics, thereby increasing the amount of time it takes for the drugs to be expired from the lungs and body tissues. Finally, patients who are overly nervous and upset prior to induction are more likely to get nauseous and have to vomit after surgery. This is due to the fact that when patients awaken in a strange, new environment, the preoperative feelings of fear and nervousness are recalled and amplified.

Surgical Variables

As previously mentioned, it is also important to consider the surgical factors that play a role in the incidence of PANV. The three that are of the most interest are the type and duration of surgery that a patient is undergoing, and the method of anesthesia that is used during the surgery. Invasive procedures that involve cutting and/or probing into highly vascularized areas lend themselves to postoperative problems like nausea and vomiting. This includes all operations on the abdominal wall and chest cavity, and surgeries involving the stomach, intestines, and bowels are particularly likely to result in an occurrence of PANV. A correlation has also been noted between the duration of a patient's surgery and whether or not they will get sick postoperativly. The longer an operation takes, the longer patients are being subjected to surgical levels of anesthesia, which is directly proportional to their chances of developing PANV. Also, the methods and types of anesthesia employed are related to this condition. Patients whose surgical levels of anesthesia are maintained with inhalation anesthetics (the most commonly used anesthetics) are at a greater risk of developing PANV than are those who are given local anesthetics.

Operations Included in This Study

Patients undergoing laparoscopic procedures, tympanoplasties, vitrectomies, and laminectomies were chosen to participate in this study. Laparoscopic procedures are those in which a surgeon uses a telescopic camera called a laparoscope to look at the uterus, ovaries, appendix, and other abdominal and pelvic organs. Because laparoscopic procedures always center around the abdomen, which is highly a vascularized area, patients who have these procedures almost always have some experience that is related to nausea and or vomiting. Tympanoplasties are performed to repair a tear in the tympanic membrane (the eardrum) or the small bones in the middle ear. Such operations are usually necessary because of a middle-ear infection, an object lodged in the ear, or a loud noise such as an explosion. Since the middle ear is where the senses of balance and spatial relations are controlled, when operations are performed on this area patients often develop PANV as a result of a temporary loss in their sense of balance and their ability to discern spatial relations.

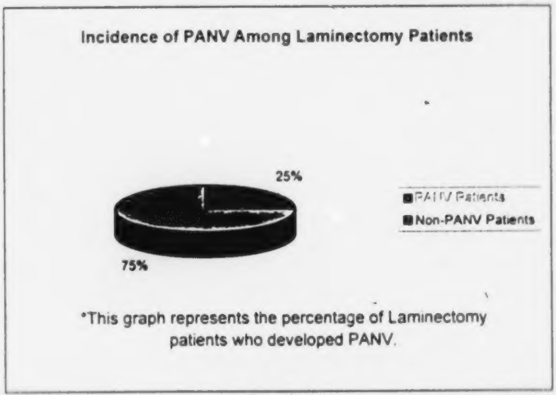
Patients who underwent laminectomies and vitrectomies are grouped into the low-risk category of this study because these operations do not usually result in a high incidence of PANV. Vitrectomies are performed to replace the vitreous membrane of the eye, and laminectomies involve removing a portion of one or several vertebrae, which are located a relatively non-vascular area of the body.

RESULTS

The results of this experiment revealed that there is a reasonably significant incidence of PANV among those patients involved in this study. The percentages of those who developed PANV are listed and summarized in the table below.

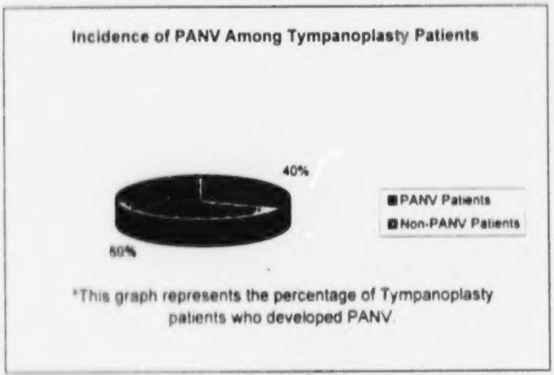
Table 1: Incidence of PANV

Surgical Procedure	Total Number of Surgeries	Percentage of PANV
Laminectomy	52	25%
Tympanoplasty	10	40%
Vitrectomy	10	60%
Laparoscopy	51	31%


Incidence of PANV Among Laminectomy Patients

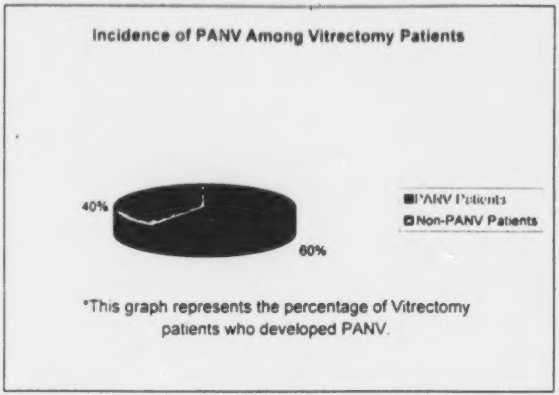
*This graph represents the percentage of Laminectomy patients who developed PANV.

Graph 1


Incidence of PANV Among Tympanoplasty Patients

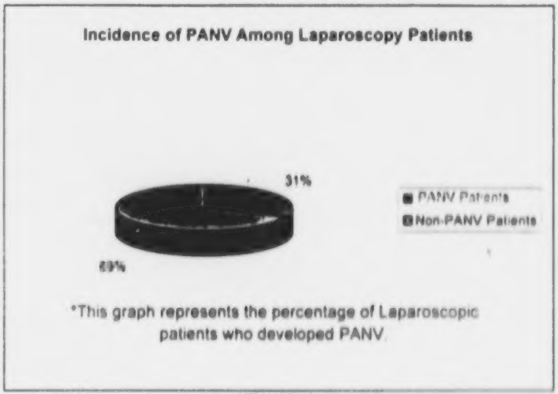
*This graph represents the percentage of Tympanoplasty patients who developed PANV.

Graph 2


Incidence of PANV Among Vitrectomy Patients

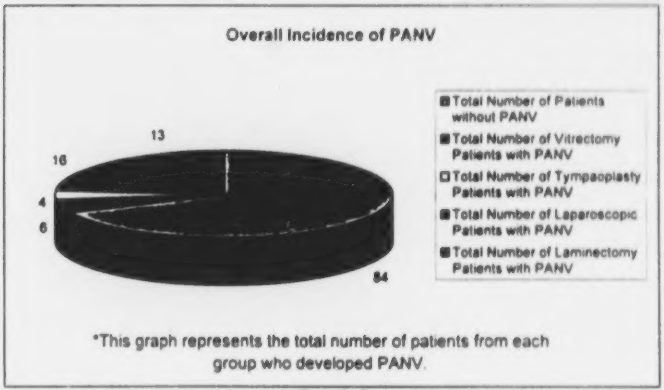
*This graph represents the percentage of Vitrectomy patients who developed PANV.

Graph 3


Incidence of PANV Among Laparoscopy Patients

*This graph represents the percentage of Laparoscopic patients who developed PANV.

Graph 4


Overall Incidence of PANV

*This graph represents the total number of patients from each group who developed PANV.

Graph 5

DISCUSSION AND CONCLUSION

A superficial analysis of the data collected indicates that a substantial number of patients undergoing surgical procedures involving the use of general anesthetics have bouts of PANV. It is important, however, that the results listed above in Table 1 are interpreted with the understanding that this study included a relatively small patient population in two areas (specifically, the vitrectomy and tympanoplasty groups). In addition, it must be noted that the results reported above are representative of any and all notations made on patients' charts regarding even the slightest patient complaints of nausea and/or vomiting. In fact, 81% of patients in this study who complained of and were treated for nausea and vomiting, were experiencing mild and transient discomfort that was easily and quickly alleviated with a small dose of an antiemeitc agent such as Phenergan or Reglan.

Although the aforementioned variables must be taken into account when analyzing the results yielded by this project, they do not warrant a dismissal of what this study has revealed. It remains that several of the 123 patients included in this study experienced some sort of postoperative discomfort that is directly related to nausea and vomiting. It was expected that those who underwent laparoscopies (especially those who had a history of nausea and vomiting) would most likely get sick to some degree, but the high incidence of PANV reported in laminectomy and vitrectomy patients was not anticipated.

Although this study reports a high incidence of PANV in patients undergoing general anesthesia, the results do not necessitate a call for wide spread PANV prophylaxis. Such a measure is not necessary and is not cost effective. Instead, we need to more carefully examine the correlation between age, sex, surgery type, etc., and determine a screening protocol that will allow anesthesiologists to prophylactically treat patients who are likely to develop PANV. Preliminary analysis reveals that the most prevalent correlations exist between the duration of an operation, the amount of blood lost during a procedure, and the whether or not a patient has a history of nausea and vomiting. A more extensive examination of the data collected is forthcoming and will reveal the statistical significance of this study's results.

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REFERENCES

DiPalma, Joseph. 1982. Basic Pharmacology in Medicine. St. Louis: McGraw-Hill Book Company.

Katzung, Bertram. 1984. Basic and Clinical Pharmacology. Boston: LANGE Medical Publications.

Thatcher, Virginia. 1984. History of Anesthesia. Montreal: J. Lippincott Company.

Knapp, Richard. 1983. The Gift of Surgery to Mankind. Chicago: Thomas Publishing.

Omoigui, Sota, M.D. 1995. The Physicians' Desk Reference. New Jersey: Medical Economics Data Production Company.

Volpitto, Perry. 1982. The Genesis of Contemporary American Anesthesiology. Chicago: Thomas Publishing.

Watcha, Mehernoor. Anesthesiology. "Postoperative Nausea and Vomiting: Its Etiology, Treatment, and Prevention" 77:162-184, 1992.

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A Study Of the Risk Factors For Cerebrovascular Accidents in African-Americans

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Over 500,000 Americans experience a cerebrovascular accident (CVA), or stroke, every year. Within the same year, 150,000 die. Today, over 3 million Americans have suffered from a stroke; all of these Americans continue to live some sort of disability. These numbers make stroke the third leading cause of death and the leading cause of disability in the U.S. Everyone is at risk of stroke, especially those older than 65. The Association of Black Cardiologists and LaFayette Singleton conclude that stroke is more prevalent and more deadly in the African-American community than the general population. Approximately 13% of African-Americans are afflicted. They are three to six times more susceptible to CVAs than Whites. African-Americans are also twice as likely to die from a CVA.

The 30% mortality rate due to stroke has experienced a decrease due to improved life expectancy, which is attributed to advancements in medical technology (Modan 1992). About 20% of persons who survive a stroke will die within one month of the infarction. Since the start of the decade, nonfatal strokes seem to be on the rise; the cause of this increase is unknown. Approximately $25 billion is spent annually on medical care for CVAs. On a side note, stroke has been often referred to as "America's Most Neglected Disease," because almost 80% of strokes are preventable.

The major risk factors can be sub-classified into modifiable, non-modifiable, and combination. Most modifiable risk factors are behavioral, such as smoking, alcohol consumption, illegal drug usage, oral contraceptive usage, and physical inactivity. These factors are largely attributed to urbanization within society (Foley 1990). Examples of non-modifiable risk factors include age, gender, geographic location, poverty, and some blood disorders. Combination risk factors, such as hypertension, heart disease, and various blood disorders, have modifiable and non-modifiable risk aspects. Gender, age, geographic location, and race will be the factors of focus.

LITERATURE REVIEW

For our discussion, the following risk factors will be reviewed. They have been identified as significant contributors to the manifestation of a cerebrovascular accident.

Gender is a non-modifiable risk factor for stroke. Stroke tends to affect men at younger ages, women at older ages (Millikan 1987). Men have 30% more strokes than women, up to the age of 65. Men exhibit more risk factors, such as hypertension and poorer health habits, than women. However, women are at an increased risk of stroke after the age of 65 because of the biological effects of aging, as well as the fact that women live longer than men. For women, stroke is the second leading cause of death. Women have a 20% chance of dying from a stroke. In women younger than 45 years of age, strokes are even more common.

Age is a non-modifiable risk factor for stroke. Strokes can affect anyone, regardless of age. Newborns who are afflicted with cerebral palsy often experience stroke. Children who have sickle cell anemia, especially African-American children, also experience strokes (Singleton 1993). In older people, strokes often occur as a result of aging. The biological processes of aging damage the blood vessels, making them more susceptible to obstructions and hemorrhaging. Aging also causes the breakdown of collagen. (Collagen is a protein that forms much of the connective tissue in the body.) Collagen gives blood vessels their strength.

Geographic location is a factor that is thought to increase the risk of stroke. There appears to be an increased incidence of stroke in the Southern and Southeastern United States, a region dubbed the "Stroke Belt." In this area, the death rates due to stroke are 10% higher than the rest of the U.S. This area is the home for over half of the African-American population living in this country, with almost 60% of African-American elderly living in this region (Lassiter 1995). Environmental and social factors are the cause of the increased risk of stroke. African-Americans in the Stroke Belt are two times more at risk for stroke than Whites. This in large part is due to the fact that Afro-Americans in this region are more afflicted with hypertension and obesity than the general population in the rest of the country. In addition, living in an urban setting also increases one's risk of stroke. The social factors that are associated with living in an urbanized region versus a rural region such as crime, violence, and speed of lifestyle (i.e. "hustle and bustle"), all contribute to the increased risk of CVAs.

Race is another non-modifiable risk factor for stroke. African-Americans have the highest stroke rates in the world, in comparison to the majority population. African-Americans are more at risk of cerebrovascular accidents for numerous reasons. Most importantly, African-Americans seem to be afflicted with combination risk factors, such as hypertension and diabetes (Scoch 1996). These two risk factors are more likely to be under-diagnosed and undertreated in African-Americans (Schieszer 1996). Also, it appears that African-Americans are not being taught as well as the general population about modifiable risk factors. Another reason for the increased incidence of CVAs in African-Americans is the prevalence of a high fat diet. "Except for individuals who do not eat pork or any other meat products, African-Americans generally enjoy foods that are high in fat content and highly seasoned, especially with salt" (Lassiter 1995).

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African-Americans are more likely to experience low socioeconomic status; 30% of African-Americans live below the poverty level. Low socioeconomic status is a significant barrier to proper health care. Poor health is associated with decreased access to health care services, discrimination in the health care system, economics, and poor health care utilization (Lassiter 1995). All of these variables adversely influence one's ability to seek out medical treatment when needed. Further, research on African-American elders suggests that culture and ethnicity have an impact on the health behavior of African-Americans, as well as their utilization of professional health services (Lassiter 1995). Fear of the health care system prevents African-Americans from obtaining information and treatment about serious health issues, including stroke (Schieszer 1996).

Moreover, environmental influences that are associated with low socioeconomic status adversely affect the risk factors for stroke. In relation to socioeconomic status, many African-Americans who experience "conflicts and stressors due to discrimination" are more apt to be afflicted with variables, such as high blood pressure, another risk factor for stroke (Lassiter 1995). Factors such as the individual's "intelligence, education, self-esteem, past experiences, and coping style" all influence the degree to which a social situation can impact the person (Lassiter 1995). If such social issues are not dealt with in a positive, effective manner, then the risk for factors related to stroke, such as hypertension and heart disease, increase.

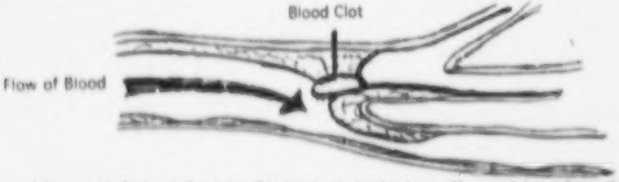
TYPES OF STROKES

The two major types of stroke are ischemic and hemorrhagic. In this discussion, the three sub-classifications of ischemic strokes, thromboses, lacunars, and embolisms will be focused on. Three types of hemorrhagic strokes will also be introduced-- cerebral hemorrhages, subarachnoid hemorrhages, and aneurysms.

Ischemic strokes, or infarctions, result because of a blockage of normal blood flow due to a blood clot or a fatty deposit. They account for 85% of all strokes (Heart and Stroke Facts 1996). An ischemic stroke can result from a thrombosis, an embolism, or a stenosis, defined as the narrowing of an artery leading in or to the brain. Different types of ischemic strokes are characterized by different points of clot origination. The main risk factors for an ischemic stroke include smoking, hypertension, and diabetes (Handbook of Primary Care Medicine 1994).

In a thrombosis, a clot, termed a thrombus, forms in one of the large arteries of the neck, or in the blood vessels within and or on the surface of the brain. The thrombus acts as a stationary plug in stopping the flow of blood to the tissue lying downstream. It is the most common type of stroke, accounting for 65% of all strokes (Heart and Stoke Facts 1996). Thromboses usually form where blood vessels turn, divide, and kink. They occur most frequently in blood vessels that have been damaged by atherosclerosis. A thrombosis usually strikes when a person is inactive or asleep, when blood pressure is low.

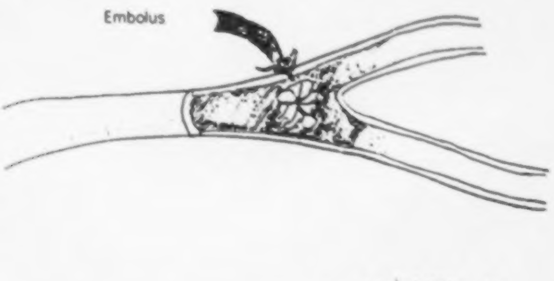
Figure 1: Thrombotic infarction



A lacunar stroke is another type of ischemic stroke that is usually regarded as a form of a thrombosis. In a lacunar stroke, small arteries in the brain are blocked. Lacunar strokes can take anywhere from a few weeks to a few months to become evident (Millikan 1987). Lacunar is derived from the term "lacunae," which means small pit, and refers to the pit that remains after macrophages carry away infarcted tissue from the wall of a blood vessel (Millikan 1987). Lacunaes are often aggravated by hypertension, a significant risk factor for stroke. For this reason, lacunar strokes are very common within the African-American community (Singleton 1993).

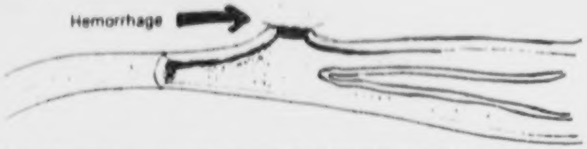
An embolism occurs when a fatty deposit, termed an embolus, forms, then detaches and travels through increasingly narrow blood vessels. An embolus usually forms around diseased heart valves or arteries by the process of atherosclerosis. The embolus becomes wedged in the neck or the brain, since it can neither go backward because of the blood flow nor forward because of its size. Once an embolus is lodged, it deprives tissue downstream of oxygen. Embolisms account for 5 to 14% of strokes, mainly affecting those aged between 56 and 64 years of age. An embolic infarction usually occurs when one is physically active (Heart and Stroke Facts 23).

Figure 2: Depiction of how an embolic infarction arises



Hemorrhagic strokes, characterized by a sudden rupture of a blood vessel, account for 15% of all strokes (Heart and Stroke Facts1996). The blood that escapes the blood vessel disrupts the normal workings of neurons, thus exerting pressure on crucial areas of the brain. This dangerous bleeding to the brain yields higher fatality rates in those afflicted in comparison to ischemic strokes. Hemorrhagic strokes often occur because of long-standing degenerative effects of hypertension, atherosclerosis, or other conditions that might weaken blood vessels. African-Americans are more at risk of hemorrhagic stroke because they are more prone to hypertension.

Figure 3. Depiction of a hemorrhagic stroke



Cerebral hemorrhages, accounting for 10% of all hemorrhages, results when a defective or weakened blood vessel in the brain bleeds or leaks into the surrounding brain tissue. This hemorrhaging, which is usually caused by degenerative changes in blood vessels, occurs deep within the brain's cortex. There is no irreversible injury to the brain tissue, as is the case in ischemic strokes (Foley 1990). The blood that seeps from a ruptured vessel can track between nerve fibers without destroying them (Rose 1981).

An aneurysm is a type of hemorrhagic stroke that usually occurs at the base of the brain. An aneurysm is a weak area or balloon-like weakness which forms a bulge in an artery's wall because of blood pressure. An aneurysm is related to an absence of a muscle layer that comprises part of the blood vessel, which stretches over time and creates a weak area. Most commonly, aneurysms form at branching points of arteries, sites of high turbulence and stress for a blood vessel (Health Report). Usually aneurysms are harmless, but if an aneurysm bursts, the effects are tragic. The result is extreme pressure on nearby surrounding tissues.

In subarachnoid hemorrhages, blood vessels burst within the fluid-filled area of tissue that surrounds the brain. These hemorrhages most commonly result from a head injury or a "massive hypertensive intracerebral hemorrhage that extends from the inside of the brain into the ventricles, and thus into the subarachnoid space" (Millikan 1987). These hemorrhages account for 5% of all hemorrhagic strokes and are most often seen in persons aged between 25 and 50. Most experience a subarachnoid hemorrhage while they are physically active.

DIAGNOSIS AND EFFECTS

Steps to diagnose the affliction begin before the patient is formally admitted to the hospital. A physician gathers data in two manners: examining the patient's medical history for risk factors of stroke and conducting neurological exams. Neurological exams will give information on level of consciousness, orientation, memory, and control of emotion. The main issue is the patient's state of alertness. If the patient is alert for 24 to 48 hours after the onset of the infarction, the mortality rate is less than 25%. The more subdued the patient is, the greater their chances of death. Survival after stroke is also adversely influenced by other variables, such as the age of the victim at the time of stroke or heart failure (Millikan 1987).

In diagnosing a stroke, physicians often use tests that outline affected areas and help define the problem. Four brain-imaging tests are frequently used. A Computerized Axial Tomographic (CAT or CT) Scan is the most well-known imaging tests. In a CT Scan, a computer is used to generate black and white pictures of the brain by way of multiple x-rays beamed through the head, thus enabling doctors to see if there is any bleeding or if the brain has sustained damage from previous "silent strokes" (Donahue 1987). In magnetic resonance imaging, a giant magnet is used to generate detailed images of the brain. A radionuclide angiography, also known as a nuclear brain scan, depicts brain functioning. In this procedure, radioactive compounds are injected into a vein in the arm while a machine depicts a map showing their uptake into different areas of the brain. The experimental Positron Emission Tomography Tests shows how the brain utilizes oxygen, glucose, and other nutrients. It identifies areas that have been weakened or damaged, by identifying which cells are "absorbing the most glucose (active, healthy ones) and which ones are absorbing very little (weakened, damaged ones)" (Donahue 1987).

Other tests measure the electrical activity in order to obtain useful information about how the brain is functioning. In an electroencephalogram (EEG), small electrodes are attached to the scalp to pick-up the electrical impulses that are transmitted and received by brain cells. The impulses are transcribed onto paper by pens that are attached to the machine. In an evoked response test, abnormal areas in the brain can be detected by measuring how the brain handles different sensory stimuli (Foley 1990).

The effects of a CVA are based on numerous factors, including the person, type of stroke, and area of the brain affected. The greater the area of brain damage, the greater the degree of neurological dysfunctioning (Rose 1981). The effects of a stroke can be slight or severe, temporary or permanent. A stroke is more likely to occur in the cerebral cortex, thus affecting the senses, speech, speech comprehension, behavior, and motility (Rose 1981). The effects are also dependent on which brain cells were injured, how widespread the injury is, how well the body repairs the brain's blood supply system, and how quickly other areas of the brain tissue take over the work of the injured cells. (The brain that suffers damage is opposite the side of injury.) Variables that make the patient more susceptible to damaging effects of stroke include intellectual ability, personality, age, sex, general health, and environmental influences (Rose 1981). When the left side of the brain is injured, medically referred to as right hemiplegia, problems with language are exhibited. In right side brain injuries, or left hemiplegia, patients have difficulty with spatial-perceptual tasks.

METHODOLOGY

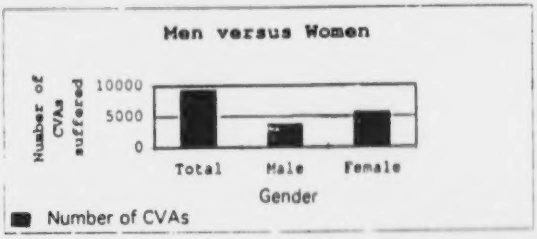
This study of CVA in African-Americans will employ a descriptive study design. Descriptive analysis will be performed in order to describe the existing distribution of variables, without regard to causal or other hypotheses. In doing so, the death certificates of individuals with residence in the state of Texas will be reviewed from 1994. The data tape that will be analyzed was developed by the state of Texas's Vital Statistics Bureau. A computer analysis file of death due to stroke will be generated by the investigator. The analysis will be performed using Number Crunching Statistical Systems (NCSS) software on a person computer (IBM Compatible).

As stated before, for the purposes of this discussion, only these risk factors-- age, race, gender, and geographic location-- will be focused on. The research question is: What is the mortality rate of African-Americans due to stroke in Harris County, Texas? The hypotheses are as follows: Mortality rate among African-Americans is greater than the mortality rate due to stroke among Whites. The mortality rate is greater among men than among women. The mortality rate due to stroke is greater among persons age 55 or older. Aging is associated with CVA. Being male increases the risk of CVA. Certain geographic locations and climates are associated with an increased risk of CVA.

RESULTS and DISCUSSION

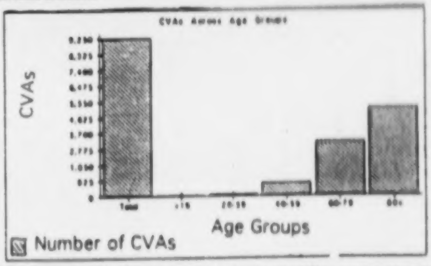
In the following figure, descriptive analysis was performed on the data, which was taken from the State of Texas's 1994 Vital Statistics Data. The number of men and women that experienced CVAs in Texas for that year were charted next to the total number of people living in the state. From the data in this state, it can be concluded that women experience stroke more than men. These results support the literature which states that women experience more stroke than men overall. Stroke tends to affect men at younger ages; stroke affects women at older ages. Furthermore, since women tend to live longer than men, women an increased risk of stroke.

Figure 4:



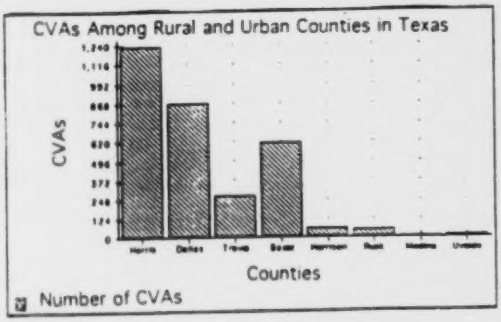
In data that detailed the age at which men and women suffered CVAs, on which descriptive analysis was performed, trends that concur with the literature were found. Older age groups experience more stroke than younger age groups because of the biological processes of aging. Further, African-American children were found to have a greater incidence of stroke than all other children of different races. (Data is not shown.) This finding supports the theory that African-American children experience more strokes because of sickle cell anemia, an inherited blood disorder found often in persons of African descent.

Figure 5:



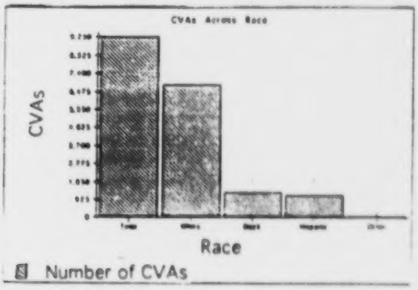
In the following figure, data from rural and urban counties in the state of Texas were ascertained and analyzed using descriptive analysis. The following counties were examined: Rural counties-- Harrison, Rusk, Medina, Uvalde; Urban counties-- Harris (Houston), Dallas (Dallas), Travis (Austin), Bexar (San Antonio). Regions of Texas, subdivided by Texas's Department of Health, were also analyzed. The data from these areas supports the literature which stated that lower rates of stroke would be found in rural communities, and higher rates of stroke would be found in urban communities. The main factors for the increase in stroke rates in urban areas in comparison to rural areas are: increased population, fast-paced lifestyle, exposure to harmful agents, and diet.

Figure 6.



Race was another risk factor that was analyzed using descriptive analysis. In the following figure, the data from the different races is shown. In this category, the data did not support the literature as well. Yes, African-Americans were at an increased risk of stroke, but the degree to which they were at risk did not concur with that reported in the literature. According to the literature, African-Americans are three to six times more susceptible to CVAs than Whites. In the data that was analyzed, African-Americans may still exhibit the increased risk for stroke, but Whites are experiencing stroke in greater proportions. From the literature, it can be concluded that African-Americans are dying of strokes more frequently than Whites. In addition to being three to six times more likely to experience a CVA, African-Americans suffer more severe strokes than Whites. It appears from the data that although African-Americans are at an increased risk of stroke, Whites are having strokes in greater numbers than African-Americans because they experience less severe strokes and consequently are able to survive them. Other reasons for this discrepancy are still being investigated.

Figure 7.



REFERENCES

Be Stroke Smart. Task Force Workbook. National Stroke Association. Bloomington, IN. 1996.
Donahue, Peggy Jo. How To Prevent a Stroke: A Complete Risk-Reduction Program. Emmaus, PA: Rodale, Press, 1989.
Foley, Conn and Pizer, H.F. The Stroke Fact Book: Everything You Want and Need To Know About Stroke-- From Prevention To Rehabilitation. Golden Valley, MN: Courage Press, 1990.
"Health Report." Time. 15 April 1996: 30.
Heart and Stroke Facts. "Stroke." American Heart Association. Dallas, Texas. 21-27.
How Stroke Affects Behavior. Dallas, TX. American Heart Association. 1996.
Lassiter, Sybil M. "African-Americans." Multi-cultural Clients: A Professional Handbook For Health Care Providers and Social Workers. Westport: Greenwood Press, 1995.
Millikan, Clark H., McDowell, Fletcher, and Easton, J. Donald. Stroke. Philadelphia: Lea and Febriger, 1987.
Modan, Baruch and Wagener, Diane K. "Some Epidemiological Aspects of Stroke: Mortality/Morbidity Trends, Age, Sex, Race, Socioeconomic Status." Stroke. 23.9(September 1992): 1230-6.
Rose, F. Clifford, and Capildeo, Rudy. Stroke the Facts. NY: Oxford University Press, 1981.
Schieszer, John. "Blacks Face High Risk Of Fatal Stroke: Researcher Cites Poverty." St. Louis Post-Dispatch. 30 January 1996: Special to Post-Dispatch.
Scoch, Eric B. "Study Tests Drugs To Prevent Second Strokes In Black Patients." The Indianapolis Star. 5 May 1996: C1.
Singleton, LaFayette and Johnson, Kirk A. The Black Health Library Guide To Stroke. NY:Henry Holt and Co,1993

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The Effect Of Training Position On Leg Flexor Power In Untrained Males And Females

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ABSTRACT

The purpose of the study was to compare the effectiveness of two different training positions on leg flexor power. The subjects were twelve untrained male and female college age students. The protocol involved resistance training three times per week over a nine week period using a periodized program. Random selection determined which leg performed prone leg curls, with the other leg trained via standing leg curls. Pre- and Post-tests were conducted on a Kincom isokinetic dynometer at 180°/s. In addition, leg girth and thigh skinfold data were collected.

The legs trained in the prone position showed significantly greater gains in power in comparison to those trained in the standing position. However, no significant gains in muscle size were evident from girth and skinfold data. This suggests that increases in power were due to enhanced neuromuscular fascilitation.

INTRODUCTION

The National Strength and Conditioning Association cites hamstring curls as a important component of resistance training for all sports (Baechle, 1994). Low hamstring strength and ratios of knee flexor to extensor strength were noted as parameters for increased risk for hamstring strains (Yamamoto, 1993). In addition, Yong, et al (1993) determined that hamstring strengthening exercises were successful in diminishing lower back pain.

Therefore, it is important that the best means for improving the performance of the leg flexors is realized. In a previous study, Starky (1994) determined there was no significant difference between 1 and 3 sets for increasing knee flexion isometric torque. In addition, Fry & Powell (1987) found the squat, hip sled, and leg press resulted in equal gains in hamstring strength. However, a parameter that has not been studied is training position. Therefore, the purpose of this study was to compare the effectiveness of the prone and standing training positions on leg flexor power.

METHODS

The subjects were twelve male and female college students (males n=8, females n=4) ages 18-22 yr., none of whom resistance trained their lower body. Before the testing began, the procedures of the study were explained to each subject and a consent form was signed. The subjects were each trained in the proper technique for both supine and standing leg curls. In addition, each subject was required to perform a practice session on the Kincom© isokinetic dynamometer to prevent a learning curve effect between pre- and post-testing.

The treatment involved resistance training three times per week over a nine week period. A periodized resistance program was used which involved three, three week cycles. Cycle one consisted of 4 sets of 10 repetitions; cycle two, 4 sets of 5 repetitions, and cycle three, 4 sets of 3 repetitions. The amount of weight used was moved up 5 lb. each time all sets and repetitions were successfully completed. Random selection determined which leg performed prone leg curls, with the other leg trained via standing leg curls. Subjects were monitored while performing the leg curls to ensure proper position, technique and speed of repetitions. Pre- and Post-tests were conducted on a Kincom© isokinetic dynamometer at 180°/s. In addition, leg girth was measured and thigh skinfold data were collected using a Lange skinfold caliper.

RESULTS

The results of the Kincom© isokinetic dynamometer tests at 180°/s showed significantly greater gains in the prone position (PP). The leg trained in the standing position (SP) yielded concentric torque values of 109.48(± 47.9)ft-lb. for pre-test and 118.18 (±45.7)ft-lb. for post-test yielding a change of 7.4%. The Kincom tests showed significantly ($p < .5$) greater gains for the leg trained in the PP. The pre-test value was 96.24(± 26.75)ft-lb. and the post-test 122.6(±46.9)ft-lb. for an increase of 21.5%. This demonstrated a 14.1% greater increase in power for the leg trained in the PP versus SP.

Circumference and skinfold measurements showed no significant difference between the two positions. For SP circumferences were measured at 52.61(±3.55)cm and 53.03(± 3.48)cm for pre-and post-tests respectively, resulting in a change of 1.0%. In the PP the results were 52.34(± 3.47)cm for the pre-test and 53.09(± 2.74)cm for post-test yielding a difference of 1.4%. The skinfold measurements for the SP were 18.33(± 7.92)mm and 17.87(± 8.30)mm for the pre-and post-tests respectively. This yielded an insignificant change of 2.5%. The PP showed a difference of 7.2% with a pre-test measurement of 19.04(± 8.20) mm and post-test of 17.67(± 8.79)mm.

POSITION	POWER (ft-lb.)	CIRCUMFERENCE(cm)	SKINFOLD (mm)
STANDING			
Pre-test	109.48 ± 47.90	52.61 ± 3.55	18.33 ± 7.92
Post-test	118.18 ± 45.70	53.02 ± 3.48	17.87 ± 8.30
Percent Change (%)	7.4	1.0	2.5
PRONE			
Pre-test	96.24 ± 26.75	52.34 ± 3.47	19.04 ± 8.20
Post-test	122.60± 46.90	53.09 ± 2.74	17.67 ± 8.79
Percent Change (%)	21.5*	1.4	7.2

* $p < .01$

Table -1: Results

DISCUSSION

The results of the leg trained in the PP showed significantly greater gains in power in comparison to those trained in the SP. Because of the limitations of this study, the reason for these findings is unclear. A possible cause of this increase in power in the PP could be because of a greater stabilization in this position. Graves et. al. (1994) showed significantly greater improvements in the isolated lumbar extension strength for the pelvic stabilized group over the unstabilized group although both the pelvic stabilization and unstabilized subjects had significant increases in workload. They cited the exercising of the muscles involved in pelvic rotation as the reason for increases in the weight load for the unstabilized group.

No significant gains in muscle size were evident from girth and skinfold data. Petersen, et.al. (1991) also found no changes in cross-sectional area after 6 weeks of heavy resistance training of the hamstring muscle group. This apparent lack of change in muscle morphology suggests that increases in power were because of enhanced neuromuscular facilitation which is common in resistance programs of this short duration (Fleck & Kraemer, 1988).

BIBLIOGRAPHY

Baechle, T.(1994) Essentials of Strength Training and Conditioning. Champaign, IL: Human Kinetics, 1994, 419.

Costill, Coyle, Fink, Lesmes, Witzmann. (1979). *Adaptation in skeletal muscle following strength training.* Journal of Applied Physiology: Respirat. Environ. Exercise Physiol., 46(1), 96-99.

Coyle, Feiring, Rotkis, Cote III, Roby, Lee, Wilmore. (1981). *Specificity of power improvements through slow and fast isokinetic training.* Journal of Applied Physiology: Respirat. Environ. Exercise Physiol., 51 (6), 1437-1442.

Fleck, Kraemer. (1988). *Resistance Training: Physiological Responses and Adaptation (Part 3).* The Physician and Sports Medicine, 16 (5), 63-72.

Fry, Powell. (1987). *Studies and researches: Hamstring quadricep parity with three different weight training methods.* Journal of Sportsmedicine and Physical Fitness, 27

(3), 362-367.

Graves, Webb, Pollock, Matkozich, Leggett, Carpenter, Foster, Cirulli (1994). *Pelvic stabilization during resistance training: Its effects on the development of lumbar extension strength.* Archive of Physical Medicine and Rehabilitation, 75 (2), 210-215

Hakkinen. (1989). *Neuromuscular and hormonal adaptations during strength and power training.* The Journal of Sportsmedicine and Physical Fitness, 29(1), 9-26

Petersen, Bell, Bagnall, Quinney (1991). *The effects of concentric resistance training on eccentric peak torque and muscle cross-sectional area.* Journal of Orthopaedic and Sports Physical Therapy, 13 (3), 132-137

Sale (1988). *Neural Adaptation to Resistance Training.* Medicine and Science in Sports and Exercise, 20 (5), S135-S145.

Starky (1994). *The effect of training volume on strength and hypertrophy of the quadriceps and hamstring muscles.* Microform Publications, 2 microfiches (166 fr.)

Yamamoto. (1993). *The relationship between hamstring strains and leg muscle strength: A follow-up study of collegiate track and field athletes.* Journal of Sportsmedicine and Physical Fitness, 33 (2), 194-199.

Yong-Sik, Sang-Gyu, Myung-Chon, Gang-Woo. (1993). *The effect of strengthening exercise of leg muscles on back pain relief*, Korean Journal of Sport Science, 5, 33-50

Measurement of Anaerobic Power in Elite Wheelchair Athletes Absolute Load Optimization of the Wingate Test Using the Monark 881 Arm Crank Ergometer

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While measures of long term power output capabilities are important indices of cardiorespiratory health and overall fitness, the availability of immediate energy (anaerobic) resources may be a better indicator of functional capacity in populations with lower limb impairments. The purpose of this study was to expand the Wingate anaerobic power test (WAT) paradigm to include arm cranking in a population of elite wheelchair athletes by determining the optimal absolute load for measuring anaerobic power. Six elite wheelchair basketball athletes were tested over a two day period using a randomized testing schedule. Four resistance loads were tested (3.50, 4.25, 5.00 and 5.75 kg) based on previous pilot work. Power output was analyzed in terms of peak power output (PP) and mean power output (MP). A repeated measures ANOVA was conducted on the dependent variables PP and MP. Significant differences were found between the loads {$p<0.01$, $F(3,15) = 13.090$}, {$p<0.01$, $F(3,15) = 10.736$} for PP and MP respectively. Post-hoc analysis revealed that power output increased as load increased in a curvilinear fashion. The optimal load for this elite wheelchair population was the highest load examined (5.75 kg) for both PP and MP. Additional testing is suggested for identifying the optimal load for non-elite wheelchair populations.

INTRODUCTION

Exercise testing of special populations has gained increasing prominence in recent years. In particular, the lower-limb impaired population has received considerable attention. This interest has been driven by growing participation in wheelchair sports (Wells & Hooker, 1990), the realization of the impact of fitness parameters on functional capacity and cardiorespiratory health and an increasing focus on special populations as a result of the Americans with Disabilities Act of 1992 (Rimmer, Braddock, & Pitetti, 1996). The bulk of previous research has been focused on cardiorespiratory fitness and long term (aerobic) power output resource measurement. While measures of long term power output capabilities are important indices of cardiorespiratory health and overall fitness, the availability of immediate power resources may be a better indicator of functional capacity in populations with lower-limb impairments. Immediate energy expenditure is an essential component of daily activities and sports performance. Most daily wheelchair activity involves a rapid transition from rest to high intensity work and occurs in a time frame which precludes the activation of the aerobic power system as a primary energy source. Immediate power resources are essential for basic mobility, particularly in negotiating environmental barriers, such as ramps and inclines. Performance in short track events and in stop-and-go sports such as basketball depend on the ability to exert immediate explosive force. A comprehensive review of anaerobic power testing of wheelchair athletes has been recently published (Mercer, 1996).

The Wingate Anaerobic Test (WAT) has become widely accepted since its introduction in 1973 (Inbar, Bar-Or, & Skinner, 1996). The WAT consists of 30s of supramaximal cycling or arm cranking against a frictional resistance determined relative to body weight. The arm cranking mode has been found to be reliable in non-disabled populations when population specific resistance loads are used (Bar-Or, 1987). The load factor tends to rely on the participant's activity level, training, and anaerobic characteristics (Dotan & Bar-Or, 1983; Patton, Murphy, & Fredrick, 1985; Gastin, Lawson, Hargreaves, & Fairweather, 1991). The resistance is also highly dependent on the type of ergometer used and the equivalent size of the flywheel.

Results of a pilot study conducted in our laboratory indicated that body weight was not a successful predictor of anaerobic performance in wheelchair athletes (Mercer & Beehler, 1997). This finding opens a question of whether the traditional Wingate paradigm of setting resistance according to body weight is appropriate for this type of population. A two stage absolute load model was proposed where an optimal load might be identified based on maximal velocity performance at a submaximal load. The purpose of this study was to identify an optimal absolute load for a group of elite athletes performing the Wingate test on the Monark 881 arm crank ergometer and explore the feasibility of the proposed multi-stage model.

METHODS

Participants

Six male players from the Dallas Wheelchair Mavericks semi-professional wheelchair basketball team gave informed consent to participate in this study in accordance with the recommendations of the American College of Sports Medicine (1997). Participant characteristics are presented in Table 1. The participants represented a range of disabilities including community ambulators as well as exclusively wheelchair mobile individuals. This study chose to view the athletes from a systems perspective that focused on the results of the available components rather than the specifics of the components themselves. This view allowed the use of a participant group with a mix of disabilities which tends to be most representative of wheelchair basketball. This study measured within-subject characteristics, therefore no control group was necessary.

Instrumentation

A modified Monark 881 Rehab Trainer (Monark, Sweden) was used to perform the Wingate test. The device was modified by attaching a wooden platform for stability and the original kp•m scale was changed during calibration to reflect kilograms of resistance only. The ergometer was positioned so that the upper arms were extended at right angles to the body, with slight flexion at the elbow. An optical sensor integrated with a personal computer was used to determine revolutions covered (Sports Medicine Industries, Chicago, IL.).

Procedures

Participants reported to the laboratory four times over the course of 2 days with a minimum of 1 hour separating each session. Participants completed one 30s WAT at each session according to a previously randomized schedule. Four absolute loads of 3.50, 4.25, 5.00 and 5.75 kg were tested. [Note: These loads are valid only for the Monark 881 and not the Monark cycle ergometers.] Prior to the presentation of the 3.50 kg load, participants also completed a 10s maximal velocity test on the ergometer at a load of 3.00 kg.

Table 1. Participant Characteristics (N = 6)

Subject	Age (yrs)	Weight (kg)	Disability	NWBA Class	Years of Play	Mobile Without Chair
1	31	70.4	Double AK amputation	II	13	With prosthetics
2	38	63.7	Paraplegia T-7	I	15	No
3	38	110.8	Incomplete feet	III	18	Yes
4	24	95.9	Guillian Barre	III	14	Yes
5	24	72.0	Bone disease	III	16	Yes
6	40	55.0	Polio T-7	I	21	With braces
Mean	31.0	82.6		2.4	15.2	
SD	7.26	21.09		0.98	2.93	

Prior to each test, participants warmed up with 2 minutes of cranking at a self-selected "easy" pace and resistance. A moving start was used because of the high cranking rates (130-250 rpm) necessary to achieve peak power and to overcome the inertial resistance of the flywheel. At -10s, a countdown was started (10,9,8,7...) to alert the participant to the beginning of the test. At -2s, the resistance was manually applied. At -1s, the participant was told to begin cranking maximally, so that he would be approaching maximal velocity as the test began. Participants were alerted to the passage of time at intervals of 5s for 30s. Participants completed a two minute cool-down and a 15 minute observation period prior to being dismissed.

Analysis

Pedal counts were converted to power output using Sports Medicine Industries' Power v 3.02 Wingate test acquisition software package. Peak Power (PP) was calculated as the highest power during any 3s interval. Both MP and PP were examined in terms of absolute power (Watts) and relative power (Watts • $kgBW^{-1}$). The rate of fatigue (RF) was calculated as {[PP - Minimum Power/PP] x 100%}. A repeated measures analysis of variance (ANOVA) was performed with the load as the within-subjects factor to determine the significance of load variation on power output. An honestly significant difference (HSD) test post-hoc analysis was performed to determine the significance of differences between loads. Advanced statistics were generated using SPSS v 5 (Statistical Package for the Social Sciences).

RESULTS

Group performance data for the four trials are detailed in Table 2. A repeated measures ANOVA was conducted on the dependent variables PP and MP. The ANOVA results are listed in Table 3. Significant differences were found between the loads {$p<0.01$, $F(3,15) = 13.090$}, {$p<0.01$, $F(3,15) = 10.736$} for PP and MP respectively. Power output increased as load increased in a curvilinear fashion. Post-hoc analysis revealed that the variation in load ceased to generate a significant difference in both mean and peak power at the 5.00 kg load. The optimal load for this elite wheelchair population was considered to be the highest load examined (5.75 kg) for both PP and MP since an attenuated tendency to increase power output was still noticeable past the point where increases ceased to be significant. The criteria for significance determined by the HSD was ≥ 25.29 Watts for PP and ≥ 14.13 Watts for MP ($p<.05$).

Table 2 Group means for absolute and relative power outputs

Load (kg)	3.50	4.25	5.00	5.75
Absolute PP (Watts)	272.29	309.31	338.78	356.68
Relative PP (W/kg)	3.76	4.23	4.59	4.85
Absolute MP (Watts)	211.58	236.79	254.08	259.84
Relative MP (W/kg)	2.87	3.21	3.42	3.51

Table 3 ANOVA Summary Table for Peak Power and Mean Power

PEAK POWER

Source of Variation	df	Mean Square	F	Significance of F
Participants	5	21265.789		
Load	3	9484.654	10.736	000
Participants x Load	15	883.482		
Total	23			

MEAN POWER

Source of Variation	df	Mean Square	F	Significance of F
Participants	5	13704.726		
Load	3	3611.659	13.090	000
Participants x Load	15	275.917		
Total	23			

DISCUSSION

This study was initiated by a search for proven testing procedures in the non-disabled domain which could be applied to individuals with lower limb impairments. The original intent of the research was to conduct validity and reliability testing of the Wingate test with a group of wheelchair athletes to determine its efficacy in evaluating the effects of training programs and predicting performance in wheelchair tasks. A review of the literature revealed that optimal loading factors had not been identified for wheelchair athletes performing the Wingate test. A pilot study was conducted to determine the optimal relative load for a group of competitive wheelchair athletes performing the Wingate test on the Monark 881 arm crank ergometer.

The pilot work indicated that body weight was not a successful predictor of an individual's optimal load, therefore, the relative load paradigm was not appropriate for populations with lower limb impairments. A multi-stage absolute load model was suggested where an optimal load might be identified based on maximal velocity performance at a submaximal load. The purpose of this study was to identify an optimal absolute load for a group of elite athletes and explore the feasibility of the proposed multi-stage model.

The results of this study indicate that the use of lower resistance with the Monark 881 yields significantly lower power outputs. Both mean and peak power demonstrated a curvilinear rise as load was increased. Variation in load ceased to be significant at an absolute load of 5.00 kg. Power output continued an attenuated rise with only one subject experiencing an actual decline in performance. An analysis of individual power output responses to the variation in load indicated that 5.75 kg represented the optimal load for all but one of the participants. The data for the subject with paraplegia conformed to the expected quadratic form with an individual load optima of 4.25 kg. Analysis of the relationship between the maximal velocity response (average rpm for top 3s) to the 3.00 kg load and the individual optimal loads suggests the preliminary testing schematic presented in Table 4. Additional data collection with a more varied subject pool is necessary to further define this schematic.

Table 4. Optimal absolute loads for the Wingate test suggested by highest rpm obtained in a submaximal velocity test

MV$_3$ (rpm)	Optimal Load (kg)
≥ 200	5.75
175-199	5.00
150-174	4.25

CONCLUSIONS

The high degree of variability in individuals with lower-limb impairments challenges the efficacy of the traditional Wingate paradigm of setting resistance according to body weight. Results of a limited sample of elite wheelchair athletes indicate that a loading factor of 5.75 kg is optimal for achieving maximal mean and peak power output in this group when using the Monark 881. Additional testing is required to identify optimal loads for non-elite populations. Future efforts would be best directed towards investigating the potential of a multi-stage absolute load paradigm where an individuals' load for the maximal test would be based on performance at a sub-maximal load.

Author's note

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REFERENCES

American College of Sports Medicine, (1997). Policy statement regarding the use of human subjects and informed consent. *Medicine and Science in Sports and Exercise*, 29, v.

Bar-Or, O. (1987). The Wingate anaerobic test: An update on methodology, reliability and validity. *Sports Medicine*, 4, 381-394.

Dotan, R. & Bar-Or, O. (1983). Load optimization for the Wingate anaerobic test. *European Journal of Applied Physiology*, 51, 409-417.

Gastin, P., Lawson, D., Hargreaves, M.., & Fairweather, I. (1991). Variable resistance loadings in anaerobic power testing. *International Journal of Sports Medicine*, 12, 513-518.

Hutzler, Y. (1993). Physical performance of elite wheelchair basketball players in armcranking, ergometry and in selected wheeling tasks. *Paraplegia*, 31, 255-261.

Inbar, O., Bar-Or, O., & Skinner, J.J. (1996). *The Wingate Anaerobic Test*. Human Kinetics, Champaign, IL.

Mercer, S.E. (1996). Practical assessment of immediate (anaerobic) power resources in wheelchair athletes: current research, applicability and future directions. *Brazilian International Journal of Adapted Physical Education Research*, 3(1), 1-24.

Mercer, S.E. & Beehler, P.J.H. (1997). Measurement of anaerobic power in wheelchair athletes: relative load optimization for the Wingate test using the Monark 881 arm crank ergometer. *Abstracts Digest - 1997 Texas Regional Chapter of the American College of Sports Medicine Annual Meeting*. Seguin, TX. February 6-7, p 6.

Patton, J.F., Murphy, M.M., & Fredrick, F.A. (1985). Maximal power outputs during the Wingate anaerobic test. *International Journal of Sports Medicine*, 6, 82-85.

Rimmer, J.H., Bradock, D., & Pitetti, K.H. (1996). Research on physical activity and disability: an emerging national priority. *Medicine and Science in Sports and Exercise*, 28, 1366-1372.

Wells, C.L. & Hooker, S.P. (1990). The spinal injured athlete. *Adapted Physical Activity Quarterly*, 7, 265-285.

THE EFFECTS OF THE RAISED MUTATION ON SEXUAL BEHAVIOR IN *DROSOPHILA MELANOGASTER* FEMALES

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INTRODUCTION

Drosophila melanogaster males perform a series of courtship behaviors in response to conspecific females (reviewed by Tompkins, 1984). The most conspicuous of these behaviors is the courtship song, which is produced when the male extends and vibrates one of his wings (Bennet-Clark and Ewing, 1968), and functions to increase female receptivity to copulation (Schilcher, 1976, Kyriacou and Hall, 1982).

Following copulation, *D. melanogaster* females undergo a series of changes, including a reduction in sexual attractiveness and sexual receptivity, along with an increase in oviposition rates (Bastock and Manning, 1955; Mane et al., 1983); Manning, 1967). As a female's sperm supply decreases, her attractiveness and receptivity increase and she will once again stimulate courtship and remate.

The *raised* (*rsd*) stock is a strain of *D. melanogaster* that carries mutations on the third chromosomes that affect the indirect flight muscles, causing the wings to be held upright (Mahaffey et al., 1985). The *rsd* phenotype renders the flies flightless and also prevents makes from producing the courtship song. As expected, the inability to sing causes *rsd* males to be less successful when courting virgin wild-type females. However, virgin females from long-established *rsd* stocks mate readily with *rsd* males (McRobert et al., 1995). Furthermore, mated *rsd* females, (4 days post-copulation) mate more readily with wild-type males than do wild-type females (Presenza and Caesar, 1996). These results suggest that the lack of courtship song in rsd stocks may have functioned as a selective force, favoring mutations that increase the receptivity of both virgin and mates females.

MATERIALS AND METHODS

Stocks

All stocks were maintained in mass culture on Carolina Instant Drosophila Media (Formula 4-24). An Iso-Female line (IF-1) was created by inbreeding the offspring of a single pair of wild-type (Canton-S) flies. All males used in the study were from the IF-1 line, as were control females. The *rsd* flies in this study were obtained from the California Institute of Technology.

Virgin flies were collected under CO_2 anesthesia within 12 hours of eclosion, unless otherwise indicated. Females were stored in groups of 7-10 in vials containing media. Males were stored individually in vials containing media.

Behavioral Assays

All behavioral assays were performed between 9:00 AM and 5:00 PM at room temperature 22° - 25° C. Virgin flies were 3-7 days old when tested, unless otherwise indicated.

Tests with Virgin Females

Onset of Sexual Receptivity

For each trial, females were collected within one hour of eclosion and placed into one of four experimental groups. Females in group one were aged six hours before testing. Group two females were tested at twelve hours post-collection. Group three females were tested at fifteen hours post-collection, and group four females were tested at eighteen hours post-collection. In each test, a single virgin female and one IF-1 male were aspirated, without anesthesia, into a cylindrical vial containing media and observed for sixty minutes. Whether copulation occurred or not was recorded. Each female was tested only once.

Movement Of Virgin Females During Courtship/Copulation Latency

A virgin female and virgin male were aspirated, without anesthesia, into a large cylindrical courtship chamber (vol. ca. 0.4 cm^3) and observed for ten minutes, or until copulation occurred. During this period, the number of times the female crossed a line bisecting the chamber was counted. If copulation occurred, the time was noted and a videotape of the test was reviewed to determine the number of times the female crossed the bisecting line one minute prior to copulation.

Tests With Mated Females

Sexual Attractiveness

Single male-female paired (either IF-1 male x IF-1 female, or IF-1 male x rsd female) were aspirated, without anesthesia, into cylindrical glass vials and observed for 60 minutes. Females that mated within the observation period were removed and stored in groups of 7-10 in fresh media vials, in a 22°C incubator on a 12:12 LD cycle. Four days later, each mated female was aspirated, without anesthesia, into a large courtship chamber (vol. ca. 0.4 cm^3) with a single virgin male. The pair were observed for ten minutes, during which the amount of time that the male spent performing courtship behaviors was determined. From this, the courtship index (CI) was determined.

Dominant-Recessive Effects

Reciprocal heterozygotes were generated by placing 3-5 virgin males and 3-5 virgin females into a vial containing media. Approximately ten days later the parents were removed. Group A heterozygotes consisted of F1 generation of *rsd* males crossed with IF-1 females. Group B heterozygotes consisted of the F1 generation of IF-1 males crossed with *rsd* females. Virgin females from the F1 generation were collected from both groups and aged as in other tests. When mature, single male-female pairs (either IF-1 male x Group A female, or IF-1 male x Group B female) were aspirated, without anesthesia, into cylindrical glass vials containing media, and observed for 60 minutes. Females that mated within the observation period were removed and stored individually in fresh media vials, in a 22°C incubator on a 12:12 LD cycle. Forty-eight hours after the initial mating, each mated female was once again aspirated, without anesthesia, into a media vial containing a virgin IF-1 male and observed for sixty minutes. Females were then removed and stored, individually, for another forty-eight hours. This process was repeated at two, four, six, and eight days post-mating, during which the remating frequency and total number of rematings was determined for each female.

Offspring Production

Mated females were stored individually in vials containing media and stored at 22°C on a 12:12 LD cycle. On day 1 after their initial mating, females were transferred to fresh vials containing media. The total number of larvae in each vial was determined using a sucrose-media submersion technique (Frank et al., in press). In this procedure, a 20% sucrose solution was added to the media and stirred. This allowed the media to sink, while the larvae floated and could easily be counted. Females were transferred every day for ten days, or until they died.

Statistical Analysis

The significance of differences between means was determined by suing a contingency Chi-square test or by calculating t (student's t test, two-tailed). For courtship index tests, the data was arc-sine transformed, before the significance of differences between means was determined by calculating t.

RESULTS

Tests with Virgin Females

Onset of Sexual Receptivity

At six hours post-eclosion, and at twelve hours post-eclosion, no copulation occurred in either line. At fifteen hours post-eclosion, *rsd* females had a significantly higher copulation rate that IF-1 females ($p < 0.02$, Table 1) as did *rsd* females tested at eighteen hours ($p < 0.05$, Table 1).

Table 1 Mating frequencies for young *rsd* and IF-1 females

Six Hours Post-Eclosion

Line	Copulation	Frequency
rsd	0/25	0%
IF-1	0/25	0%

Twelve Hours Post-Eclosion

Line	Copulation	Frequency
rsd	0/25	0%
IF-1	0/25	0%

Fifteen Hours Post-Eclosion

Line	Copulation	Frequency
rsd	5/25	20%
IF-1	0/25	0%
		(p < 0.02)

Eighteen Hours Post Eclosion

Line	Copulation	Frequency
rsd	8/25	32%
IF-1	1/25	4%
		(p < 0.05)

Movement Of Virgin Females During Courtship/Copulation Latency.

During courtship, there was no difference in the total number of lines crossed per minute between virgin *rsd* females and virgin IF-1 females during courtship (p > 0.05, Table 2). There was also no significant difference in the amount of lines crossed one minute prior to copulation between virgin females from the two lines (p > 0.05, Table 2). However, for virgin females that mated, virgin *rsd* females mated significantly faster than virgin IF-1 females (p <0.005, Table 2).

Table 2 Average lines crossed per minute and copulation latency for virgin *rsd* and IF-1 females

Lines Crossed/Minute

Line	N	Mean Lines Crossed/Minute
rsd	25	31.8 ± 10.8
IF-1	25	26.3 ± 8.7 (p > 0.05)

Lines Crossed One Minute Prior to Copulation

Line	N	Mean Lines Crossed
rsd	22	26.1 ± 14.1
IF-1	10	25.5 ± 13.3 (p > 0.05)

Copulation Latency

Line	N	Copulation Latency (seconds)
rsd	22	127.7 ± 81.9
IF-1	10	240.3 ± 122.1 (p < 0.005)

Tests with Mated Females

Sexual Attractiveness

In both lines, all females stimulated courtship four days following their initial mating. However, mated *rsd* females elicited a significantly higher mean courtship index than did IF-1 females (p < 0.01, Table 3).

Table 3 Courtship Index for mated females (four days post mating)

Line	N	Mean Courtship Index (%)
IF-1 females	25	37.3 ± 26.9
rsd females	25	19.7 ± 12.8

Dominant-Recessive Effects

Females from both heterozygote lines (A and B) stimulate vigorous courtship and remated. There was no significant difference in remating frequency between these lines ($p > 0.05$, Table 4). However, as shown in Table 4, the remating frequencies of the heterozygous females were significantly higher than those of IF-1 females ($p < 0.05$), but significantly lower than those of *rsl* females ($p < 0.05$).

Table 4. A comparison of remating frequencies between heterozygous (*rsl*/+), *rsl*, and IF-1 females

Comparison of Reciprocal Crosses

Heterozygote Line	N	Rematings	Frequency
A	30	19/120[1]	15.8%
B	29	16/116[1]	13.9%
			$p > 0.05$

[1] Each female was given an opportunity to mate at 2, 4, 6, and 8 days post-mating. Thus, these figures represents the total number of rematings/opportunity.

Comparison of Heterozygous (*rsl*/+), *rsl* and IF-1 Remating Frequencies

Line	N	Rematings	Frequency*
(*rsl*/+)	59	35/236[1]	14.8%^{ab}
IF-1	25	5/100[1]	5%^{a}
rsl	25	36/100[1]	36%^{b}

[1] These figures represent the total number of rematings/opportunity

* Values with the same superscript are significantly different ($p < 0.05$)

Offspring Production

Mated *rsl* females produced less offspring over a ten day period than did IF-1 females ($p < 0.005$, Table 5).

Table 5. Offspring production for mated *rsl* and IF-1 females

Line	Number of Offspring		
rsl	246.6 ± 77.3	n = 19	
IF-1	356.1 ± 114.9	n = 18	($p < 0.002$)

DISCUSSION

It has been found that *raised* flies carry dominant factory on the X and third chromosomes that increase the sexual receptivity of mature virgin females (McRobert et al., 1995). In this report it was shown that mated *rsl* females are significantly more attractive than mated wild-type females. It has already been shown that the receptivity of mated *rsl* females returns to "virgin-like" levels faster than wild-type females (Presenza and Caesar, 1996), and in this study it was shown that a mated *rsl* females' attractiveness also returns at a faster rate than that seen in mated wild-type females.

Furthermore, mutations in *rsl* stocks affect the onset of receptivity in immature virgin females, causing them to reach sexual maturity significantly faster than wild-type females.

However, *rsl* and control females are not significantly different with regard to their movement during courtship. Females that move slowly elicit more copulation attempts from courting males (McRobert, 1986), and females that do not slow down immediately before copulation mate more quickly than females that do not slow down (Tompkins, et al., 1982). This suggests that *rsl* females do not copulate quickly because they elicit more courtship or move slowly enough to copulate. Rather, *rsl* females mate more quickly because they are more receptive to courting males.

The frequencies at which heterozygous females remated was different from that of *rsd* and wild-type females This could suggest that, with regard to remating, the remating phenotype may not be completely dominant

Mated *rsd* females also produced fewer offspring that wild-type females This could also be a factor that led to the selection for increased receptivity in *rsd* stocks If the number of offspring resulting from a single copulation is low, the fitness of *rsd* parents would be decreased   However, females that regain their receptivity quickly would remate more often and lay more eggs over their lifetime In this way, increased sexual receptivity could lead to increased fitness

LITERATURE CITED

Bennet-Clark, H C , and Ewing, A W (1968) The wing mechanism involved in the courtship of *Drosophila* *J. Exp. Biol.* 49 117-128

Bastock, M and Manning, A (1955) The courtship of *Drosophila melanogaster* *Behavior* 8 85-111

Frank, J C , Adams, C , and McRobert, S P (1995) Sucrose density separation of Drosophila larvae from instant media *Dros. Inf. Serv.* in press

Kyriacou, C P , Hall, J C (1982) The function and courtship song rhythms in Drosophila *Anim. Behav.* 30 794-801

Mahaffey, J W , Coutu, M D , Fyrberg, E A , and Inwood, W (1985) The flightless Drosophila mutant *raised* has two distinct genetic lesions affecting accumulation of myofibrillar proteins in flight muscles *Cell* 40 101-110

Mane, S D , Tompkins, L , and Richmond, R C (1983) Male esterase 6 catalyzes the synthesis of a sex pheromone in *Drosophila melanogaster* females *Science* 222 419-422

Manning, A (1967) The control of female receptivity in female *Drosophila* *Anim. Behav.* 15 239-250

McRobert, S P (1986) The effects of yeast on sexual behavior in *Drosophila melanogaster*. *Behav. and Neural Biol.* 45 150-154

McRobert S P , Schnee, F B , Tompkins, L (1995) Selection for increased female sexual receptivity in *raised* stocks of *Drosophila melanogaster*. *Behavior Genetics* 25 303-309

Presenza, T , Caesar, J   The effects of the *raised* mutation on remating in *D. melanogaster*. *Proceedings from the Tenth National Conference on Undergraduate Research*. 1654-1658

Schilcher, F V , (1976) The role of auditory stimuli in the courtship of *Drosophila melanogaster*. *Anim. Behav.* 24 18-26

Tompkins, L (1984) Genetic analysis of sex appeal in Drosophila *Behavior Genetics* 14 411-439

Tompkins, L , Gross, A C , Hall, J C , Gailey, D A , and Siegel, R W , (1982) The role of female movement in the sexual behavior of *Drosophila melanogaster*. *Behavior Genetics*. 12 295-307

THE INFLUENCE OF MENSTRUAL CYCLE PHASES ON THE CHAOTIC BEHAVIOR OF ELECTROCARDIOGRAMS IN COLLEGE-AGE WOMEN

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The chaotic dynamics of the electrocardiogram (ECG) have been well studied and documented in the literature. These dynamics appear to reflect the normal variability and adaptability necessary for responding to a fluctuating environment. This study focuses on the relationship between the different phases of the menstrual cycle and the chaotic behavior of ECG's. Four females and two males acting as controls had their ECG's recorded three times a week over a ten-week period. ECG's from females exhibited evidence of chaotic dynamics in their Lyapunov Exponent, Capacity and Correlation dimension. The Lyapunov Exponent appears to be the best predictor of cardiovascular changes in women. Significant changes during the different phases of the menstrual cycle occurred, but a phase-specific or gender-specific generalization cannot be made, rather the changes appear to be individual specific. Nevertheless, the analysis of electrocardiograms using the techniques of deterministic chaos can help determine or possibly predict the phases of the menstrual cycle and diagnose pathologies specific to females.

INTRODUCTION

The heart is part of a complex system, involving positive and negative feedback loops that ultimately give rise to very complicated dynamics (Kanters, et al. 1996). Heart rate variability has been studied by many investigators for many different reasons. Some of the mechanisms controlling the variability of heart rate have been well established: e.g. autonomic tone, breathing patterns and diurnal rhythms. The ability to automatically change heart rate appears to be lost or greatly diminished in disease states and the normal aging process (West, 1990). The purpose of this study is to examine the heart rate variability in college-age females, in light of the menstrual cycle, using the techniques of nonlinear dynamics.

The origin of modern nonlinear dynamics, dating back to the late 19th century, is attributed to the mathematician, Henri Poincare. Deterministic chaos or nonlinear dynamics is based on the theory that a Poincare system can exhibit both randomness and periodicity (Bassingthwaighte, 1994). Randomness is characterized by behavior which is disorganized, unpredictable, and non-repetitive. There are some biological processes which exhibit random behavior such as genetic translocation and fertilization. Periodicity is characterized by behavior which is organized, predictable, and repetitive. It is a dynamic system in which equations of motion, variables, and parameters are determined exactly by some rule (Persson & Wagner, 1996). There are some biological processes which exhibit periodic behavior such as sinus rhythm and menstruation. Chaos, while distinct from both of these elements, reflects characteristics of both stochastic and deterministic behavior. Chaotic behavior seems disorganized and random; yet it is deterministic. Chaos can be described as a type of dynamic behavior that shows a sensitive dependence on initial conditions and parameter changes and is quantified by a positive Lyapunov exponent. It is characterized by trajectories diverging exponentially with time, yet it is restrained within a definite area in phase space (Persson & Wagner, 1996). The chaotic system essentially produces random looking results that are not truly random (Peters, 1991). A few biological systems are considered chaotic, such as evolution models, the electroencephalogram, and models of cardiac behavior (Lipsitz & Goldberger, 1992).

Conventional theory stated that the electrocardiogram appeared to be solely periodic in nature; however, the normal human heart appears to exhibit both stochastic and deterministic qualities. Complicated cardiac electrical behavior has already been shown to be explained concisely by nonlinear dynamics mechanisms; in other cases, nonlinear dynamical systems appear to mimic behavior seen in the heart (Kaplan & Goldberger, 1991). In order to establish the heart rate variability, the relationship between heart rate changes and the different phases of the menstrual cycle (menstruation, proliferation, ovulation) are investigated. By incorporating the theory of deterministic chaos or nonlinear dynamics, electrocardiograms may be analyzed, therefore, allowing for the prediction of the onset and duration of the different phases of the menstrual cycle.

There are several techniques, both qualitative and quantitative, which are used for distinguishing dynamical behavior in measured data. The Fast Fourier Transform (FFT) is a method of spectral analysis that results in a graph of the frequency versus the signal amplitude and permits determination of the most predominant frequencies for the data. It essentially consists in converting information in the time domain into information in the frequency domain (Mensier, et al, 1996). Some of the quantitative techniques used to distinguish chaos from periodic and random data include the Lyapunov Exponent, Capacity Dimension, and Correlation Dimension. These parameters ultimately determine variation from individual to individual throughout the various phases of the menstrual cycle. The Lyapunov Exponent is a measure of the rate at which nearby trajectories diverge in phase space and it represents the length of time that a data point will remain in the trajectory (Sprott, 1995). The magnitude of this exponent is related to how chaotic the system is; the larger the exponent, the more chaotic the system. A positive Lyapunov exponent indicates sensitive dependence on initial conditions and is almost without exception diagnostic of chaos (Denton et al, 1990). The capacity and correlation dimensions calculate the minimum number of equations needed to describe the system. Capacity and correlation dimension, which are calculated by successively dividing the phase space with embedding dimension D, should saturate at some value less than five for chaotic data (Sprott, 1995). Correlation dimension describes the complexity of the time series of a chaotic system, and it is considered to be a measure of the number of independent variables needed to describe a particular system (Kanters, et al. 1996). Capacity dimension is more useful for larger data sets, whereas correlation dimension is more useful for smaller data sets.

The theory of chaos in heart rate variability has grown in its usefulness in clinical settings. Research has suggested that heart rate variability consists of interrelated periods with differing non-linear dynamics, leading to the conclusion that heart rate is controlled by a system with numerous attractors (Kanters, et al. 1996). Nonlinear dynamics in cardiac physiology is being studied to determine differences between a healthy heart and certain arrhythmias, abnormal heart rhythms. Using the electrocardiogram records and the results of the qualitative and quantitative parameters, it is then possible for an analysis of chaos in female heart rate variability. This analysis allows for the observation of changes in the heart during the phases of the menstrual cycle, for the possible detection of certain pathologies specific to females, and for the prediction of the different phases, e.g., ovulation.

MATERIALS AND METHODS

Four college-aged female subjects and two college-aged male subjects, acting as controls were used for this study. Each subject was informed of the parameters of the study, before completing a general medical history and signing a consent form. Each female subject had a normal menstrual cycle, averaging twenty-six to thirty-two days in length. All subjects were in good health and physical condition.

Electrocardiograms (ECG's) were recorded either biweekly or triweekly for ten weeks. ECG's were taken for ten minutes at 50 samples per second, generating approximately 4,000 data points, for female subjects in one of the phases of the menstrual cycle (menses, proliferation, ovulation). ECG's were taken for five minutes at 50 samples per second, generating approximately 2,000 data points, for the male subjects, and for the female subjects not in one of the phases of the menstrual cycle. Each female subject's individual cycle length was used in order to calculate the onset of each menstrual phase. The subjects were alert and placed in an upright, quiet position for five minutes prior to data collection in order to minimize external influences. ECG's were recorded through the use of three disposable Vermed EL 503 vinyl electrodes, attached to the inner area of both wrists and to the inner area of the left ankle, which served as the ground electrode.

The BIOPAC System MP 100WS for Windows was used in order to record the data. Shielded leads linked the electrodes to the BIOPAC System. The BIOPAC System also included an EKG 100A amplifier module programmed to receive the wave signals (P, Q, R, S and T waves) with minimal distortion. The wave data was stored in an IBM compatible pentium computer. The Acqknowledge Program (Version 3.0 1994 BIOPAC Systems Inc.) was used to produce a Fast Fourier Transform and to convert the wave data into an ASCII format. The Chaos Data Analyzer Professional Version (1995, J.C. Sprott) was then used to analyze the text file data through both quantitative and qualitative parameters: Lyapunov Exponent, Capacity Dimension, and Correlation Dimension. The calculated values were entered into a spreadsheet and plotted as a function of time using Sigma Plot.

RESULTS

All of the subjects displayed between 3 and 4 peaks in the Fast Fourier Transforms (FFT). The predominant peak (first peak) in females ranged between 1.0 and 1.5 Hz. The remaining peaks were between 1.8 and 5.2 Hz. The predominant peak in the male subjects was 1.2 Hz and the remaining peaks were between 2.5 and 5.2 Hz.

In female Subject N, for example, the predominant peak shifted to the left 30% of the time while in menses, 50 % of the time while in proliferation, and 0% while ovulating. Female Subject K's predominant FFT peak shifted to the left 66% of the time while in menses, 44% of the time while in proliferation, and 100% while ovulating. The predominant peak in male Subject D shifted to the left 50% of the time. Overall, there were distinguishable shifting trends within each of the phases of the menstrual cycle, for all of the individual female subjects, although there was no specific gender-related pattern of shifting.

The phase space plot for all of the subjects showed individual-specific discernible structure, characteristic of a chaotic system. There was noticeable variability in the female subject's plots between consecutive data sets. The greatest variations occurred during the menses phase, where the plots had a less structured appearance (Figure 1). The phase-space plots for the male subjects showed slight variations between consecutive data sets.

The Lyapunov Exponent, Capacity Dimension, and Correlation Dimension values plotted as a function of time showed variation from individual to individual and from one menstrual phase to another. The Lyapunov Exponent for data collected from males was consistently lower than those for all female subjects. In the females tested, the Lyapunov exponent values proved to be inherently greater in variation (Figure 2). The Lyapunov Exponent values were analyzed for increases and decreases between consecutive data sets, however slight or dramatic the change was. In female Subject N, the Lyapunov Exponent values increased 44% of the time while in menses, 43% of the time while in proliferation, and 60% while ovulating. The Lyapunov Exponent values for female Subject K increased 73% of the time while in menses, 50% of the time while in proliferation, and 67% while ovulating. There was an increase between consecutive data sets, for male Subject D, 41% of the time.

The capacity and correlation dimension had values less than 5 in all cases, which is characteristic of a chaotic system. The capacity dimension values were always lower than the correlation dimension values. The capacity and correlation dimension values showed variability but no noticeable phase-specific trends were observed. Therefore, these are less reliable predictors than Lyapunov Exponent in the determination of variability in the heart rate of females during the phases of their menstrual cycle in comparison to males.

DISCUSSION

Chaotic behavior was observed in all six subjects, using Fast Fourier Transforms, graphs of data, and the measured quantitative parameters. Shifting patterns of the predominant peak in the FFTs of the female subjects seemed to be phase related with the most consistency during ovulation. The shifting patterns were less pronounced during menses and proliferation and all shifting trends were individual specific. Movement of the predominant peak in males was relatively equal, in both directions, therefore serving as a control against the females.

A more structured phase-space plot indicates a more chaotic system, whereas a less defined plot represents a more random system. While the phase-space plots for all of the female subjects showed variability from one ECG to the next, the less defined plots during menses seemed to indicate a slight decrease in the chaotic tendencies of the system, during this phase (Figure 1).

Upward and downward shifts in Lyapunov Exponent values are indicative of the increasing and decreasing chaotic nature of a system. Based on this study, females display menstrual cycle related shifts in Lyapunov values (Figure 2). During ovulation, the shifts are more noticeable and are usually more positive thus revealing an increase in chaos. While there was no discernible gender-specific trend, these shifts in chaos seem to be inherent to the individual.

In comparing shifts in the predominant peak of the FFT to the fluctuating Lyapunov Exponent values, there seemed to be a relationship between the up/down and left/right shifts in each individual subject. This was supported by the trends seen in Subjects N and K. In Subject N, there was always an FFT shift to the right and usually an increase in Lyapunov values during ovulation. In Subject K, there was always a shift to the left and an increase Lyapunov values during ovulation. These results show that there may be a relationship between these two parameters but the directionality of the relationship may vary according to the individual.

The Capacity Dimension and Correlation Dimension values showed chaotic behavior since all of the values were less than 5. There were no distinguishable trends observed because of the variability between phases and menstrual cycles in each of the female subjects. Characteristic changes were seen in all subjects but they depend on the individual and therefore cannot be used to make broad generalizations. In this study it was found that Lyapunov Exponent values and FFT shifts were better predictors of the various phase changes of the menstrual cycle, most especially ovulation. However, these findings are based on the individual.

Previous research has shown that the pattern of heart rate variability is reproducible within the same subject, but the differences in patterns between subjects is quite clear. The heart rate variability was found to be unique to each individual subject, but characteristic patterns could not be found to categorize the sample population into subgroups (Kanters, et al, 1996). The findings of the present study support these conclusions, revealing that the parameters of heart rate variability, regarding its chaotic behavior, is indeed individual-specific.

There were a number of factors that could have affected the ECG. These include movement, stress, noise and other external distractions. In the early stages of the study, there was a significant amount of noise appearing on the ECG recordings. This was eliminated, for the most part, by the use of abrasive pads to prepare the area where the electrodes were placed. Thus, promoting better conduction. The data may have also been affected by the small sample size as well as predicting ovulation in the female subjects.

There are a number of practical applications regarding the prediction of menstrual cycle phases based on the chaotic nature of the system. This system can be used to determine pathologies as well as changes in women's health such as fertility problems or menstrual irregularity. Previous studies have shown that a decrease in chaotic behavior in heart rate points to disease or death. These results suggest a relationship between the menstrual cycle and the underlying patterns in the chaotic behavior of heart rate. However, with a larger sample and increased frequency of data collection, more definite conclusions can be drawn about menstrual phase related changes in heart rate.

BIBLIOGRAPHY

Bassingthwaighte, J.B., L.S. Liebovitch and B.J. West. 1994. Fractal Physiology. Oxford University Press, New York, p. 145.

Denton, T.A., G.A. Diamond, and R.H. Helfant. 1990. Fascinating Rhythm: A Primer on Chaos Theory and Its Application to Cardiology. American Heart Journal 6:1419-1440.

Kanters, J.K., M.V. Hojgaard, E. Agner, and N. Holstein-Rathlou. 1996. Short and Long-Term Variations in Non-linear Dynamics of Heart Rate Variability. Cardiovascular Research 31:400-409.

Kaplan, D.T. and A.L. Goldberger. 1991. Chaos in Cardiology. Journal of Cardiovascular Electrophysiology 2: 342-354.

Lipsitz, L.A. and A.L. Goldberger. 1992. Loss of 'Complexity and Aging'. Potential Applications of Fractals and Chaos Theory to Senescence. Journal of the American Medical Association 267: 1806-1809.

Mensier, P., J. Clairambault, N. Charlotte, C. Medigue, C. Vermeiren, G. LePape, F. Carre, A. Gounaropoulou, and B. Swynghedauw. 1996. Linear and Non-linear Analyses of Heart Rate Variability: A Minireview. Cardiovascular Research 31: 371-379.

Persson, P.B. and C.D. Wagner. 1996. General Principles of Chaotic Dynamics. Cardiovascular Research 31: 332-341.

Peters, E.E. Chaos and Order in the Capital Markets. A New View of Cycles, Prices and Market Volatility. New York: John Wiley & Sons, 1991, p. 76-82.

Sprott, J.C. Chaos Data Analyzer Professional Version. Madison; University of Wisconsin. 1995

West, B.J. Fractal Physiology and Chaos in Medicine. Singapore; World Scientific, 1990. p. 145-179

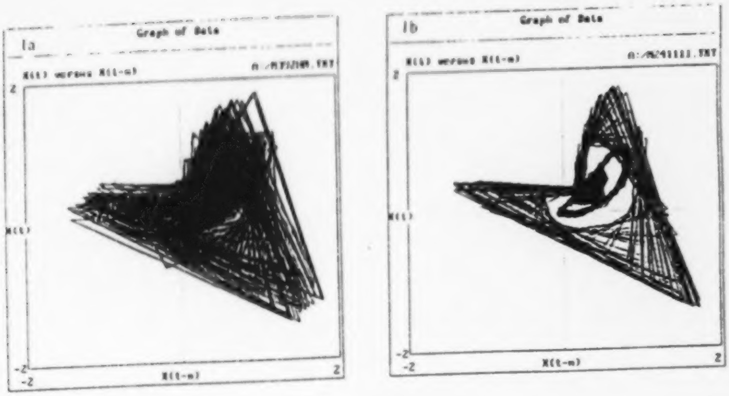

Figure 1 - Phase-space plot of female Subject N appears as a less discernible structure during the menses phase of the cycle in figure 1a compared to figure 1b showing the same subject not in menses, proliferation or ovulation.

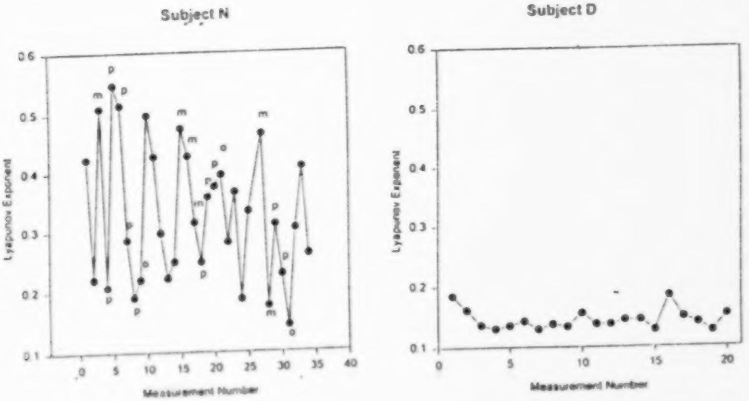

Figure 2 - The Lyapunov Exponent value plotted during the course of this study for two subjects. More points are plotted for Subject N (female) than for Subject D (male) because a greater number of data points were collected in order to represent each phase of the cycle. Typically, the male's values do not vary to the degree or with the same pattern as the female's. M = menses, P = proliferation, O = ovulation

1779

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Pollinated Maize Ovaries Are Resistant to Infection by the Smut Fungus *Ustilago maydis*

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Ears of sweet corn (*Zea mays*) were studied to determine if the fungal infection caused by *Ustilago maydis* prevented fertilization and if fertilization prevented infection. Ears were treated in one of four ways: (1) Inoculated only, (2) Inoculated then pollinated four days later, (3) Pollinated only, and (4) Pollinated then inoculated four days later. Ears that were inoculated only and ears that were inoculated then pollinated four days later were both about 75% infected and 7% pollinated. This suggests that infection of an ovary prevents fertilization of that ovary. Ears that were pollinated only were about 77% pollinated and had no infection; ears that were pollinated then inoculated four days later were 73% pollinated and 20% infected. These results indicate that kernels that are pollinated first are protected from subsequent smut infection.

INTRODUCTION

The smut fungus *Ustilago maydis* causes a disease called corn smut that is characterized by the formation of large spore-filled galls in the corn ears. The galls are edible and considered a delicacy, called Cuitlacoche, in several Latin American countries. Studies by Pataky (1991) and Pope and McCarter (1992) have been performed in order to determine an effective inoculation technique to maximize gall yield. Most often, however, studies are aimed at reducing smut infection because it reduces corn crop quality and overall yield, especially in sweet corn (Christensen, 1963). Numerous studies have been performed for almost 300 years in attempts to control this fungal infection of corn crops. According to Christensen (1963), seed treatment experiments have all proven ineffective, and results from other research on crop rotation and cultural practices have not proven effective enough to warrant further study. To date, practical means of reducing smut infection have involved attempts to develop resistant varieties.

Like many pathogenic fungi, *U. maydis* is dimorphic. It grows saprophytically as a yeast when haploid, and only infects plants when two compatible haploid strains mate and form the parasitic filamentous form. The filaments can infect any meristematic parts of the corn plant; most often the ears are infected through the corn stigmas, called silks. Infection hyphae grow between the epidermal cells of the silk, in the direction of the corn ovary (Snetselaar and Mims, 1993). The fungus proliferates within the ovary, and eventually forms galls containing masses of spores within the ovaries of the corn ear. Mature galls break open, allowing spores to be carried by the wind to other susceptible corn plants.

Under normal conditions, the silks are also the route by which pollen tubes grow to the corn ovary and effect fertilization. Wind-borne pollen grains are collected by the silks of a corn ear, pollen tubes form and provide a channel for the pollen nuclei to reach the unfertilized egg in the corn ovary; successful fertilization results in the formation of a kernel. After a pollen tube has grown through the base of the silk into the ovary, a zone of

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dead cells called an abscission zone forms at the base of the silk (Heslop-Harrison *et al.*, 1985).

Previous workers had noted that when natural pollination of corn plants was prevented, as during the controlled pollination that occurs during hybrid corn production, smut infections seemed to be more serious (Christensen, 1963). The experiments described here used controlled pollination and inoculation techniques to determine whether pollinated ovaries are protected from smut infection.

MATERIALS AND METHODS

The variety Golden Cross Bantam Hybrid sweet corn was used because it is highly susceptible to the *U. maydis* infection. A 36 sq. meter open field plot was roto-tilled one day before sowing, and seven rows of corn were sown and watered during the first week of June, 1996. Two weeks later, the plot was thinned, leaving approximately 20 cm between plants. Only one ear per plant was treated, and 115 ears were harvested.

Plants began to form ears when they were about 1.5 m tall. When silks emerged from the ears, the husks and silks were cut off just above the tip of the ear, and the ear was covered with a numbered ear bag (Lawson). The day following silk cutting, the silks had grown approximately 5-10 cm more. At this time they received one of the four treatments described below.

Pollen from numerous plants was collected each morning using a paper bag, and anthers were separated from the pollen and discarded. The ear bag was removed, silks cut, and the pollen was then evenly sprinkled onto the silks of ears receiving a pollination treatment. Replacement of the bag over the pollinated ear prevented wind pollination or uncontrolled infection. Every cut ear was covered by an ear bag for the duration of the experiment.

Cultures of each of two haploid strains of *U. maydis*, FB1 and FB2 (Banuett and Herskowitz, 1989), were grown at room temperature in dishes of potato-dextrose agar and transferred every four days. The afternoon before an inoculation treatment, a small sample of each culture was transferred to an individual flask containing 10 mL of potato-dextrose broth using the sterile loop technique and then placed on a wrist-action shaker with continuous agitation at room temperature overnight. The following morning the cells were centrifuged at 7,000 rpm for 3 minutes in a benchtop centrifuge and resuspended in sterile water. Optical density was measured with a spectrophotometer at a wavelength of 600 nm. Each culture was prepared so that the optical density was between 0.8 and 1.0.

To produce inoculum, equal volumes of each of the cultures were combined and used within one hour of preparation. Inoculum was injected into the husks surrounding ears with a 22-gauge needle and 10-cc syringe. Depending on the size of the ear, between 1 mL and 5 mL was required per ear.

Four treatments were used: (1) Inoculated only, (2) Inoculated then pollinated four days later, (3) Pollinated only, and (4) Pollinated then inoculated four days later. Ears were treated in the order that they matured. After treatment, ears were kept covered by ear bags so no uncontrolled pollination or infection could occur. Mature ears were harvested, husked, and categorized within treatments (1-4) according to the percent of the ear pollinated, infected, and neither pollinated nor infected. Any kernel not showing any sign of infection was counted as a kernel; any kernel with fungus growing in or on it was considered infected.

RESULTS

115 ears were harvested and analyzed in early August, 1996. For all treatments, the majority of kernels was located at the base of the ears and that the majority of infection was located the top of the ear (Fig. 1).

Mean percent infection and pollination for each treatment are shown in Figure 2. For Treatment 1 (Inoculated only), ears were about 75.0% infected and 7.3% pollinated. Ears from Treatment 2 (Inoculated then pollinated four days later) had a mean infection of 73.9% and mean pollination of 8.2%. Thus, mean infection and pollination frequencies from ears from these two treatments were very similar.

Mean percent infection and pollination for treatments 3 and 4 were very different (Fig. 2). For Treatment 3 (Pollinated only) ears were on average 77.1% pollinated and there was no infection in any ears. Ears from Treatment 4 (Pollinated then inoculated four days later) were on average 74.6% pollinated and 20.4% infected.

DISCUSSION

Previous workers have sometimes had difficulty in obtaining controlled infection of corn ears with *U. maydis* (Christensen, 1963). The injection method described here allowed reliable infection of ears. Likewise, the pollination technique resulted in high rates of kernel formation in control ears.

Results of the experiments where ears were both pollinated and inoculated indicate that when individual ovaries are pollinated they become less susceptible to smut infection. When individual ovaries are first infected with *U. maydis* they do not form the normal kernels that result from pollination and fertilization. Thus, it seems that pollination and smut infection are mutually exclusive processes for each ovary. This conclusion is supported by what is known about the pollination and infection processes. Pollen tubes grow rapidly through the silks to the ovaries, and when several pollen tubes have passed through the base of a silk, a zone of dead cells forms at the base of the silk. This prevents additional pollen tubes from entering the ovary (Heslop-Harrison *et al.*, 1985). The dead cells may also prevent the fungus from growing into the ovary. *Ustilago maydis* is a biotrophic fungi; it grows only in living cells of its host (Snetselaar and Mims, 1993).

Pollination did not protect entire ears from later infection; there was a low level of smut gall formation in ears that were pollinated and then infected. It is important to note, however, that these galls were primarily found in the upper part of the ear (Fig. 2C). This same part of the ear was poorly pollinated in control ears (Fig. 2A). Again, this indicates that unpollinated kernels are more susceptible to smut infection.

Much corn grown commercially today is hybrid corn, and production of hybrid seed often involves controlled crosses between parent corn varieties. Self-pollination must be prevented for hybrid corn production, and this is often effected by mechanical removal of the pollen-producing tassles. Previous authors (e. g. Christensen, 1963) have noted that detasseled corn plants seemed more susceptible to smut infection and hypothesized that the detasseling process created wounds in the plant that allowed the fungus to enter. This study suggests, however, that the increased susceptibility to smut infection in these plants occurs because there is no pollen to fertilize the corn ovaries.

This finding opens up some new possibilities in terms of selecting for resistance to smut infection. Typically, resistant varieties are selected simply on the basis of field trials, and the mechanism by which some corn varieties are resistant to *U. maydis* is unknown. Based on the results described here, it might be profitable to concentrate on characters of the male gametophyte (i.e. the pollen grains) in looking for resistance to corn smut. For example, corn with fast-growing pollen tubes might be more resistant to the fungal infection, and it would be quite easy to screen for this character.

A number of smut-resistant corn hybrids are available, so seeking new sources of resistance to the fungus is not a high priority. However, there are other more serious diseases caused by smut fungi that infect the ovaries of the host and thus prevent formation of fruits and seeds. For example, the crop pearl millet is an important food source in some dry regions of the world, especially certain parts of Africa. Pearl millet yields are seriously damaged by an ovary-infecting smut that seems to infect in the same way as *U. maydis*. Perhaps screening for fast-growing pollen in this species will be productive.

ACKNOWLEDGMENTS

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LITERATURE CITED

Banuett, F. and I. Herskowitz. 1989. Different *a* alleles of *Ustilago maydis* are necessary for maintenance of filamentous growth but not for meiosis. *Proc. Natl. Acad. Sci. USA* 86:5878-5882.

BEST COPY AVAILABLE

Christensen, J. J. 1963. Corn smut caused by *Ustilago maydis*. Monogr. 2. The American Phytopathological Society, St. Paul, MN.

Heslop-Harrison, Y., Heslop-Harrison, J. and Reger, B. J. 1985. The pollen-stigma interaction in the grasses. VII. Pollen-tube guidance and the regulation of tube number in *Zea mays* L. *Acta Bot. Neerl.* 34:193-211.

Pataky, J. K. 1991. Production of Cuitlacoche [*Ustilago maydis* (DS) Corda] on sweet corn. *HortScience* 26(11):1374-77.

Pope, D. D. and McCarter, S. M. 1992. Evaluation of inoculation methods for inducing common smut on corn ears. *Phytopathology* 82(9):950-5.

Snetselaar, K. M. and Mims, C. W. 1993. Infection of maize stigmas by *Ustilago maydis*: light and electron microscopy. *Phytopathology* 83:843-50.

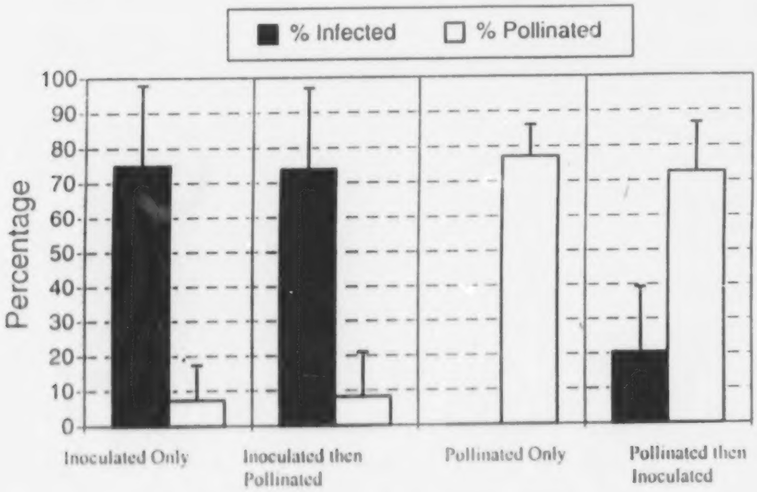

Figure 1. Means and standard deviations for the four treatments of corn ears.

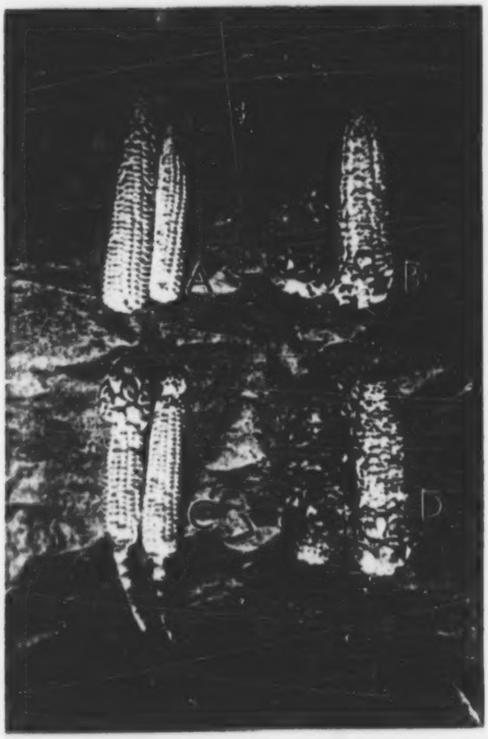

Figure 2. Representative ears from each of the four treatments: Pollinated only (A), Inoculated only (B), Pollinated then inoculated (C), and Inoculated then pollinated (D).

1731

GENETIC CHARACTERIZATION OF THE AXR5 GENE

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ABSTRACT

The objective of this research is to understand the effects of the plant hormone auxin in Arabidopsis thaliana and to identify and study the genes that regulate the action of this hormone. Characterizing the mutant genes genetically is important in understanding the normal function of the genes involved in the action of auxin. Standard procedures were used to cross the axr5-1 mutant plant with three visible markers: hy4, abi1, and pr1, which are located on chromosome 4. These crosses will allow us to determine the different types of progeny in the F2 population which will enable us to map the AXR5 gene relative to these visible markers on chromosome 4.

INTRODUCTION:

Auxin is a small molecule that is important in plant growth and development. The naturally occurring form of auxin is indole-3-acetic acid, or IAA. However, a variety of synthetic compounds such as naphthalene acetic acid and 2,4-D (dichlorophenoxyacetic acid) have been identified that behave like auxin. Auxin causes elongation when present in the right concentration and in the right tissue. Auxin is important for phototropism. In response to light, the distribution of auxin in a stem tip changes in such a way that there is more auxin on the side away from the light. The cells of the side which contains more auxin elongates more than the cells on the side near the light. In a similar fashion, auxin is also involved in gravitropism, plants response to gravity. In addition to cell elongation, auxin is also involved in cell division and differentiation.

A genetic approach is being used to understand auxin's effects in these cellular processes. For example, to understand the genes important for the role of auxin in root elongation, we need to isolate mutant seedlings altered in root elongation in response to auxin. We are characterizing mutant plants genetically and physiologically to understand the normal function of the gene. The root growth of the wild type seedlings is inhibited by high concentration of auxin. We are studying a mutant of the weed Arabidopsis thaliana, called *axr5*, that elongates roots on high concentration of auxin. Arabidopsis is used because it is small and grows fast, so laboratory studies can be done easily. This organism also has less junk DNA which makes it easier to clone. Arabidopsis is relative of broccoli and mustard. It has only five chromosomes. The *axr5* mutant was isolated in the lab of Dr. Mark Estelle at Indiana University by Jim Britton and Anna Ruesink. The *axr5* mutant is a single allele that is dominant and auxin-resistant.

Dr. Hobbie has roughly mapped the *axr5* mutant, positioning the *AXR5* gene on chromosome 4, but it needs to be mapped more closely (Dr. Hobbie, unpublished results). Our research involves positioning the *axr5* mutant relative to three visible markers: *abi1*, *prl*, and *hy4*, which are located on chromosome 4. *abi1* is a dominant mutant that is resistant to abscisic acid, a plant hormone that imposes seed dormancy and inhibits seed germination. *hy4* mutant plants have longer hypocotyls compared to the wild type. Heterozygous *prl* mutant plants are resistant to kanamycin and homozygous *prl* mutants are dead. The results and analysis of F_2 population produced by crossing *axr5* to each of these mutant plants individually will be described.

MATERIALS AND METHODS

axr5 x hy4 cross Wild type, *axr5*, *hy4*, and the F_2 seeds of the *axr5* x *hy4* cross were sterilized and spread on 2D Plates. These plates contain $2x10^{-7}$ M 2,4-dichlorophenoxyacetic acid, a synthetic auxin, along with 0.7% agar, 1% sucrose and a mixture of salts and minerals (Wilson et al., 1990). These plates were placed at 4 °C for two days, and then put into a Percival Scientific Growth Chamber set at 16 hour light and 8 hour dark cycle at 22 °C for one week. This growth chamber has a light intensity of 70-95 microEinstien M^{-2}/S^{2}.
axr5 x abi1 cross Wild type, *axr5*, *abi1*, and the F_2 seeds of the *axr5* and abi1 cross were sterilized. The sterilized seeds were then spread onto plates that contained 10 µM abscisic acid. The plates were given cold treat (4 °C) for two days and then placed in the growth chamber for one week. After a week, the nongerminated seeds were transferred onto 2D plates or 2,4-D plates. The plates were placed in the growth chamber for one week. The purpose of this method was to distinguish between the four phenotypes of the F_2 seedlings.
axr5 x prl cross Wild type, *axr5*, *prl*, and F_2 seeds of *axr5* x *prl* were sterilized and spread onto 2D plates. The plates were then placed at 4 °C for four days. The plates were put in the growth chamber for one week. At the end of the week, the $auxin^R$ and $auxin^S$ seedlings were separated and transferred onto plates containing 5o µg per milliliter Kanamycin. These plates were then put in the growth chamber for a week. After a week, the Kan^S and Kan^R seedlings were separated and the F_2 population was scored.

RESULTS

To measure the genetic distance between the *AXR5* gene and other chromosome 4 markers, F_2 populations resulting from crosses between *axr5* mutant and other genes on chromosome 4 were analyzed. Results are presented in tables 1, 2, and 3.

Table # 1: axr5 x hy4 result summary
_F_2 Seedlings_

	$Auxin^R$ (LR)	$Auxin^S$ (SR)	A. Total Seedlings
HY4 (SH)	2788	83	2871
hy4 (LH)	246	1246	1492
B. Total Seedlings	3034	1329	C. Total Scored: 4363

Number of Seeds Scored = 4363

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HY4 = wild type = short hypocotyl (SH),
hy4 = mutant = long hypocotyl (LH),
AXR5 = wild type = short roots (SR),
axr5 = mutant = long roots (LR)

Table # 2: *axr5* x *abi1* results summary
F_2: Seedlings

	Auxin^R	Auxin^S	A. Total Seedlings
Abscisic Acid (ABA^R)	Not Determined	Not Determined	377
Abscisic Acid (ABA^S)	232	111	343
B. Total Seedlings			720

Number of Seeds Scored = 720

Table # 3: axr5 x prl result summary

F_2 Seedlings

	Auxin^R	Auxin^S	A. Total Seedlings
Kanamycin (Kan^R)	297	78	375
Kanamycin (Kan^S)	301	55	356
B. Total Seedlings	598	133	731

Number of Seeds Scored = 731

Calculation of Map Distance For Table #1 Using the Product-Ratio Methods (F_1 in Coupling Phase)

According to the Product-Ratio Method, a value of z is determined by the following formula : (LR, LH) x (SR, SH/(LR, SH) x (SR, LH). This z value corresponds to a recombination frequency of x (Stansfiel, 3th Ed.).

Coupling Data: (LR, LH) x (SR, SH)/(LR, SH) x (SR, LH)
(246) x (83)/ (2788) x (1246) = 0.00587

Using the product ratio table, we can conclude that 0.00587 lies between the values of 0.005318 and 0.007366. This corresponds to recombination frequency of 0.06 and 0.07 respectively. Thus, the recombination is approximately 6% which corresponds to a map distance of 6 cM.

Table #2: Calculation involving the *axr5* x *abi1* Cross Using the Square-Root Method (F_1 in Repulsion Phase)

F_2:

Frequency of double recessive = 111/720 = 0.154
Percentage of crossover gametes =2frequency of double recessive = 2√0.154= 0.785 =78 %.

Table #3: Calculation involving the *axr5* x *prl* Cross Using

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the Square-Root Method (F_1 in Repulsion Phase)
F_2:

Frequency of double recessive = 55/731 = 0.0752
Percentage of crossover gametes = 2 √ frequency of double recessive =
2√ 0.0752 = 0.548 =54.9 %.

DISCUSSION

The presence of recombinant type gametes indicates the event of crossover. The F_2 populations are produced by self-fertilizing the F_1 generation. Such an F_2 generation does not show the typical independent assortment ratio of 9:3:3:1. This lack of independent assortment ratio is used as an evidence for linkage. In this part of our paper, two methods used for estimating the degree of linkage from F_2 data will be presented.

Product-Ratio Method. This method utilizes the F_2 phenotypes to estimate the frequency of recombination from double-heterozygous parents. In order to use this method, it is important to know whether the F_1 was in coupling phase or in repulsion phase. The F_1 is in coupling phase if the dominant alleles of two genes are on the same chromosome, which is true for *axr5* x *hy4* cross. F_1 is in repulsion phase if the dominant alleles are on two different chromosomes. Since the *axr5* and *hy4* mutations are on the same chromosomes and there are four possible phenotypes from the F_2 generation, the product-ratio method was used to estimate the distance between the *AXR5* and *HY4* genes. The calculation indicated that the *AXR5* is 6 map units or 6cM (centiMorgan) away from *HY4*.

The frequency of recombination increases as the distance between linked genes increases, but it will never exceed a maximum of 50%. Since the frequency of recombination of the *axr5* and *abi1* cross is 78 %, we can conclude that the two genes are spaced far apart on chromosome 4 and do not appear to be genetically linked.

Our calculation for the *axr5* and *prl* cross also indicated that the frequency of recombination is more than 50% which enables us to conclude that the *AXR5* and *PRL* genes are not genetically linked. There appear to be some contradiction in the results as *AXR5* is closely linked to the *Hy4* gene (6cM), yet appears unlinked to *PRL* gene which is 22.7 map units (according to one measure of map distance, that using recombination inbred lines) away from *HY4*. The F_3 progeny of the *axr5* x *hy4* cross is currently being retested to verify our F_2 results. The analysis of the *axr5* x *prl* cross will also be repeated to verify the results.

Exact positioning of the *AXR5* gene on the genetic and molecular maps of chromosome 4 will be the first step in cloning the *AXR5* gene by a position cloning approach.

After the submission of this paper, it was noted that the *prl* mutation has reduced transmission of gametes and behaves differently than the wild type. Due to this reduced transmission of gametes, the Square-Root Method can not be used. After accounting for this, it was calculated that the *AXR5* gene is 34 map units away from *PRL*. Furthermore, after retesting the F_3 progeny of *axr5* x *hy4* cross, the results indicated that the *AXR5* gene is 3 map units away from *HY4*.

Since *HY4* is 58 map units away from *ABI1* and *AXR5* is 3 map units away from *HY4*, it is logical to conclude that the *AXR5* gene will show no linkage to *ABI1*, as supported by the findings presented in this paper. If *PRL* is 22 map units away from *HY4* and *AXR5* is 3 map units away from *HY4*, the *PRL* gene will be less than 34 map units away from *AXR5*. However, it is not surprising that the map distances do not add up perfectly because it is often difficult to compare map

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distances derived from different crosses.

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REFERENCES

Ahmad, M., and Cashmore, A.R. 1993. The HY4 gene involved in blue light sensing in Arabidopsis thaliana encodes a protein with the characteristics of a blue light photoreceptor. Nature **366**: 162-166.

Griffith, J. F., Miller, H. J., Suzuki, T. D., Lewontin, C.R. and Gilbert, M., W. (1993). Linkage Maps. In Introdution to Genetic Analis. 5th Ed. W. H. Freeman and Company. p124-128.

Koorneef, M., Reuling, G., and Karssen, C.M. 1984. The isolation and characterization of abscisic acid-insensitive mutants of Arabidopsis thaliana. Plant Physiology **61**: 377-389.

Purves, W. K., Orions, H. G., and Heller, H. C., (1995). Regulation of Plant Development. In *Life: the Science of Biology*. Sinauer Association, Inc. P 733-754.

Springer, P.S., McCombie, W.R., Sundarsan, V., and Martienssen,R.A. 1995. Gene trap tagging of PRLIFERA, and essential MCM2-3-5-like gene in Arabidopsis. Science **268**: 877-800

Stansfield, D. W. (1991) Autosomal Traits. In Schaum's Outline Series: Theory and Problems of Genetics 3rd Ed. McGraw-Hill, Inc. P 120-121.

The Competitive Relationship Between the Perennial *Cardaria draba* and the Annual *Lepidium virginicum*

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Life history predicts that perennials, having a higher investment in vegetative rather than reproductive structures, should be superior to annuals in their ability to compete for resources. To investigate this hypothesis and to determine if this competitive relationship was affected by a delay in seedling emergence, the perennial *Cardaria draba* and the annual *Lepidium virginicum* were planted alone and together in 4 inch pots. In each pot, a focal plant was surrounded by five neighbors of either the same or the other species, and seeds of the focal plant were planted at the same time as the neighbors or five days later. Relative competitive ability was assessed by measuring root and shoot dry masses of the focal plants. At harvest, the perennial had higher root and shoot biomass under all treatments. For planting times, the annual had its higher shoot mass in intraspecific treatments and the perennial had its higher shoot mass in interspecific treatments. In the simultaneous plantings, the perennial had a higher root: shoot mass ratio than the annual but the annual had a higher root: shoot ratio in the delayed planting. This, combined with the large decrease in shoot mass of the annual in the delayed planting, indicates the more dramatic effect of competition on the annual. These results demonstrate that the perennial's higher allocation to vegetative structures (roots and shoots) may make it a superior competitor over the annual.

BACKGROUND

The life history of a species describes the timing and pattern of vegetative and reproductive stages. In plants, differing life histories are sometimes classified into two categories: early-successional species, including most annual, and late-successional species, including most perennials (Huston and Smith 1987). Annuals complete their entire life cycle within a single year and tend to allocate a larger portion of their energetic and mineral resources to reproductive rather than to vegetative organs, such as roots, primarily because they have only one chance to reproduce. Several studies have demonstrated that annuals have greater reproductive effort, greater seed and fruit production per unit leaf area (Abrahamson 1979; Primack 1979) and allocate a much smaller portion of their resources to roots (Pitelka 1977) than do perennial species. In contrast, the perennial life cycle extends over many years and typically includes many fruiting periods, translating into a larger prereproductive investment in vegetative structures (root, shoots, leaves). Vegetative organisms have limited energy and resources that must be allocated differentially to growth, reproduction, and defense. Because of energetic and physiological constraints, trade-offs result when a plant allocates resources to one function rather than to another.

An interesting question in plant ecology concerns the relationship between life history (e.g. annuals vs. perennials) and competitive ability. In general, annuals, which lack a persistent root system, make better competitors in disturbed environments where adult mortality is great, while perennials fare best in a stable environment where selection favors the longer-living plant (Huston and Smith 1987). In addition to such environment-specific differences in competitive abilities, annuals and perennials compete differently due to variable allocation patterns and life histories.

Perennials, which have slower growth rates than annuals but a greater investment in roots and vegetative structures, tend to be superior long-term competitors. Annuals, which are characterized by high seed output and dispersibility, high stress tolerance, small seed size and rapid growth, are better competitors in the low population densities of early succession, as well as in disturbed environments where density-dependent mortality (e.g. environmental stochasticity) is high. Conversely, perennials are superior competitors in stable environments where the adult plant is favored and density-dependent mortality (e.g. from competition) is high.

A relevant study by Pitelka (1977) delineated the differential energy allocation patterns between the annual *Lupinus nanus* and the perennial herb *Lupinus variicolor*. The annual devoted 61% of its energy to reproductive tissues, 29% to seeds alone, and only 3-4% to roots. In contrast, the perennial devoted only 18% to reproduction and at least 40% of its energy to a large taproot system. Consequentially, *L. variicolor* was found to thrive in climatically harsh but stable environments where high survivability is favored (Pitelka 1977).

A second variable in my experiment was the timing of seedling emergence. This effect was evaluated in my experiment to determine if delayed seedling emergence would affect competitive ability and if this effect differed between annuals and perennials. Based on the competitive disadvantages tied to late germination, it seems likely that delayed plants in my experiment would have a lower final biomasss. Indeed, it is widely known that germination rate and seedling emergence can have a profound effect on plant populations (Ross and Harper 1972; Miller 1987). Experiments have indicated that small alterations in emergence time can contribute greatly to the final biomass of the plant. For example, when grown with competition, the mean final biomass of *Dactylis glomerata* increased by an average of 222% from a simultaneous planting when the plant received one day's headstart (Ross and Harper 1972). Other experiments have shown similar results (Black and Wilkinson 1963; Miller 1987).

Thus, the competitive abilities of the perennial, *Cardaria draba*, and the annual *Lepidium virginicum* were investigated, by comparing biomass allocation patterns to roots and shoots, and in the focal plants whose seedlings emerged concurrent with, and subsequent to, seedlings of competing neighbors.

METHODS AND MATERIALS

This experiment examined two members of the Brassicaceae (mustard family) because of their morphological similarity and tendency to co-occur in the U.S. (Agricultural Research Service 1971). This diverse family contains more than 3500 species in 300 genera including weedy species as well as agricultural relatives such as cabbage, cauliflower and broccoli (Agricultural Research Service 1971). *Lepidium virginicum* L. (Virginia pepperweed) is an annual or a winter annual herb, reproducing by seeds. It grows 20-90 cm tall and produces coarsely toothed leaves on a linear stem and inflorescences in elongate racemes with small white or greenish flowers. Native to most the U.S., it grows from May to December and can often be found growing as a weed in dry soils (Agricultural Research Service 1971). *Cardaria draba* Desv. (hoary cress) is a perennial herb typically 10-80 cm tall producing round leaves and terminal inflorescences on a linear stem. It is naturalized from Europe and is often found in a similar habitat as *L. virginicum*, where it grows from June to October (Agricultural Research Service 1971).

Seeds were obtained (F. and J. Seed Service, Woodstock, Ilinois), and planted in 4 inch pots in a seven week greenhouse experiment. In each pot, a focal plant to be harvested and weighed was surrounded by five neighbor plants, either of the same or a different species. In one treatment, all seeds were planted simultaneously. In the second treatment ("delayed"), the focal seed was planted five days later than the seeds of the neighboring plants. There were four identical plantings in the two treatment, yielding a total of eight plantings. The first two plantings dealt with interspecific competition: one with an annual target surrounded by perennial neighbors and another with a perennial target surrounded by annuals. The other two plantings examined intraspecific competition: one with an annual target surrounded by annual neighbors and in the second, a perennial target surrounded by perennial neighbors.

Twelve replicates of each of the eight planting types was used for a total of 96 pots. In two additional pots, extra seedlings of both species were planted. Pro-Mix fine soil mix was used as a planting medium and approximately 4 seeds were planted for each of the six spots available in each pot. The additional seedlings were weeded out one week after germination, and after two weeks, transplants from the two extra pots were planted as necessary to replace missing plants. The pots were kept under strictly natural lighting, were randomly placed on a greenhouse bench, and were randomized twice a week. To maintain a sufficient level of moisture in the soil, the plants were watered twice a day, or as needed, using a misting nozzle. The initial planting was done on 6-13-96, with delayed seeds planted on 6-18-96.

Measurements included the average seed size of both species (each n=20), the average number of days to seedling emergence (each n=7), and seedling mass after 15 days for plants growing singly in 4 inch pots (each n=7).

After seven weeks, the focal plants were harvested. The shoots were cut off at the soil surface with a razor blade and the soil was washed from the roots after extraction from the soil. The plants were dried at 76C for one week, and the individual root and shot biomasses of each plant were determined. The data

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were analyzed using a three-way analysis of variance, with the target species, neighbor species, and planting date as the main effects.

RESULTS AND DISCUSSION

Due to losses from aphid herbivory, the final sample size of the experiment was 91. Root and shoot biomass, as well as root: shoot mass ratios in both the simultaneous and delayed plantings are shown in Figure 1. At harvest, perennial targets had higher root and shoot biomass than annuals under all simultaneous treatments, with the exception of shoot mass in the intraspecific treatment, in which the two species did not differ significantly. This trend for higher root and shoot mass indicates the perennial's higher allocation to vegetative tissue, as well as its ability to compete well in stable environments regulated by density-dependent effects such as competition from other plants.

For both planting times, the annual performed better, displaying higher shoot mass, in intraspecific plantings while the perennial had its higher shoot mass when grown with the other species. These results are consistent with the theory that the superior competitor will be favored in interspecific plantings, while the inferior competitor will perform best in intraspecific plantings (de Wit 1960).

Results from analysis of variance are given in Table 1. As shown by the significant effect of time on root and shoot growth ($p<0.001$), delayed plants were smaller. In addition, the target*time interaction was significant for root, shoot and ratios ($p<.05$), displaying that delayed seedling emergence has a differential effect on the competitive abilities of the two species. In addition, the neighbor*time interaction was significant for shoots ($p=.005$) and the target*neighbor*time interaction was significant for root: shoot mass ratios ($p=0.034$).

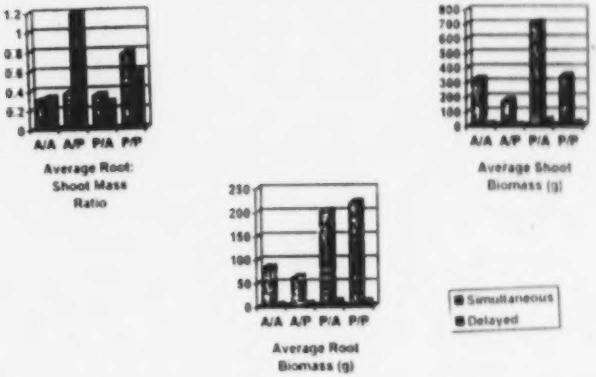

Figure 1: Average Root and Shoot Biomasses and Mass Ratios for Varying Treatment Groups (target/neighbor) n=91

Table 1: ANOVA on the Significance of Neighbor Type, Planting Time and Target Plant (n=91)

	Roots		Shoots		Mass Ratio	
Interaction	*F-ratio*	*P-value*	*F-ratio*	*P-value*	*F-ratio*	*P-value*
target	47.239	0.000	12.529	0.001	0.262	0.610
neighbor	0.007	0.933	10.098	0.000	15.858	0.000
time	167.591	0.000	76.725	0.000	1.993	0.162
target*neighbor	0.882	0.350	1.763	0.188	0.222	0.639
target*time	39.833	0.000	9.463	0.003	6.850	0.011
neighbor*time	0.013	0.909	8.415	0.005	2.559	0.114
target*neighbor*time	0.969	0.328	1.502	0.224	4.628	0.034

In theory, the perennial would be expected to have a higher root: shoot ratio due to its characteristic high allocation to below ground tissue. However, the effect of delayed seedling emergence skewed this tendency as heavy competition from the mature perennials forced the annual to devote a disproportionate percentage of its resources to roots rather than to shoots. In the simultaneous plantings, the target perennial plants displayed higher root: shoot ratios than did the annuals, but in the delayed plantings, the annuals had higher mass ratios, especially evident in the interspecific treatment. The virtual lack of any shoot growth in the delayed annual showed the amplified effect that delayed seedling emergence had on *L. virginicum* due to space preemption and sunlight blocking by the larger and more mature perennials. In contrast, the delayed *C. draba* had lower root: shoot ratios as they devoted more resources to shoot growth. This is most likely due to the smaller difference in size between the mature neighbor plants and the delayed target plant. Even when delayed by five days, *C. draba* plants were significantly larger than their annual counterparts, a result of their superior competitive ability.

The size dichotomy between *C. draba* and *L. virginicum* indicates that competitive differences between the two species were at least partially rooted in genetic characteristics as well as in differential allocation patterns. The average seed mass of the perennial was 2.348 mg (n=20) and after 15 days, the seedling mass was 7.601 mg (n=7). In contrast, the average mass of *L. virginicum* seeds was 0.351 mg (n=20) and 15-day seedling mass was 2.001 mg (n=7). The competitive superiority of *C. draba* can be explained first, by its characteristically high investment in root growth, allowing it to exploit resources form the soil more effectively, and second, the greater shoot growth of *C. draba*, depleting sunlight and space for not only annual targets, but also those of the same species. Although the size difference between the two species makes it more difficult to attribute competitive differences to differential allocation patterns alone, this experiment simulates nature in that it examines the coexistence of two weeds that are commonly found together in nature, regardless of size. Realistically, competition often occurs between plants of varying sizes.

CONCLUSIONS

This experiment has shown that the perennial may be a superior competitor based on its higher vegetative allocation to roots and shoots. Consistent with this finding, the perennial had its higher shoot mass in interspecific competition while the annual had its higher shoot mass in intraspecific plantings. The effect of delayed seedling emergence was a disadvantage for both species; however, it had an amplified effect on the annual, which displayed very little shoot growth when grown with the competitively dominant perennial.

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REFERENCES

Abrahamson, W.G. 1975. Patterns of resource allocation in wildflower populations of fields and woods. American Journal of Botany. 66: 71-79.

Agricultural Research Service. 1971. Common Weeds of the United States. Dover Publications, Inc., New York. 461 pp.

Black, J.N. and G.N. Wilkinson. 1963. The role of emergence in determining the growth of individual plants in swards of subtarrenean clover. Australian Journal of Agricultural Research. 14: 628-638.

DeWit, C.T. 1960. On competition. Verslagen van Landbouwkudige Onderzoekingen. 66: 1-82.

Huston, M. and T. Smith. 1987. Plant succession: life history and competition. The American Naturalist. 130: 168-198.

Miller, T.E. 1987. Effects of emergence time on survival and growth in an early old-field plant community. Oecologica. 72: 272-278.

Pitelka, L. 1977. Energy allocation in annual and perennial lupines. Ecology. 58: 1055-1065.

Primack, R. 1979. Reproductive effort in annual and perennial species of *Plantago* (Plantaginaceae). The American Naturalist. 144: 51-61.

Ross, M. and J.L. Harper. 1972. Occupation of biological space during seedling establishment. Journal of Ecology. 62: 473-486.

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Self-Incompatibility: a Model for Pollen- and Pollen Tube-Mediated Signal Transduction in *Petunia inflata*

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Self-incompatibility is the mechanism by which an individual plant prevents the fertilization of its female gametes by its own male gametes by recognizing and rejecting self pollen. Although the female component of this recognition reaction is well-studied in *Petunia*, the male (pollen) component has eluded all researchers. In fact, very few pollen-specific genes have been characterized. To contribute to the study of pollen-specific proteins, the expression patterns of two pollen promoters were mapped. The temporal and spatial expression of the Lat52 and PRK1 promoters were tracked by histochemical assay and immunolocalization of the beta-glucuronidase reporter gene fused to each of the two promoters. The Lat52 promoter directed protein expression to the cytoplasm of pollen in stage 3 of floral development and to the placenta of the ovary. The PRK1 promoter showed extremely low levels of expression in the ovary.

BACKGROUND

Sexual reproduction in flowering plants, or angiosperms, is characterized by the fertilization of the female gamete in the ovule by the male gamete in the pollen grain. Pollen grains land on the surface of the stigma, the crown of the long pistil. Pollen germinates by sprouting a pollen tube that grows through the style, the body of the pistil. At the base of the pistil is the ovary containing several ovules which in turn contain the female gametes. The pollen tube grows into the ovary and fertilizes a gamete in an ovule. (Shivanna, 1985)

Hermaphroditic angiosperms produce both pollen and ovules in the same plant, introducing the possibility of male and female gametes from the same individual encountering each other. Inbreeding occurs if an individual plant's male gamete reaches the plant's own ovule and fertilizes the egg inside. The egg itself is unable to distinguish between pollen of different genotypes (Shivanna, 1985). Self-incompatibility is the cell-cell recognition mechanism by which inbreeding is discouraged. To encourage outcrossing and therefore to promote genetic diversity within a population, most self-incompatibility reactions prevent self pollen from germinating into a pollen tube in order to reach the ovule in the ovary (de Nettancourt, 1977). Elucidation of the recognition reaction is important to the signal transduction field and as a model system of maintaining evolutionary fitness of a population.

Self-incompatibility is controlled by one or more polymorphic loci. In most single-locus systems studied, this multiallelic locus is called the S locus, and alleles are called S alleles. Genetically distinct S alleles are numbered to indicate diploid genotypes such as S1S1 (homozygous), S1S2 (heterozygous), S13S13, etc. Homozygous plants carrying a certain S allele are by definition compatible with homozygous plants carrying a different S allele. The product of the S gene, a ribonuclease (McClure et al., 1989), is expressed in the pistil. These S-RNases were first discovered by identifying proteins that co-segrated with S alleles. Pollen-pistil interactions allow the pistil of the recipient plant to recognize the S-genotype of the pollen and either reject or accept the pollen.

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In sporophytic incompatibility, one of two kinds of self-incompatibility (Figure 1), pollen rejection depends on the genotype of the pollen-producing plant (deNettancourt, 1977). Each pollen grain carries products of both S alleles of the pollen donor. If the either of the pollen donor alleles are the same as those in the pistil, then the pollen is rejected (Newbigin, 1993). Petunia, however, exhibits gametophytic self-incompatibility, in which pollen the product of only one of the two S alleles of the donor plant. If this single allele is the same as either of the recipient plant's alleles, the pollen is rejected.

Figure 1 illustrates the difference between sporophytic and gametophytic self-incompatibility. *Petunia inflata* exhibits the latter, in which incompatible pollen tube growth is arrested in the upper third of the pistil. Compatible pollen germinates freely and the pollen tube reaches the embryo sac in the ovary.

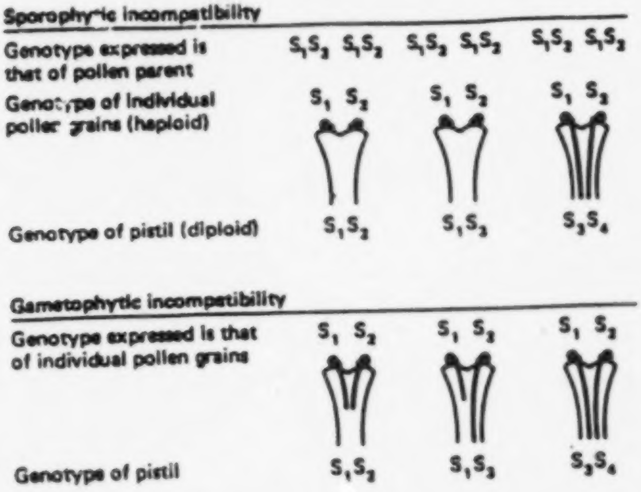
Sporophytic incompatibility
Genotype expressed is that of pollen parent
S_1S_2 S_1S_2 S_1S_2 S_1S_2 S_1S_2 S_1S_2
Genotype of individual pollen grains (haploid)
S_1 S_2 S_1 S_2 S_1 S_2
Genotype of pistil (diploid)
S_1S_2 S_1S_3 S_3S_4
Gametophytic incompatibility
Genotype expressed is that of individual pollen grains
S_1 S_2 S_1 S_2 S_1 S_2
Genotype of pistil
S_1S_2 S_1S_3 S_3S_4

Figure 1: Pollen tube growth in sporophytic and gametophytic self-incompatibility systems. (from Clarke, 1985)

This cell-cell recognition between pollen and pistil depends on the tissue-specific expression of certain gene products. The recipient plant can distinguish between pollen of different genotypes; for example, it may reject S1 pollen but accept S2 pollen. This suggests that the pollen component is polymorphic, with different forms expressed uniquely in pollen of each genotype. To analyze pollen-specific gene expression in petunia, the tissue-specific expression of genes controlled by pollen-specific promoters was mapped.

Signal transduction studies in petunia have been facilitated by the use of pollen promoters such as the LAT52 promoter in transgenic studies. When introducing transgenes into plant tissue, it is necessary to ensure that the promoter directing the transgene's expression is active in the correct tissues to which the transgene is being targeted, and that it is active during the correct stage of development. Mapping the expression patterns of promoters used to drive transgenes is supporting evidence that phenotypic changes in a transgenic plant are truly caused by the transgene and are not artifacts.

The PRK1 protein, a receptor-like kinase in petunia pollen, is thought to be involved in signal transduction. The PRK1 protein has an extracellular domain, a small membrane spanning domain, and a cytoplasmic kinase domain that phosphorylates both serine/threonine and tyrosine residues (Mu et al., 1994). After it was found that PRK1 was most expressed in mature pollen and in in vitro-germinated pollen tubes, the gene was inactivated by transforming petunia plants with the antisense PRK1 gene driven by the LAT52 promoter to determine the function of PRK1 (Lee et al., 1996).

The purpose of this study was to compare the expression patterns of both the LAT52 and PRK1 promoters, within pollen grains as well as in the female tissues of petunia.

LAT52 promoter

In the study of the role of pollen in self incompatibility, the LAT52 promoter from the tomato LAT52 pollen gene has become a popular promoter to use in directing transgene expression to pollen grains. The LAT52 promoter is highly expressed at the start of microspore mitosis in pollen (Twell et al., 1991). LAT52 promoter expression was mapped in tomato tissues by Twell, Yamaguchi and McCormick by fusing the promoter to the b-glucuronidase (GUS) reporter gene in a Ti plasmid and transforming the construct into *Lycopersicon esculentum*. Histochemical assays showed that Lat52 promoter-driven GUS activity was localized in mature anthers and was missing from roots, stems, leaves, sepals, petals, and pistils (Twell et al, 1990). The Lat52 promoter was fused to GUS, was transformed into and mapped in both *Nicotiana alata* and *Arabidopsis thaliana* by Eady et al (Eady et al., 1994), who found no GUS activity in leaves, stems, flowers, or roots. Only pollen showed promoter activity.

Data from LAT52-directed transgenic tomato, tobacco and arabidopsis cannot be applied to petunia without also mapping promoter expression in petunia, because expression patterns of the same gene often vary from one species to another. Lee et al. began studying LAT52 promoter activity in pollen using the LAT52-GUS transgenic plants used in this study. By conducting histochemical assays on the surfaces of both wild type pollen and LAT52-GUS transgenic pollen, they found that approximately 50% of pollen grains had LAT52 promoter-driven GUS activity (Lee et al, 1996). The temporal expression pattern was determined by fluorimetric GUS assay. The LAT52 promoter is active starting with stage 3 of floral development, in which petunia buds are 1.0 to 1.5 cm long.

PRK1 promoter

In comparison to the LAT52 promoter, the PRK1 promoter is much more weakly expressed in pollen. Its activity was immunolocalized to pollen cytoplasm by Dr. Y. Chung (unpublished data). Lee et al. established by RNA blot analysis that PRK1 mRNA first appears in petunia anthers at stage 3, matching the temporal expression pattern of the LAT52 promoter. This stage is that of microspore mitosis. 50% of pollen microspores are aborted in antisense PRK1 plants, indicating that PRK1 plays a role in the signal transduction pathway directing pollen development (Lee et al., 1996).

Antisense PRK1 transgenic plants also exhibit a phenotype affecting the female tissues as well as the male tissues of petunia. For this reason, it was important to make sure that the promoters used to drive PRK1 and its antisense message showed activity in *Petunia* ovaries.

MATERIALS AND METHODS

Transformation of *P. inflata* plants of $S_2 S_3$ genotype with LAT52 and PRK1 promoters fused to GUS reporter gene.

The tomato LAT52 promoter was obtained from Dr. S. McCormick, fused with the GUS reporter gene, cloned into a Ti plasmid, and transformed into *Agrobacterium* by Dr. A. G. McCubbin. The agrobacterium mixture was used to coat petunia leaf strips. Ti plasmid transfer was mediated by tobacco nurse cells. Shoots were grown from transformed leaf strips on kanamycin and carbenicillin selection shoot-inducing MSMO medium (with benzyladenine and a-naphthalene acetic acid growth hormones). Shoots were transferred to root-inducing medium and then to soil. Seven individual plants expressed b-glucuronidase to varying degrees of intensity as measured by Western blot. Transgenic plants containing the PRK1-GUS construct were all prepared by Dr. Y. Chung. One PRK1-GUS plant showed significant GUS activity, as determined by coloригenic GUS substrate assay of PRK1-GUS pollen from a stained anther squashed on a glass slide. The number of blue pollen grains in a random sample of 100 pollen grains was counted for each PRK1-GUS plant.

Histochemical GUS activity assays

Five anthers each from 5 LAT52-GUS transformed *Petunia inflata* buds (developmental stages 1-5) were collected. Bud lengths for each of the five stages were as follows: stage 1, 0-0.5 cm; stage 2, 0.5-1.0 cm; stage 3, 1.0-1.5 cm; stage 4, 1.5-2.0 cm; stage 5, 2.0-2.5 cm. Whole buds in each of these stages and ovaries from stage 5 and open flower were also collected from LAT52-GUS and PRK1-GUS transformants. Anthers, ovaries and whole flowers in each of the 5 stages from wild type S2S2 *Petunia* were used as negative controls for the assays.

Tissues were fixed in formaldehyde (0.23%), mannitol (0.3 M), MES (0.01 M), and fresh phosphate buffer (0.1 M, pH 7.0), washed twice with 100 mM phosphate buffer, and stained overnight. Staining solution contained potassium ferricyanide (0.5 mM), potassium ferrocyanide (0.5 mM), EDTA (0.01 M, pH 8.0), and 1 mM 5-bromo-4-chloro-3-indolylglucuronide (X-Gluc, Jersey Lab Supplies, Livingston, USA). A blue-colored product is the result of cleavage of X-Gluc by GUS.

Sectioning and Light Microscopy

After staining with X-Gluc overnight, the tissues were washed twice with 100 mM phosphate buffer, soaked in 70% ethanol for 15 min., and boiled in 95% ethanol for 10 min. Samples were gradually infiltrated with LR-White™ resin, cast into blocks at 60°C for 6 hrs. and sectioned with an LKB-Bromma ultramicrotome. The 1 μm sections were mounted on poly-L-lysine-coated glass slides, stained for 8 s. in 0.0125% methylene blue, and examined with an Olympus light microscope. Areas of the tissue in which GUS was expressed were stained blue.

Immunolocalization

The activity of the two pollen specific promoters in the ovaries was too weak to be detected by histochemical GUS assay. To pinpoint the subcellular ovary expression patterns of LAT52-GUS and PRK1-GUS promoters, GUS protein was immunolocalized in sections of PRK1-GUS and LAT52-GUS ovaries from stage 4 buds, stage 5 buds and open *Petunia* flowers. Wild type S2S2 ovaries were used as negative controls, and LAT52-GUS stage 4 anther sections were used as positive controls.

Sections prepared as above were first blocked with TBST-BSA (10 mM Tris, 500 mM NaCl, 0.3% Tween 20™, 1% BSA, pH 7.2) for 1.5 hr. Primary anti-GUS antibody (Amersham) was diluted 1:50 with TBST-BSA, incubated at room temperature for 10 min., and placed on the section after blocking for 4 hrs. Sections were washed by shaking and rinsing in TBST-BSA three times for 15 min. each, then incubated 1 hr. with secondary antibody-protein A-gold particle conjugate (AuroProbe EM, Janssen), diluted 1:50 with TBST-BSA. Slides were washed twice for 15 min. each in TBST-BSA, twice with TBST, once 30 min. in dH_2O, and air-dried for at least 10 min.

Silver enhancement of the gold particles was done by mixing 7 drops each of initiator solution and enhancer solution (Amersham International Silver Enhancement kit RPN 491) and placing the mixture on the sections at room temperature for 5 min. The slides were washed in dH_2O, incubated in silver enhancement mixture for another 5 min, washed again, and dried. Light microscopy as described above was used to examine the immunolocalized GUS in each section.

RESULTS

Histochemical GUS assay

GUS was expressed in LAT52-GUS anthers beginning in stage 3 buds. Pollen in stage 3, 4, and 5 anthers were stained blue in approximately equal intensity, while stage 1 and 2 pollen remained colorless. Only the pollen cytoplasm was stained blue in these anthers; GUS was not expressed in the pollen nuclei, vesicles and membranes.

One individual plant transformed with PRK1-GUS was identifed by histochemical GUS assay as having significant GUS activity in the pollen. In a random sample of 100 pollen grains, 22 were stained blue. In comparison, other individual PRK1-GUS plants showed 10 or fewer blue pollen grains in each sample.

Blue color indicating GUS activity was absent in the rest of the buds. The results of histochemical assays of the ovaries were inconclusive, because the blue color was not significantly more intense than in the negative control.

Immunolocalization

In a section of an ovary from a LAT52-GUS transgenic plant in which GUS has been immunolocalized, dark areas where the silver enhanced signal can be seen comprise the placenta of the ovary (Figure 2). The positive control (stage 4 LAT52-GUS pollen sections) exhibited intense silver enhanced signals in the pollen cytoplasm. The negative control (wild type S2S2 ovary showed no silver grains.

A few silver grains were observed in the ovules of PRK1-GUS transgenic plants, but the intensity of the signal was not high enough above background to draw any firm conclusions.

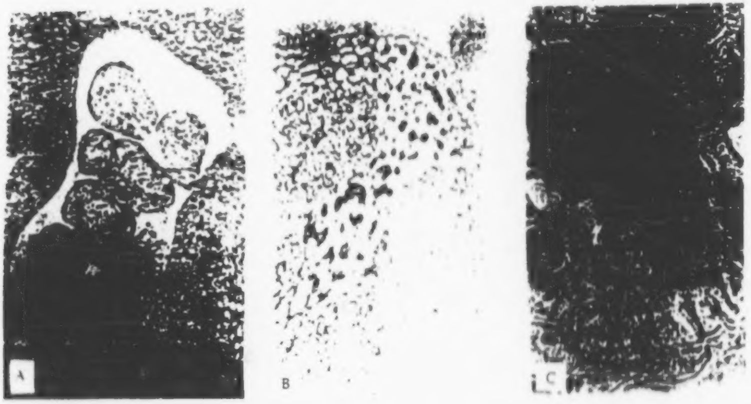

Figure 2: Immunolocalization of GUS with anti-GUS antibody, detected with secondary antibody with protein A-gold particle conjugate followed by silver enhancement. *A)* Immunolocalized section of wild type S2S2 ovary at 10X magnification (negative control). *B)* Section of LAT52-GUS ovary at 10X magnification. Placenta cells show silver enhanced signal, indicating GUS activity. *C)* Section of LAT52-GUS stage 4 anther showing GUS activity in pollen cytoplasm at 32X magnification (positive control).

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DISCUSSION

The temporal expression in pollen cytoplasm of the LAT52 promoter corresponded to the pattern previously reported (Lee et al., 1996). The temporal expression in pollen cytoplasm of the LAT52 promoter corresponded to the pattern previously reported (Lee et al., 1996). LAT52-GUS expression coincides with the onset of the self-incompatibility reaction in the pistil; therefore, this promoter is conducive to use in further self-incompatibility research. Further studies must be conducted to determine the implications of LAT52 expression in the placenta of the ovary.

Immunolocalization of PRK1-GUS in ovaries tentatively supports the results of Dr. H.S. et al. (manuscript in preparation, 1997) that the phenotype manifested in antisense PRK1 ovules is indeed caused by inactivation of the PRK1 pollen receptor-like kinase.

REFERENCES

Clarke, A.E. "Molecular Basis of Cell Recognition During Fertilization in Higher Plants." The Cell Surface in Plant Growth and Development. Cambridge, UK: Company of Biologists Ltd. 1985.

de Nettancourt, D. Incompatibility in angiosperms: Monographs on Theoretical and Applied Genetics. R. Frankel, G.A.E. Gall, and H.F. Linskens, eds. Berlin: Springer-Verlag, 1977.

Eady, C., Lindsey, K., and Twell, D. "Differential activation and conserved vegetative cell-specific activity of a late pollen promoter in species with bicellular and tricellular pollen." The Plant Journal. Vol. 5, p. 543-550, 1994.

Lee, H.-S. et al. "PRK1, a receptor-like kinase of *Petunia inflata*, is essential for postomeiotic development of pollen." The Plant Journal. Vol. 9, p. 613-624, 1996.

McClure, B.A., Haring, V., Ebert, P.R., Anderson, M.A., Simpson, R.J., Sakiyama, F., and Clarke, A.E. "Style self-incompatibility gene products of *Nicotiana alata* are ribonucleases." Nature. Vol. 342, p. 955-957, 1989.

Mu, J., Lee, H.-S., and Kao, T.-h. "Characterization of a pollen-expressed receptor-like kinase gene of *Petunia inflata* and the activity of its encoded kinase." Plant Cell. Vol. 6, p. 709-721, 1994.

Newbigin, E., Anderson, M.A., and Clarke, A.E. "Gametophytic self-incompatibility systems." Plant Cell. Vol. 5, p. 1315-1324, 1993.

Shivanna, K.R. and Johri, B.M. The Angiosperm Pollen: Structure and Function. New Delhi: Wiley Eastern Ltd., 1985.

Twell, D., Yamaguchi, J., and McCormick, S. "Pollen-specific gene expression in transgenic plants: coordinate regulation of two different tomato gene promoters during microsporogenesis." Development. Vol. 105, p. 705-713, 1990.

Investigating Temperature Sensitive Mutants of *Ustilago maydis*

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The Basidiomycete fungus *Ustilago maydis* causes disease on maize plants when haploid yeast-like cells mate to form the infectious dikaryon. There is evidence that the ability of the cells to mate is cell cycle dependent. One way to better study genes involved in cell cycle regulation is to characterize strains with mutations in their genes. Many of the genes involved in the cell cycle are essential, so our strategy for creating mutants is to screen for conditional mutations in essential genes. Mutants of *U. maydis* were generated by ultraviolet (UV) radiation treatment. Irradiated cells were replica plated at 22°C and 32°C. Cells that could grow at 22°C but not at 32°C have temperature sensitive mutations in essential genes. Over fifteen thousand colonies have been screened, and more than twenty temperature sensitive mutants were isolated. Two mutants were selected for further study. Their mutations were complemented by transformation, and the phenotypes of these mutants were also examined with light and epifluorescence microscopy.

INTRODUCTION

Ustilago maydis, a Basidiomycete fungus, belongs to the order Ustilaginales. This fungus causes a disease of the corn plant *Zea mays*. The infection usually affects the ears of young corn plants and is commonly called 'corn smut.' The characteristics and symptoms include the appearance of yellowing of tissues (chlorosis), production of dark masses of sooty spores that give rise to the name smut, and stunting of the plant (Christensen, 1963).

Ustilago maydis reproduces both sexually and asexually and exhibits three forms during its life cycle: the haploid sporidium, parasitic dikaryotic mycelium and the diploid teliospore. The sporidium form is unicellular, and reproduces by budding like yeast. It is easily grown on solid or liquid media. Like all eukaryotic cells, *U. maydis* must complete the cell cycle in order to reproduce.

Mutagenesis by UV radiation is an effective means of disrupting DNA (Miller, 1972). In order to obtain mutants affected in essential genes, such as those involved in cell cycle events, a strategy involving screening for mutants that are normal when grown under one set of conditions, but unable to grow under other conditions can be used. The most commonly used method involves screening for mutants that can grow at one temperature (the permissive temperature) but not at another (the restrictive temperature).

For effective mutagenesis by UV radiation certain factors must be considered. These include appropriate dosage to acquire maximum and effective kill rate (99-99.9%), appropriate cell density to allow random target and effective penetration of UV radiation to all cells, with resulting random mutations and confirmation of permissive and restrictive temperatures. Holliday (1964) was successful in the production of temperature sensitive auxotrophs, and we have adapted his procedure to seek mutants that have defects in genes involved with the cell cycle.

MATERIALS AND METHODS

The haploid *U. maydis* strain FB2 (Banuett and Herskowitz, 1989) was used for all experiments. Cultures were maintained on Difco Potato Dextrose Agar (PDA) and grown in Difco Potato Dextrose Broth (PDB) for these experiments.

UV mutagenesis -- A 10 ml overnight liquid culture was made and from this a 1:5 dilution using 1 ml of the cell culture and 4 ml sterile PDB was prepared and incubated for an additional 2 hr. The cells were centrifuged and resuspended in 10 ml sterile water. The optical density (OD) at 600 nm was determined and adjusted to 0.11 - 0.12 with sterile water if necessary. Dilutions of 10^{-1}, 10^{-2} and 10^{-3} were plated onto PDA in triplicate to determine the initial colony forming units per ml in the cell suspension. A UV Stratalinker 1800 was used to irradiate 4.0 ml of the cell suspension with ultra-violet light (254 nm). From this irradiated suspension dilutions were prepared as described above (10^{-1}, 10^{-2} and 10^{-3}) to determine the killing rate. The remaining irradiated cell suspension was diluted into PDB and incubated at 28° C with shaking for 2½ hr to allow one generation of growth. Twenty plates of PDA were inoculated with 100 µl of the irradiated cell suspension and incubated at 22° C for 72 hours.

After the 72 hr incubation, the number of colony forming units (CFU) per ml was determined for the suspension both before and after irradiation. The percentage survival was then calculated:

$$\frac{\text{CFU per ml at 78 }\mu\text{J x100\%}}{\text{CFU per ml at 0 }\mu\text{J}}$$

Colonies from suspensions with survival rates of 0.1 - 1% were replica plated onto two PDA plates. One plate from each pair was incubated at 22°C and the other was incubated at 32° C. Colonies which grew at 22° but not at 32° were suspected mutants, and were rescreened. Some temperature sensitive mutants were selected for complementation and further analysis.

Complementation of mutations -- To confirm that the mutant phenotypes resulted from a single mutation, a complementation test was performed. A library of BamHI fragments of wild-type FB2 chromosomal DNA, ligated into a plasmid which can replicate autonomously in *U. maydis*, was used to transform cultures of the mutant cells. Briefly, this involved protoplasting the cells using a chitinase (Novozyme) in an osmotically buffered medium (PDB supplemented with sorbitol). Protoplasts were mixed with aliquots of the wild-type *U. maydis* library on ice. Polyethylene glycol was added to promote uptake of the plasmids into the protoplasts. The transformed protoplasts were then plated onto regeneration medium (PDA plus sorbitol) containing the antibiotic hygromycin to select for transformants.

Transformants in which the plasmid DNA complemented the mutation were either selected directly by incubating the regeneration plates at 32° (the non-permissive temperature) or indirectly by first growing the transformants at 22°C and then incubating replica plates at 32°C. Transformants which were hygromycin resistant and capable of growth at 32°C were further examined to confirm that the plasmid DNA was responsible for the complementation. Transformants were grown for 10 or more generations in PDB without hygromycin. Under these conditions, the plasmid is not stable and is frequently lost (cured) from the cells. Hygromycin sensitive cells were then rescreened for their ability to grow at 32°C. If these cured cells were now temperature sensitive, then the chromosomal DNA in the plasmid did complement the mutation.

Microscopic examination of temperature sensitive mutants --A 10 ml culture of wild-type cells and of each mutant to be studied was prepared and incubated overnight at 22°C with shaking. The cells were then shifted to 32°C. The $O.D._{600}$ of the cultures was determined at 2.5 and 5 hr after transfer to the restrictive temperature. Cells were also stained with the fluorochrome DAPI, which is specific for DNA, and examined microscopically using Differential Interference Microscopy (DIC) and epifluorescence microscopy.

RESULTS

A kill curve was established by exposing cells to different amounts of radiation and then determining the percent survival at each dosage. The dosage which gave the desired survival rate of 0.1-1% was 75-80 µJ. This survival rate was chosen since it typically results in "single hit" mutations and reduces the likelihood of several different mutations occurring in the same cell (Miller, 1974). This dosage of radiation was used for all subsequent experiments. More than 15,000 colonies were screened and 20 temperature sensitive mutants were isolated. Two were selected for complementation and more detailed analysis. These mutants are here referred to as 15-25 and 28-44. Both mutations were complemented using the BamHI genomic library containing wild-type chromosomal DNA from FB2. When the complemented cells were cured of the plasmids the temperature sensitive phenotype was restored.

The effects of the two mutations were examined more closely by growing the cells at the permissive temperature and then transferring them to the restrictive temperature. Cellular and nuclear growth characters were compared with those seen in wild-type (FB2) cells that were treated in the same way.

As seen in Fig. 1, both mutants were extremely reduced in growth rate at 32° C compared with FB2. 28-44 cells doubled once before they stopped growing, and 15-25 cells did not even double before they stopped growth. Mutant 15-25 appeared completely normal at the permissive temperature (Figs. 2-3) but growth stopped quickly at the restrictive temperature. After five hr at the restrictive temperature, most cells were uninucleate and unbudded, or with a small bud (Figs. 4-5). Mutant 28-44 formed multiple buds, and cells remained attached either in clusters or short chains at the permissive temperature (Figs. 6-7). At the restrictive temperature, these cells became multinucleate (Figs. 8-9).

DISCUSSION

The two mutants complemented and described so far are similar in that their mutations are temperature sensitive and recessive, but the phenotypes are quite different. Mutant 15-25 grows normally at the permissive temperature but is unable to form mature buds at the restrictive temperature. The mutation giving rise to such a phenotype could be involved in cell-cycle regulation or with the establishment of cell polarity that is required for bud formation. Alternatively, this mutation could impair some step in metabolism which causes the cells to rapidly halt their growth. At this point it is not possible to speculate further on the exact effect of this mutation.

Mutant 28-44 has a multiple-budding phenotype, even at the permissive temperature. These buds differ from the rare, multiple budded cell observed in wild-type cultures in that the mutant forms multiple buds in a chain or in a stellate pattern at one or both poles. In wild-type cells, multiple buds are rarely observed, and typically consist of only one bud forming at each pole (data not shown). At the permissive temperature, this mutant appears to still regulate karyokinesis with cytokinesis since multinucleate cells were not typically observed (Figs. 6-7). The close link between nuclear division and bud formation is disrupted at the restrictive temperature of 32°C. At this temperature multinucleate cells, often with four or more nuclei, are frequently observed (Figs. 8-9). We believe that in these cells, a protein which links karyokinesis to bud formation is non-functional. The nuclear cycle thus proceeds at a maximal rate, creating new nuclei even though no buds have been formed. Thus, the extra buds formed at 22°C are due to an attempt by the cell to accommodate rapid nuclear proliferation. Alternatively, this mutant could be defective in new bud formation. This would account for both the multiple bud formation at the permissive temperature and the reduced bud formation at the non-permissive temperature. This defect would, however, also require a disruption in the normally tight link between nuclear division and bud formation in *U. maydis*. In another study it was found that wild-type cells must complete the S phase of the cell cycle before bud formation can initiate. If the mutation in this mutant involves bud initiation or positioning, then the multi-nucleate phenotype would also require a disruption of this linkage.

Current investigation of these mutants is focused on an analysis of the DNA fragments from the complementing plasmids. The goal is to define the minimum complementing region, determine its nucleotide sequence and examine any predicted products. Knowledge of these sequences may provide insights into the functions of these gene products through any homologies which they have to proteins of known function in other organisms.

LITERATURE CITED

Banuett, F., and Herskowitz, I. 1989. Different *a* alleles of *Ustilago maydis* are necessary for maintenance of filamentous growth but not for meiosis. Pro. Natl. Acad. Sci. USA 86: 5878-5882.

Christensen, J.D. 1963. Corn Smut caused by *Ustilago maydis*. The American Phytopathological Society. Monograph #2.

Forsburg S.L. and Nurse P. 1991. Cell cycle regulation in the yeasts *Saccharomyces cerevisiae* and *Schizosaccharomyces pombe*. Annual Reviews Cell Biology 7:227-256.

Holliday, R. 1964. Induced mitotic crossing over in relation to genetic response in synchronously dividing cells of *Ustilago maydis*. Genet. Res. Camb 6:104-120.

Holliday, R. 1974. in Handbook of Genetics (R.C King, ed.) Vol. 1 Plenum Press NY pp.575-595.

Miller, J.H. 1974. Experiments in Molecular Genetics, 2nd edition. Cold Spring Harbor NY pp: 121-124.

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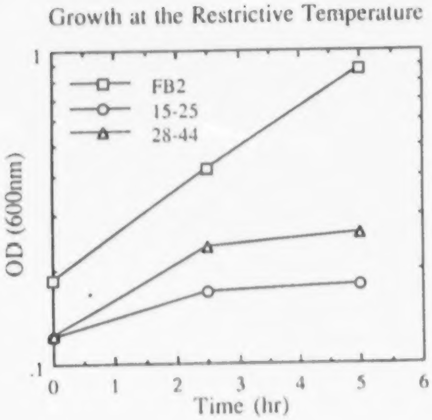
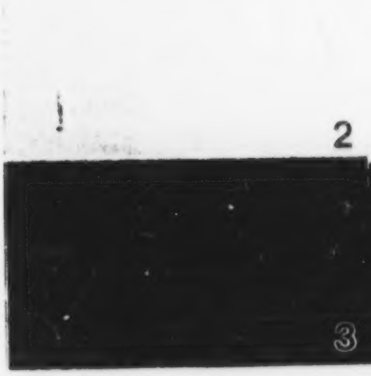


Fig. 1. Growth rate of cells at the non-permissive temperature. Two temperature sensitive mutants (15-25 [o] and 28-44 [Δ]) were grown in PDB at the permissive temperature (22°C) for several generations. The cultures were then shifted to the non-permissive temperature (32°C) and growth was measured by monitoring the optical density (OD) of the culture at 600nm. A culture of the wild-type parent strain, FB2 (❑), was treated similarly for comparison.



Figs 2-3. DIC (Fig 2) and epifluorescence (Fig 3) of the same field of cells of mutant 15-25 stained with the fluorochrome DAPI immediately after being shifted from 22° to 32°C

Figs 4-5. DIC (Fig 4) and epifluorescence (Fig 5) of the same field of cells of mutant 15-25 stained with the fluorochrome DAPI 5 hr after being shifted from 22° to 32°C. While many of the mutant cells had buds (Fig 4) these buds were smaller than those observed on cells growing at the permissive temperature (Fig 4). The 15-25 cells stop their nuclear cycle when their growth ceases, after 5 hr the cells were uniformly uninucleate (Fig 5).

Figs 6-7. DIC (Fig 6) and epifluorescence (Fig 7) of the same field of cells of mutant 28-44 stained with the fluorochrome DAPI immediately after being shifted from 22° to 32°C. Even when grown at the permissive temperature, large numbers of cells with multiple buds were present (Fig 6)

Figs 8-9. DIC (Fig 8) and epifluorescence (Fig 9) of the same field of cells of mutant 28-44 stained with the fluorochrome DAPI 5 hr after being shifted from 22° to 32°C. Cells with multiple buds are still present (Fig 8) although these cells and buds appear longer and thicker than at the permissive temperature (Fig 6). Frequently cells with many nuclei were observed at this point in the culture (Fig 9).

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Partial purification and properties of putrescine oxidase from *Candida albicans*

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Putrescine oxidase [PO; E.C. 1.4.3.4] which catalyzes the oxidative deamination of putrescine into γ-aminobutyraldehyde has been partially purified from *Candida guilliermondii*. Among the substrates tested, putrescine has the highest reaction rate followed by spermidine and cadaverine. The K_m values for putrescine, spermidine and cadaverine were 20 μM, 200 μM and 1.1mM, respectively. The optimum pH and the temperature for putrescine oxidase were 8.0 and 37°C, respectively. Growth of *Candida species* on putrescine as the sole nitrogen source induced the synthesis of putrescine oxidase that converts putrescine into Δ'- pyrroline and γ-aminobutyric acid. These two products were detected and identified from the culture medium. The enzyme was not activated by divalent cations. Among the tested species of *Candida*, highest enzyme activity was found in cell-free extracts of *Candida guilliermondii*.

INTRODUCTION

The diamine putrescine (1,4-diamine) and its aminopropyl derivatives, spermidine and spermine, found in various mammalian tissues and many microorganisms, have been implicated a wide variety of biological reactions, including synthesis of deoxyribonucleic acid (DNA), ribonucleic acid (RNA) and protein (Tabor and Tabor, 1976). Specifically, in fungi, spermidine and putrescine have been reported to be important nitrogen sources and regulators of growth (Haywood and Large, 1984, 1985). However, the exact function of the polyamines is not clear. The biosynthesis of these polyamines has been studied and reviewed (Taber and Taber, 1985). Nevertheless, pathways of putrescine degradation in microorganisms have not been surveyed in intricate detail.

Earlier studies indicate that there are two distinct pathways of putrescine degradation (Large, 1992) (Fig.1). In the non-acetylated pathway, putrescine is converted into Δ¹-pyrroline and γ-aminobutyric acid. The Δ¹-pyrroline is then oxidized by either diamine aminotransferase or Δ¹-pyrroline dehydrogenase into 4-aminobutyrate, which is converted to succinate semialdehyde. This compound is subsequently converted into succinate by semialdehyde dehydrogenase. Succinate can then be metabolized by normal cell metabolism (Large, 1992). The other pathway of putrescine degradation, the acetylated pathway, also yields 4-aminobutyrate, which is converted to succinate, but it goes through a different biological reaction. In this pathway, the polyamine is initially acetylated and then undergoes a series of enzymatic reactions, in which the nitrogen atoms are removed by a series of aminotransferases and oxidases. Specifically, in fungi, most of the oxidation is attributed to acetylputrescine oxidase. Finally, the molecule is deacetylated byacetamidobutryrate deacetylase and converted in 4-aminobutyrate. Haywood and Large (1985) reported that putrescine degradation in *Candida boidinii* occurred

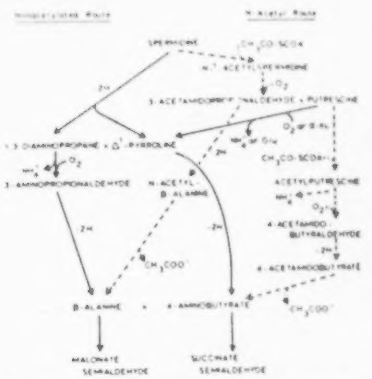

Fig 1. Possible routes for the breakdown of spermidine and putrescine in microorganisms. Broken lines denote the reactions of the *N*-acetyl route

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through this acetylated pathway. In this report, we show that putrescine degradation in an opportunistic yeast pathogenic to humans, *Candida guillermondii*, occurred by oxidative deamination of putrescine through the non-acetylated pathway. The optimal conditions and properties of partially purified putrescine oxidase are also presented.

MATERIALS AND METHODS

Chemicals:

Chemicals were purchased from Sigma Chemicals Co. St. Louis, Mo. and Aldrich, Wisc. [1-4- ^{14}C] putrescine dihydrochloride (specific activity, 72.50 mCi/mmol) was obtained from New England Nuclear Corporation, Boston, Mass.

Cultural Conditions:

Candida guilliermondii (ATCC #6260) was grown in a liquid medium which contained the following ingredients in grams per liter of deionized water: glucose 20; KH_2PO_4, 3.5; $MgSO_4.7H_2O$, 2.5; $CaCl_2$, 2.5; and biotin 30 µg. The nitrogen source used in various experiments was either ammonium sulphate, 2.5 g, or putrescine chloride, 1.0 g per liter of medium. Flasks (500 ml) containing 100 ml of synthetic medium were stoppered with foam plugs, autoclaved and inoculated with yeast suspension from a 16 hour old culture of *C. guilliermondii*. After incubation for the desired period of time at 37°C in a rotary shaker, the cells were harvested by centrifugation at 7000 x g for 15 minutes. Cells were washed with sterile saline and centrifuged again. Cell pellets were frozen or immediately used for enzyme extraction.

Enzyme extracts:

Crude enzyme preparations were obtained by disrupting cells suspended in 0.01 M potassium phosphate buffer, pH 7.2. Approximately 10 g of glass beads (0.45 to 0.5 mm) were added to 2 g (wet weight) of cells in pre-chilled 50 ml Braun glass homogenizing flasks. Cells were disrupted in a Braun disintegrator (Braun, Melsunger, Germany) using two 30-second bursts with a minute interval between bursts. The temperature of the flask chamber was maintained at approximately 4°C by a continuous flow of carbon dioxide. The disrupted cell mass was centrifuged at 20,000 x g for 20 minutes to remove cell debris, unbroken cells, and glass beads. The supernatant fluid was dialyzed in the cold against 100 volumes of buffer for 18 hours with three changes of buffer. The dialyzed extracts were stored at -20°C. Protein content was measured by the Bradford method using serum albumin as the standard (Bradford, 1976).

Putrescine oxidase (PO) assay:

The release of Δ'-pyrroline from putrescine by cell-free extracts was assayed by modifying the method of Shimizu et al. (1988) for putrescine oxidase. The reaction mixture contained 1.0 ml of 0.2 M Tris-HCl buffer, pH 8.0, 0.5 ml of 20mM putrescine, 0.3 ml of 0.1% O-amino-benzaldehyde and 0.5 ml of enzyme in a total volume of 3.0 ml. The assay was carried out at 37°C with continuous shaking and stopped with 0.5 ml of 50% trichloroacetic acid and 2.0 ml of absolute ethanol. The reaction mixture was filtered and the absorbency of the filtrate was measured at 435 nm. Enzyme activity was expressed as nmoles of Δ'-pyrroline produced per minute per mg of protein.

Enzyme purification:

Putrescine oxidase was partially purified from yeast cells of *Candida guilliermondii* by modifying the method of Yamada (1971) and DeSa (1972). The cells were ground and the enzyme was extracted with 0.01 M phosphate buffer, pH 7.0. The cell free extract was then fractionated with ammonium sulfate (40%-60% saturation). The precipitate was suspended in phosphate buffer and then dialyzed for 48 hours against 4 changes of one liter of phosphate buffer. The dialyzed enzyme was then applied to a DEAE-cellulose column (7x50cm) and equilibrated with phosphate buffer. The enzyme was eluted with 0.1 M phosphate buffer, pH 7.0, containing 0.1M NaCl. The fractions were pooled and concentrated by the addition of ammonium sulfate (70% saturation) and dialyzed again. The dialyzed enzyme was then applied to a DEAE-Sephadex (A-50) column (5.5x 6.5 cm) and equilibrated with phosphate buffer. After removal of impurities, the enzyme was eluted with 0.1 M phosphate buffer, containing 0.3 M NaCl. The fractions were then pooled and concentrated by addition of ammonium sulfate (70% saturation). The enzyme was finally dialyzed for 48 hours against four changes of 5 liters each of 0.01 M phosphate buffer, pH 7.0.

Determination of optimum conditions for PO from *Candida guilliermondii*:

The effect of temperature on PO activity was measured by incubating the reaction mixtures at various temperatures ranging from 15 to 50°C. The effect of pH on enzyme activity was measured by adjusting the pH of the substrate using three types of buffers (Citrate-phosphate, Tris-maleate and glycine-sodium hydroxide) over a pH range from 4 to 9.5 under standard enzyme assay conditions.

Identification of PO reaction products:

Using [1-4- ^{14}C] putrescine, the products of the PO reaction was separated by thin layer chromatography (Haywood and Large, 1985). The reactive spots on the thin layer plates were carefully removed with a razor blade, mixed with liquid scintillation fluid and counted in the ^{14}C channel of Beckman LS 1801 liquid scintillation counter.

All the experiments were repeated at least three times and the mean values are given. Samples were analyzed in duplicates. The assays were reproducible within 10% of the standard deviation of the mean values.

RESULTS AND DISCUSSION

Although their mechanism of action still remains unclear, polyamines are widely regarded as central in the cellular growth process (Tabor and Tabor, 1985). Putrescine, in particular, has been shown to be an important nitrogen source and growth factor in fungi (Tabor and Tabor, 1984). Because of the central role polyamines play in cell proliferation, there have been numerous studies on polyamine synthesis and ornithine decarboxylase, as well as polyamine degradation and polyamine oxidases ((Tabor and Tabor, 1976, 1984, 1985). Only recently, however, have studies been done on putrescine degradation and putrescine oxidase in fungal systems (Haywood and Large, 1984, 1985).

Recent studies have postulated that there are two pathways, namely, acetylated and non-acetylated pathways of putrescine degradation in different organisms. Both pathways finally create 4-aminobutyrate, but through different processes. In most higher eukaryotic organisms, polyamine catabolism has been shown to proceed through the non-acetylated pathway (Large, 1992). Recently, however, studies have shown that putrescine catabolism in two species of *Candida*, *Candida boidinii* and *Candida nagoyaensis*, have occurred through the acetylated pathway (Haywood and Large, 1986). In this study, the pathway of putrescine degradation by putrescine oxidase in *Candida guilliermondii* was studied by using the ^{14}C-labelled putrescine as a substrate and measured the the production of γ-aminobutyric acid (GABA), a product in the non-acetylated pathway. This investigation revealed that putrescine degradation does indeed occur through the non-acetylated pathway. GABA was labelled with ^{14}C and was measured in the culture medium and in cell free extracts of *C. guilliermondii*. The data are presented in Table 1.

Table 1. Isolation of ^{14}C-labelled γ-aminobutyric acid (GABA) from culture medium and cell free extracts of *C. guilliermondii*

Putrescine added:	5 X 10^{6} cpm
Putrescine left in the medium:	2.07 X 10^{6}
Putrescine utilized:	2.93 X 10^{6}
Total counts from cell free extracts:	4.3 X 10^{5}
Counts in GABA:	1.1 X 10^{5}
Total counts from culture filtrates:	20.7 X 10^{5}
Counts in GABA:	8.0 X 10^{5}
Total Counts in GABA:	9.1 X 10^{5}
% Conversion:	18.2

Over half of the putrescine added was utilized by the cells. Nearly twenty percent of the putrescine was converted into GABA. It was interesting to note that there was a much larger count of GABA in the culture filtrate (8 times) as in the cell free extract. This is consistent with other studies in fungi that have reported a similar pathway for putrescine breakdown (Haywood and Large,1986, Yamada, Isobe, and Tani, 1980).

Furthermore, the activity of putrescine oxidase was surveyed in six different *Candida* species, and purified and characterized from *Candida guilliermondii*. The specific activity of putrescine oxidase was measured in six species of *Candida*, *Candida albicans*, *Candida guilliermondii*, *Candida krusei*, *Candida tropicalis*, *Candida parapsilosis*, and *Candida stellatoidea*, and the data are presented in Table 2. The growth of the organisms was predominantly the same; interestingly enough, *Candida guilliermondii* did have strikingly less growth than the other organisms. However, in terms of the specific activity of putrescine oxidase, *C. guilliermondii* did have far greater activity than the other organisms. The activity of *C. tropicalis* was nearly as high as in *C. guilliermondii*; the other four organisms showed significant activities as well. From these data, it seems very possible that putrescine degradation in these other organisms may proceed through the non-acetylated pathway. Further investigation is necessary to confirm this hypothesis.

Table 2. The specific activity of putrescine oxidase from different *Candida* species with putrescine as the substrate.

Organisms	Growth (g)	Specific activity*
Candida albicans	2.65	241
Candida guilliermondii	1.95	409
Candida krusei	2.35	307
Candida tropicalis	2.55	398
Candida parapsilosis	2.45	246
Candida stellatoidea	2.15	125

* Δ'-pyrroline n moles/mg protein

Putrescine oxidase from *C. guilliermondii* was also partially purified and characterized. The optimum pH for enzyme activity was 8.0, and the optimum temperature was 37°C. Again, the data were consistent with previous studies that reported optimum pH and temperature to be in that range (Yamada, Isobe, and Tani, 1980). The M_r of PO from *C. guilliermondii* was determined by gel filtration to be 50, 000 which was also consistent with previous reports in fungi and in higher organisms (Ishizuka, Horinouchi, Beppu, 1993). Prior studies had also reported that divalent cations had served to inhibit enzyme activity. We found that divalent cations had no significant effect on the activity of putrescine oxidase from *C. guilliermondii* (Yamada, Isobe, and Tani, 1980). The substrate specificity was also tested, using five different substrates, putrescine, spermidine, cadaverine, spermine, and histamine. The data are presented in Table 3.

Table 3. Specific activity, amount of oxidation, and K_m, of putrescine oxidase from *Candida guilliermondii*, with different polyamine substrates.

Substrate	Specific Activity*	Percent of Oxidation	Apparent K_m (mM)
Putrescine	407	100	0.02
Spermidine	210	52	0.20
Cadaverine	192	47	1.10
Spermine	7	2	N.D
Histamine	0	0	N.D

* Δ'-pyrroline n moles/mg protein
N.D. = Not determined

The enzyme showed activity with only putrescine, spermidine or cadaverine as a substrate; the activity with putrescine was twice as high as the activity with either spermidine or cadaverine. The K_m values for putrescine, spermidine, and cadaverine were 0.02 mM, 0.20 mM, and 1.10 mM, respectively. Use of spermine and histamine showed no activity. Based on these data, these two polyamines show potential as competitive inhibitors of putrescine oxidase.

The breakdown and utilization of polyamines, such as putrescine, in fungal systems still remains extremely incomplete. Further work needs to be done to better understand the role of polyamines as growth factors and organisms' ability to utilize them.

ACKNOWLEDGMENTS

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REFERENCES

Bradford, M. M. 1976. A rapid and sensitive method for the quantification of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem. 72: 248-254.

De Sa, R.J. 1972. Putrescine oxidase from *Micrococcus rubens*. Purification and properties. J. Biol. Chem. 247: 5527-5534.

Haywood, G.W. and Large, P. J. 1984. Partial purification of a peroximal polyamine oxidase from *Candida boidinii* and its role in growth on spermidine as sole nitrogen source. J. Gen.Microbiol. 130: 1123-1136.

Haywood, G.W. and Large, P. J. 1985. The occurrence, subcellular localization and partial purification of diamine acetyltransferase in the yeast *Candida boidinii* grown on spermidine or putrescine as sole nitrogen source. Eur. J. Biochem. 148: 277- 283.

Haywood, G.W. and Large, P. J. 1986. 4-Acetamidobutyrate deacetylase in the yeast *Candida boidinii* grown on spermidine or putrescine as sole nitrogen source and its probable role in polyamine catabolism. J. Gen. Microbiol. 132: 7-14.

Ishizuka, H. Horinouchi, S. and Beppu, T. 1993. Putrescine oxidase from *Micrococcus rubens:* primary structure and *Escherichia cali.* J. Gen. Microbiol. 139: 425-432.

Large, P.J. 1992. Enzymes and pathways of polyamine breakdown in microorganisms. FEMS Microbiol. Rev. 88: 249-262.

Shimizu, E., Tabata, Y. Hayakawa, R. and Yorifugi. 1988. Specific measurement of putrescine with putrescine oxidase and aminobutyraldehyde dehyrogenase. Agric. Biol. Chem. 52: 2865-2871.

Tabor, C. W. and Tabor, H. 1976. 1,4-Diaminobutane (putrescine), spermidine, and spermine. Annu. Rev. Biochem. 45: 285-306.

Tabor, C. W. and Tabor, H. 1984. Polyamines. Annu. Rev. Biochem. 53: 749-790.

Tabor, C. W. and Tabor, H. 1985. Polyamines in microorganisms. Microbiol. Rev. 49: 81-99.

Yamada, H. 1971. Putrescine oxidase (*Micrococcus rubens*). Methods. Enzymol. 17B: 726-730.

Yamada, H. Isobe, K. And Tani, Y. 1980. Oxidation of polyamines by fungal enzymes. Agric. Biol. Chem. 44: 2469-2476.

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Role of Host Plants in Egg Hatching of the Soybean Cyst Nematode

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Heterodera glycines, the Soybean Cyst Nematode, is a major pest of the soybean crop. Hatching of *H. glycines* eggs occurs spontaneously over a long period of time or more quickly in response to root diffusates from host plants. Little is known about the physiological factors that effect the efficacy of the plant's diffusates on hatching. In order to test the role of macronutrients on host plants, diffusates were collected from plants that were grown hydroponically. Plants were fed a modified Hoagland's solution with different levels of the macronutrients calcium and magnesium. Diffusate from plants treated with moderate levels of calcium hatched more nematodes than plants treated with low or high amounts of calcium. Magnesium treatment did not produce any dosage related effects. The role of photoperiodism was also investigated by treating nematode eggs with diffusates derived from plants grown in 8 hour and 14 hour photoperiods. The plants grown in the short photoperiod hatched fewer eggs than those grown under the long photoperiod. Additionally, hatching of encysted eggs and cyst free eggs treated with cyst fluid and cyst homogenates was less than cyst freed eggs.

INTRODUCTION

The cyst nematode *Heterodera glycines* is a destructive obligate endoparasite of soybean plants. Since there are no lasting means for control of these worms, the range of this parasite is increasing. The control of this organism is difficult because it has a life cycle with several stages that are not accessible for experimentation. Females produce eggs that are either located in external sacs or encysted in their bodies. Those eggs located in the cyst can remain dormant for long periods of time withstanding unfavorable conditions. When exposed to proper stimulation, the eggs are released from diapause and the larvae emerge from the eggs. When the eggs in the cyst are stimulated, permeability of the eggshell increases and trehalose is released. The trehalose concentration is thought to play an important role in maintaining dormancy and protecting against desiccation by regulating water content (Clark and Perry, 1981). When trehalose is released, the water uptake of the juvenile can occur due to the lowering of osmotic stress. Aside from permeability changes, enzymatic changes to the eggshell are necessary for eclosion (Perry, 1989).

Certain substances act as hatching stimulants. Salts of zinc and root diffusate of the soybean plants have been found to increase the permeability of the egg and to cause a greater percentage of hatch. Chelation of the root diffusate by EDTA has been shown to potentiate the response to root diffusates.

Environmental conditions and nutrient status of host plants may play a role in the efficacy of plant diffusates or have a direct role in the development of the nematode within the plant. For this reason, investigation of the effects that photoperiodism and macronutrient deficiency had on the diffusates produced from the roots of host plants were conducted. Photoperiodism may be an important cue in the synchronization of host-parasite life cycles. Exposure of host plants to long photoperiods has been shown to effect the hatching of the closely related potato cyst nematode (Hominick, 1986).

When plants lack certain macronutrients, development and viability are compromised. Two such macronutrients are magnesium and calcium. Magnesium has an effect on the photosynthetic process and its deficiency results in the presence of early maturity, chlorotic, and spotted leaves. Calcium also has an effect on the viability of the plant due to its involvement in photosynthesis and membrane integrity. Plants grown hydroponically were exposed to a wide range of calcium and magnesium prior to the collection of diffusates.

In addition to the host plant influencing the rate of hatching and development of these parasites, the cyst environment may play a role in the establishment and maintenance of diapause. Okada (1978) suggested there were factors in the cyst fluid that inhibited egg hatching in *H. glycines*.

MATERIALS AND METHODS

Nematodes were collected from infested soybean plants (William's var.) grown in a climate controlled greenhouse. The infected soil was sieved (mesh 250 μm) and cysts were collected by hand under a dissecting microscope. Where appropriate, eggs were freed from cysts and stored at ambient temperature in water. Soybean root diffusates were collected from uninfected plants grown in pots of sterile sandy loam soil or hydroponically in one liter containers. Plants were removed from the solutions or soil, rinsed, and placed in small flasks with distilled water. After 24 hours, the volume of the liquid was measured (ml), and the roots were weighed (g). The diffusates were quantified in root gram hour / ml (RGH).

In order to determine the effects of the macronutrients on the efficacy of root diffusates to stimulate hatching of *H. glycines* eggs, soybean plants were grown hydroponically in nutrient solutions with six different dosages of magnesium sulfate (1.25 - 250 μM) and calcium nitrate (1.7 μM-1.7 mM) salts. The anions chosen were already in abundance. Four plants were grown for each treatment until reaching the late reproductive stage at which time root diffusates were collected. Egg hatching was assessed by exposing nematode eggs for two weeks to the various diffusates with and without 3.0 mM EDTA (in order to chelate divalent cations) in small test tubes. All diffusates were calibrated to a final concentration of 2.0 RGH. Solutions were changed three times during the incubation. Three aliquots of eggs were treated with zinc chloride (known hatching agent), with distilled water, and with 3.0 mM EDTA to serve as controls. After two weeks of incubation, the ratio of larvae hatched to eggs was determined for each tube.

It has been speculated that the environmental conditions of host plants may have effects on reproduction in cyst nematodes. To determine the effect that photoperiodism may have on host plant diffusates in stimulating the hatching of *H. glycines* eggs, soybean plants were reared in controlled growth chambers under 8 hr. light/16 hr. dark cycle and 14 hr. light / 10 hr. dark cycle. Fecundity was assessed by inoculating ten potted plants grown under the two light conditions with equal aliquots of eggs from 150 cysts. Plants were grown until flowers appeared and then the total number of nematode cysts was determined for each infected plant. To test the effect of photoperiod on the efficacy of host plant diffusates to induce hatching, root diffusates were obtained from another group of plants grown hydroponically in the two different light regimes. An egg hatching study was then set up to test diffusate from each plant with and without EDTA. Controls consisted of egg aliquots incubated in double distilled water, 3.0 mM $ZnCl_2$, and 3.0 mM EDTA. All controls were run three times. After two weeks of incubation, the ratio of hatched larvae to eggs was determined for each tube.

As a preliminary study to examine the effects of the cyst environment on egg hatching, the hatching of encysted eggs was compared to cyst free eggs. Individual cysts or the eggs from individual cysts were placed in wells of microtiter plates. Hatching was assessed over a two week period and compared. Additionally, fluid was collected from cysts in which hatching occurred and from cysts in which hatching occurred at a low rate. A separate batch of eggs was exposed to this fluid and hatching was assessed. Finally, eggs were exposed to homogenates made from cyst walls in order to see if exposure to the cyst wall affected hatching. Homogenates were tested boiled and unboiled. Data were analyzed by Student's t-test or ANOVA and the $p<0.05$ level was considered significant.

RESULTS

Experiments were done to determine the hatching rate of cysts treated with root diffusate from plants grown with selected concentrations of the macronutrients calcium and magnesium. A total of 24 plants were grown in a magnesium free nutrient solution supplemented with a range of 6 concentrations from 1.25 μM - 250 μM magnesium sulfate. The plants raised with the lowest concentration (1.25 μM) were discarded due to a low survival rate. The root diffusate collected from the remaining 20 plants was used to treat eggs either alone or in combination with EDTA. The hatching percentages ranged from 13.35%-35.7%. The highest percent hatching rate occurred in eggs treated with root diffusate collected from plants treated with 2.5 μM magnesium sulfate. The lowest percent hatching occurred in the eggs treated with a combination of root diffusate and EDTA from plants treated with 2.5 μM Mg. However, there was no dosage related trend in the efficacy of diffusates from plants treated with different levels of magnesium. The root diffusates were collected from a total of 18 out of 24 plants (three from each treatment) that were grown in a range of 5 concentrations of calcium nitrate (17μM - 1.7mM). The diffusates were used to treat eggs either alone or in combination with EDTA. The hatching percentages ranged from 10.26%-34.04%. The lowest percent hatching occurred in eggs treated with root diffusate collected from the plants treated with the complete solution. Percent hatching of eggs treated with root diffusate collected from plants treated with an intermediate amount of calcium was higher than small or large amounts of calcium. Overall, EDTA potentiated the response of eggs to diffusate, Figure 1.

The eggs treated with root diffusate collected from plants grown in the long photoperiod showed an almost equivalent rate of hatching as the water control, even with the addition of EDTA. The percentage hatching was 68.5% for both long photoperiod treatments. In contrast, the percentage of hatching for the eggs treated with root diffusate collected from those plants raised in the short photoperiod were lower. Those eggs treated with root diffusate alone decreased to 48.7% hatching. Eggs treated with both root diffusate and EDTA showed an even lower percent hatch of 38.8%, Figure 2. The mean fecundity of nematodes raised on plants exposed to short photoperiod (89.9 cysts/plant) was significantly higher than nematodes reared on plants exposed to a long photoperiod (144.9 cysts/plant).

Encysted eggs that were incubated for two weeks in double distilled water or in the hatching stimulant zinc hatched less than cyst freed eggs. Cyst freed eggs incubated in double distilled water showed a higher percentage of hatch (13.3%) than encysted eggs (3.9%). The cyst freed eggs hatch at 65% for the zinc treated compared to 35% for the encysted eggs, Figure 3. Eggs were treated with cyst fluid and cyst wall homogenates to see if hatching could be inhibited. Eggs that were treated with cyst fluid and zinc hatched 49% compared to 75% hatching in eggs treated with zinc alone, Figure 4. When cyst wall homogenate was added to eggs, the hatching in water decreased from 48.6% to 35.3% for the unboiled and 25.1% for the boiled homogenates.

DISCUSSION

There seemed to be no dosage related trend in the efficacy of diffusates from plants treated with different levels of magnesium or calcium. However, the diffusates collected from plants grown with an intermediate amount of calcium seemed to increase hatching of the eggs. Since calcium and magnesium play such a pivotal role in the overall physiology of the plant it is difficult to speculate on a mechanism. However, the fact the chelated diffusate causes a potentiated effect obviates a direct role played by the divalent ions in the diffusate. It is known that EDTA increases the permeability of nematode eggshells and this may be what potentiates its effect. The eggs treated with diffusate collected from the plants grown in a long photoperiod had a higher percent hatching than those eggs treated with diffusates collected from plants grown in a short photoperiod. This effect may be mediated by factors released by the host plant and used as an environmental cue to regulate diapause in this parasite.

Synchronizing life cycle with season and host development would increase the reproductive success of this parasite.

Interestingly the number of cysts on plants reared in the short photoperiod was higher compared to plants reared in long photoperiod. These differences in infestation suggest that cues from the host may be influencing the development or success of infection. Experiments are under way to examine the effects of other photoperiod regimes.

Encysted eggs hatched less than eggs that were freed from the cyst. Cyst fluid and homogenates made from cyst walls also decreased the percentage of nematode egg hatch. This could mean that the cyst environment, whether it is the cyst wall or the fluid inside the cyst, may have a role in maintenance of diapause of the eggs.

LITERATURE CITED

Hominick, W.M.(1986). Photoperiod and Diapause in the Potato Cyst-Nematode, *Globodera rostochiensis*. *Nematologica*. 32:408-418.

Okada, T.(1972). Hatching Inhibitory Factor in the Cyst Contents of the Soybean Cyst Nematode *Heterodera glycines* Ichinohe (Tylenechida: Heteroderidae). *Applied Entomology and Zoology*. 7:99-102.

Perry, R.N.(1989). Dormancy and Hatching of Nematode Eggs. *Parasitology Today*. 5(12):377-383.

Tefft, P.M., and Bone, L.W.(1985). Plant-Induced Hatching of Eggs of the Soybean Cyst Nematode *Heterodera glycines*. *Journal of Nematology*. 17(3):275-279.

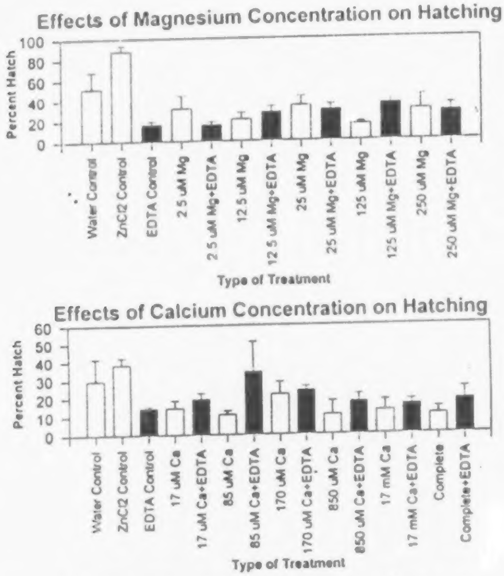

Figure 1: Comparison of percent hatching of eggs treated with root diffusate (2 RGH) collected from plants raised in different concentrations of the indicated macronutrient. Percent hatch = # of larvae per sample / # of unhatched eggs per sample.

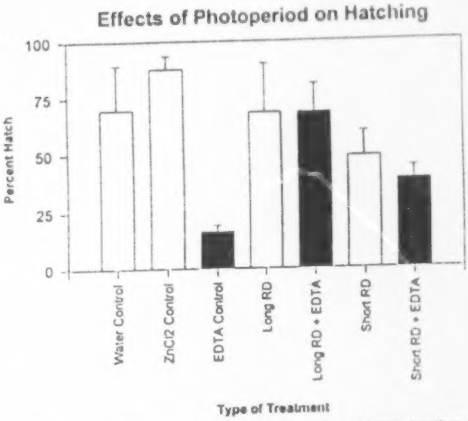

Figure 2: Comparison of percent hatching of eggs treated with root diffusate (2 RGH with or without 3.0 mM EDTA) collected from plants raised in a long photoperiod (14 hours) vs. root diffusate collected from plants raised in a short photoperiod (8 Hours). Percent hatch = # of larvae per sample / # of unhatched eggs per sample.

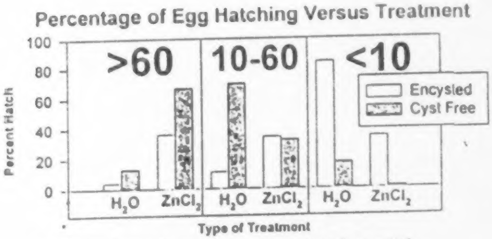

Figure 3: Comparison of percent hatching of encysted versus cyst free eggs using either double distilled water or 3.0 mM $ZnCl_2$ treatment. Percent hatch = larvae hatched / # of wells per treatment.

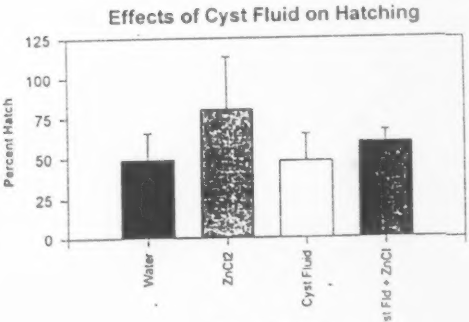

Figure 4: Comparison of percent hatching of eggs incubated with cyst fluid versus eggs incubated without cyst fluid using either double distilled water or 3.0 mM $ZnCl_2$. Percent hatch equals # of larvae / # of unhatched eggs after treatment.

Coat Protein Analysis of Tomato Mosaic Virus (ToMV)

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ABSTRACT

The coat proteins of tomato mosaic virus (ToMV) belonging to the tobamovirus group were characterized by polyacrylamide gel electrophoresis and Western blot analysis, followed by serological probing. The virus isolate had a major coat protein of about 21,000 daltons and a minor coat protein of about 14,400 daltons, both of which reacted with ToMV-specific antisera in Western blot analysis. ToMV RNA extracted from purified virions and translated in the rabbit reticulocyte lysate (RRL) system using tRNA-mediated biotin labelling (Amersham), produced proteins of various sizes, but only two polypeptides, of about 21,000 and 14,400 daltons, were immunoprecipitated with ToMV-specific antiserum. Dot blot analysis using biotinylated ToMV polyclonal antibody allowed for the detection of the virus in crude plant preparations.

INTRODUCTION

A variety of agricultural crops including tomato (*Lycopersicon esculentum*) are easily infected by tomato mosaic virus (ToMV) (Brunt, 1986). Tomato mosaic virus symptoms are known to be caused by several strains of the tobacco mosaic virus. Most of these strains cause local lesions when inoculated into appropriate test plants (for review see Broadbent, 1976). In the Netherlands, eight distinct strains were identified in tomato, based on symptom expression (Rast, 1975).

Recently, a long, rod-shaped virus was isolated from naturally infected tomato plants exhibiting light green mosaic symptoms (Barthel et al., 1996). The purified virus was extremely stable and the disrupted RNA was highly infectious (Barthel et al., 1996). Crude sap preparations from such tomato plants typically produced local lesions when *Chenopodium quinoa* and *Nicotiana glutinosa* were inoculated with the virus. The virus was classified as a member of the tobamovirus group based upon host range, virus morphology, molecular weight of the coat protein (21,000 daltons), and the approximate size of the genomic RNA (6.2 kilobases) (Barthel et al., 1996).

Although there is no known invertebrate vector (Gibbs, 1977), the virus spreads rapidly under field conditions through routine cultural practices (Broadbent, 1976). ToMV is a stable soil and waterborne RNA virus. Widespread transmission of ToMV has been reported in Red spruce in the eastern United States (Costello et al., 1995), through fog and clouds. In this paper, we report on the expression of tomato mosaic viral genome in the cell-free system. Polyproteins and viral-specific coat proteins were analyzed by Western blot analysis using polyclonal antibody to ToMV.

MATERIALS AND METHODS

Virus purification and SDS-Polyacrylamide gel electrophoresis

The ToMV isolate used in this study was obtained from naturally infected tomato (*Lycopersicon esculentum*) plants from Aberdeen, South Dakota. Virus was subsequently established and propagated in *Nicotiana clevelandii* kept in an environmental growth chamber maintained at 27°C with 16 hour lighting. Virus was purified from *N. clevelandii* as described earlier (Barthel et al., 1996). Proteins were separated by discontinuous SDS-polyacrylamide gel electrophoresis (SDS-PAGE) using 12.5% acrylamide in the resolving gel, according to the method of Laemmli (1970). Prior to loading onto the gel, the purified virus pellet was resuspended in 0.06 M Tris-HCl (10 microliters per gram fresh weight), pH 6.8 and combined with 10% glycerol, 2% sodium dodecyl sulfate (SDS), 5% 2-mercaptoethanol, and 0.00125% bromophenol blue. The samples were heated for five minutes in boiling water. To visualize the coat proteins, a portion of the gel was sliced and stained with coomassie blue. Mid-size molecular weight protein markers ranging in size from

97,400 daltons to 14,400 daltons (Promega Corp., Madison, WI) were also electrophoresed under the same conditions.

Polyclonal antibodies to ToMV were produced in New Zealand white inbred rabbits. Three intramuscular injections were given at six day intervals followed by two intravenous injections at seven day intervals. For each intramuscular injection, 1 mg of purified virus, resuspended in 0.5 ml of 0.01 M phosphate buffer, pH 7.2, were emulsified with 0.5 ml Freunds adjuvant. Serum was collected three weeks after the final intravenous injection.

Western blotting and Serological detection

After electrophoresis, the resolving gel containing the proteins was electroblotted to Hybond ECL (Amersham, IL) nitrocellulose membrane as recommended by the manufacturer with few modifications. Membranes were soaked in distilled water and equilibriated in protein transfer buffer (25 mM Tris, 192 mM glycine, pH 8.3). Electroblotting was performed overnight using a 40 mA current at 4°C. Blots were air dried and stored between sheets of 3 mm paper wrapped in Saran Wrap at 4°C until use. For immunodetection optimum concentrations of primary (1:750) ToMV antibodies and secondary (1:1500) biotinylated ToMV antibodies were used. ToMV secondary antibodies were biotinylated as described by the manufacturer (Amersham, IL). ToMV polyclonal antibodies at a concentration of 1 mg/ml were incubated in biotinylation reagent (supplied by the manufacturer) for one hour. The protein was obtained by eluting the solution through a Sephadex G-25 column in aliquots, and measuring the optical density at 280 nm. The blots were incubated with ToMV primary and biotinylated secondary ToMV antibody at various time intervals. The blots were washed each time in Phosphate buffered saline (PBS), pH 7.5 containing 0.1% (v/v) Tween-20. A 1 microgram/ml solution of preformed streptavidin-horseradish peroxidase conjugate was then added to the membrane and incubated for 1 hour at room temperature. After washing 3 times in PBS-Tween (15 minutes each), horseradish peroxidase activity was observed using the principle of enhanced chemiluminescence (ECL). ECL detection reagents were added and luminography was done using Hyperfilm ECL in Kodak X-OMat cassettes.

RNA purification and *in vitro* translation

Freshly purified virus preparations were dissociated by incubation in RNA dissociation buffer (0.1M Tris-HCl, pH 9.0, 2mM EDTA, 1% SDS) for 10 minutes at 60°C. The preparation was quick cooled in an ice-water bath, phenol was extracted, and the product was precipitated as described elsewhere (Bharathan et al., 1992). Translation of ToMV RNA in the rabbit reticulocyte lysate (RRL) system was performed as described by the manufacturer (Amersham, IL) unless noted otherwise. A standard 50 microliter translation mixture consisted of 4 microliters of translation mix minus lysine, 2 microliters of 2.5M potassium acetate, 1 microliter of 25mM magnesium acetate, 1 microliter of biotin-lys-tRNA and 20 microliters of rabbit reticulocyte lysate. Up to 8 micrograms of ToMV RNA was used in 50 microliters of reaction mixture. The reaction mixtures were incubated at 30°C for 60 minutes, and the reactions were terminated by adding three volumes of protein disruption buffer. The translation products were denatured and analyzed by SDS-PAGE and electroblotted to nitrocellulose membrane as described earlier. The membrane was incubated with preformed streptavidin-HRP conjugate and luminography was performed as described for Western blot analysis.

RESULTS AND DISCUSSION

Coat protein

Semipurified preparations from ToMV infected *N. clevelandii* showed, through use of SDS-PAGE, a major protein band of 21,000 daltons (Fig. 1A, lane 3) and one minor band of 14,400 daltons. Neither of these two proteins was present in similar preparations from healthy plants (Barthel et al., 1996). In ultrapurified virion preparations, a 21,000 dalton protein was identified as being the major protein (Fig. 1A, Lane 1). In addition to the 21,000 coat protein, ToMV RNA may encode for three nonstructural proteins of 30,000, 130,000, and 165,000 daltons (Leonard and Zaitlin, 1982). The *in vitro* translation of ToMV RNA in the present study using the RRL system, stimulated incorporation of HRP conjugated streptavidin into proteins 30-50 fold higher than endogenous controls. The major translation products, as determined through SDS-PAGE, ranged in size from 21,000 daltons to 14,400

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daltons (Fig 1A. lane 2) The translation products were analyzed by immunoprecipitation. and this confirmed the translation of a 21.000 dalton protein (Fig 1B. lane 1) The translation products were detected due to their ability to react with streptavidin-HRP. which detected the biotinylated lysine present in the translation products Some of these products were similar in size to the proteins seen in coat protein analysis (Fig. 1A. lane 3) The translation products did not reveal the presence of large size nonstructural proteins (Fig 1B. lane 1) Protein bands representing both 21.000 dalton and 14.400 dalton proteins reacted strongly with polyclonal antibodies specific to ToMV in Western blot analysis (Fig 1C. lanes 1.2. and 3) Similar results were observed when dot blot analysis. using crude sap obtained from ToMV infected tobacco plants as well as purified virus. was performed (Fig. 2A. columns b-f. Fig 2B. columns b-g) No reaction was observed with healthy sap preparations (Figs 2A & 2B. column a)

Reducing agents like Dithiothreitol (DTT) are known to promote proteolytic cleavage of viral RNA translation products (Pelham. 1979. Yeh and Gonsalves. 1985) In the present study the aliquots with and without DTT yielded the same translation product profile with no apparent high molecular weight protein (data not shown) Western blot analysis using crude healthy sap and ToMV infected sap showed sensitivity to 10^{-6} dilution of the infected sap There was little or no signal with the healthy sap Thus. in this study. two viral proteins. translated from ToMV RNA. were identified serologically Work is currently being done to construct a genomic map of the viral RNA. and to determine the proteolytic processing pathway of its translation products

REFERENCES

Barthel. J . Ehli. E.. Huber. V . Bharathan. S . and Bharathan. N Proceedings. Tenth National Conference on Undergraduate Research. Characterization of Tomato Mosaic Tobamovirus isolated from Tomatoes pg 1416-1419 1996

Bharathan. N and Tavantis. S.M Phytopathology. Genetic diversity of double stranded RNA in *Rhizoctonia solani* Vol 80. pg 631-635 July. 1990

Broadbent, L Annual Review Phytopathology. Epidemiology and control of tomato mosaic virus. Vol 14. pg 75-97 1976

Brunt. A.A Tomato mosaic virus. pg 181-204 in: The Plant Viruses Vol 2 M H Van Regenmortel and H Frankel-Conrat. eds Plenum Press. New York 1986

Brunt. A A . Crabtree. K.. Dallwitz. M J.. Gibbs. A.J.. Watson, L.. and Zurcher. E J (eds)(1996 onwards) Plant Viruses Online Descriptions and Lists from the VIDE Database Version 16th January. 1997 URL http biology anu edu au Groups MES vide

Castello. J D.. Lakshman. D K.. Tavantzis. S M.. Rogers. S O.. Bachand. G D . and Liu. Y Phytopathology. Detection of infectious tomato mosaic tobamovirus in fog and clouds. Vol 85. pg 1409-1412 Nov 1995

Gibbs. A.J 1977 Description of Plant Viruses Commonwealth Mycological Institute Association of Applied Biologists. Kew. England

Hollings. M.. and Huttinga. H Tomato Mosaic Virus Description of Plant Viruses No 156 Commonwealth Mycological Institute Association of Applied Biologists. Kew. England 1976

Leonard. D A.. and Zaitlin. M.. A temperature strain of tobacco mosaic virus defective in cell-to-cell movement generates an altered viral coded protein Virology 117 416 1982

Pelham. H R B Synthesis and proteolytic processing of Cowper mosaic virus proteins in reticulocyte lysate Virology 96 463-477 1979

Rast. A T B Variability of tobacco mosaic virus in relation to control of tomato mosaic in glasshouse tomato crops by resistance breeding and cross protection Agri. Res. Rep Wageningen. 834 1975

Yeh. S D.. and Gonsalves. D Translation of papaya ring spot virus RNA *in vitro*: Detection of a possible polyprotein that is processed for capsid protein. cylindrical inclusion protein and amorphous-inclusion protein Virology 143: 260-271 1985

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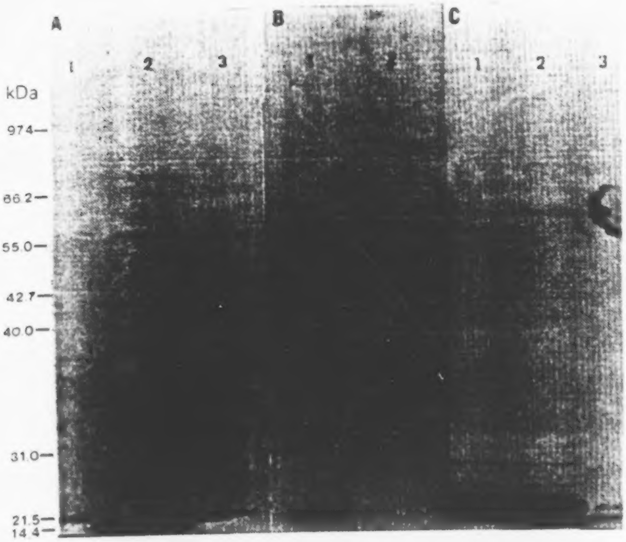

Fig 1 A. **Polyacrylamide gel electrophoresis of ToMV coat protein.** Lane 1 represents the purified viral coat protein. Lane 2 is the *in vitro* translation products from the RRL system and Lane 3 is crude protein from ToMV infected *Nicotiana clevelandii* leaves. The numbers on the left are markers with relative molecular masses in kilodaltons of phosphorylase B, bovine serum albumin, ovalbumin, carbonic anhydrase, soybean trypsin inhibitor, and lysozyme.

B. Analysis of the *in vitro* translation products of tomato mosaic virus RNA using the rabbit reticulocyte lysate (RRL) system with biotinylated tRNA containing lysine. Products were separated by SDS-PAGE and detected by streptavidin-HRP using the principle of enhanced chemiluminescence (ECL). Lane 1 shows the translation products from ToMV RNA. Lane 2 shows the translation products obtained when no ToMV RNA was present during *in vitro* translation.

C. Western blot analysis of crude protein from ToMV infected tobacco plants and of the products of *in vitro* translation. The two samples of crude protein from ToMV infected plants and the sample containing the products from *in vitro* translation, were separated by SDS-PAGE and blotted onto a hybond nitrocellulose membrane as described in the Materials and Methods section. The proteins present on the membrane were precipitated with ToMV secondary antibodies labeled with biotin and detected by streptavidin-HRP using the principle of enhanced chemiluminescence (ECL). Lane 1 and 2 contained the crude protein from ToMV infected tobacco plants. Lane 3 contained the translation products obtained from ToMV RNA using the RRL system.

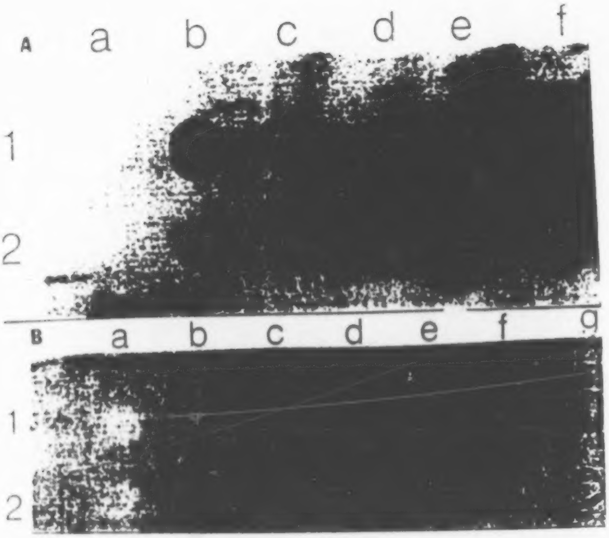

Fig. 2 A. Crude protein from both healthy and ToMV infected tobacco plants were spotted in duplicate onto a hybond nitrocellulose membrane and probed with antibodies to ToMV as described in the Materials and Methods section. Spots 1a and 2a contained crude protein from healthy tobacco plants, where as all other spots: 1b, 2b, 1c, 2c, 1d, 2d, 1e, 2e, 1f, and 2f, contained crude protein from ToMV infected tobacco plants.

B. Crude protein from healthy tobacco plants and purified viral protein isolated from infected tobacco plants was spotted in duplicate onto a hybond nitrocellulose membrane and probed with antibodies to ToMV as described in the Materials and Methods section. Spots 1a and 2a contained crude protein isolated from healthy tobacco plants, where as all other spots: 1b, 2b, 1c, 2c, 1d, 2d, 1e, 2e, 1f, 2f, 1g, and 2g, contained purified ToMV protein isolated from infected tobacco plants.

Feeding Behavior of the Tropical Stick Insect *Extatosoma tiaratum*: A Study in Palatability of Thirty-one North American Plants

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The feeding behavior of *Extatosoma tiaratum* was studied, with emphases on determination of food preference and the effect of food selection on insect growth and development. Food preference tests established that the insects were generalist feeders, feeding on nineteen species in ten plant families. This represented sixty-one percent of the total plant species tested. Growth and development data suggest that the insects are much more specialized. Although willing to feed on a fairly broad spectrum of plant species, the insects were able to reach full maturity on a much smaller number of plants. Even on plants on which they were able to develop, the insects showed a large variability in weight gain, indicating that not all of the species were equally desirable as feeding substrates.

INTRODUCTION

Feeding behavior is one of the keys to survival in any animal species. It is also one of the major ways in which many animal populations interact with human populations as we compete for limited food and other natural resources. If we are to interact successfully with insects, either in the interests of conservation or control, it is important to understand the mechanisms which regulate their feeding behavior. One of the primary characteristics of the feeding behavior of any species is the width of its feeding spectrum, that is, how varied are the potential foods from which it can successfully extract nutrients.

Extatosoma tiaratum was used as a model system to investigate feeding behavior, especially the process of food selection and how food resource selection affects the growth and development of the organisms. Through previous research these stick insects are known to feed on a few species of eucalyptus in their native Australian habitat (Korboot 1961; Carlberg 1987), while other host plants have been found to be acceptable under laboratory conditions (Carlberg 1987, 1988).

MATERIALS AND METHODS

The feeding behavior of *Extatosoma tiaratum* was studied using a combination of food preference tests and data on growth and mortality. All food plants were obtained locally. A total of thirty-one host plant species from seventeen families were tested. Insects were obtained as eggs and reared in either large plastic cups or hanging netted cages. Insects were fed fresh leaves from their assigned host plant daily and kept at room temperature under ambient light conditions.

Food Preference

Leaves from two different species of plants were placed in a testing arena. Leaves were adjusted to comparable sizes by trimming or including multiple leaflets depending on the species. Insects at various instars reared on various host plants were tested individually for a twenty-four hour period. At the end of the twenty-four hour trial, leaves were scored as either noticeable feeding or no noticeable feeding. The total number of leaves tested was then calculated as well as the number fed upon and not fed upon. The overall percentages of feeding and no feeding from all trials were calculated and used as the expected values in chi-square tests for significance.

Growth and Mortality

As eggs hatched, nymphs were placed ten to a cup on the assigned host plants. Leaves were left with stem intact and placed in testtubes of water to maintain their condition. Leaves were replaced daily and any newly molted individuals were collected and weighed. Weighed insects were placed in a new container. Dead insects were removed. When food plants were no longer available all remaining instars were killed.

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RESULTS

Food Preference

The food preference results showed significant differences in acceptability. If the insects do show a preference, then it would be expected that some leaves would be fed upon proportionally more and some leaves proportionally less than the average observed in all of the trials. If no preference existed the expected results would show that each species was fed upon the same relative number of times. The chi-square results showed specific species were consumed significantly more times than all other tested species. Some species were fed upon significantly fewer times than all other test species. A few species showed no significant difference. Twelve species were fed upon significantly more often than the other species, seven showed no significant difference and nine were eaten significantly fewer times than the others. These plants were then classified into three groups: completely acceptable, moderately acceptable, and not acceptable (Table 1).

Table 1: Classification of Food Plant Preference Based on the Relative Frequency of Feeding

Completely Acceptable		Moderately Acceptable		Not Acceptable	
Basswood *Tilia americana*	<.01	Blackberry *Rubus allengheniensis*	>.05	Big Tooth Aspen *Populus grandidentata*	<.01
Birch *Betula papyrifera*	<.01	Black Locust *Robina pseudoacacia*	>.05	Elderberry *Sambicus canadensis*	<.01
Black Cherry *Prunus serotina*	<.01	Boxelder *Acer negundo*	>.05	Green Ash *Fraxinus pennsylvanica*	<.01
Elm *Ulmus americana*	<.01	Gray Poplar *Populus canescens*	>.05	Honeysuckle *Lonicera canadensis*	<.01
Gooseberry *Ribes cynosbati*	<.01	Hazelnut *Corylus americana*	>.05	Lombardi Poplar *Populus nigra*	<.01
Ironwood *Ostrya virginiana*	<.01	Raspberry *Rubus idaeus*	>.05	Prickly Ash *Zanthoxylum americanum*	<.01
Pea Shrub *Caragana arborescens*	<.01	Sugar Maple *Acer saccharum*	>.05	Virginia Creeper *Parthenocissus quinquefolia*	<.01
Red Oak *Quercus rubra*	<.01			Wild Grape *Vitis riparia*	<.05
Rose *Rosa multiflora*	<.05			Willow *Salix pedicellaris*	<.01
Sumac *Rhus glabra*	<.01				
Walnut *Juglans nigra*	<.01				
White Oak *Quercus alba*	<.01				

Growth and Mortality

Growth data showed that insects raised on Raspberry ultimately weighed more than insects raised on any other plant. Insects fed Raspberry were not, however, invariably the largest. After the first few molts several insects fed on other plants had higher average weights than those fed Raspberry. Average weight gains for insects fed on the three different plant categories (Table 1) are shown in Figure 1. Insects raised on five of the plant species (Basswood, Birch, Ironwood, Raspberry and Red Oak) reached the adult stage. Insects fed on twelve plant species (Ginko, Sugar Maple, Virginia Creeper, Black Locust, Green Ash, Prickly Ash, Wild Grape, Elderberry, Honeysuckle, Gray Poplar, Fern, and Lilac) did not complete the molt to the second instar. Insects survived but did not reach adulthood, within the time period of the experiment, on the eleven remaining plants (Elm, Rose, Pea Shrub, Black Cherry, Hazelnut, Sumac, Gooseberry, Walnut, Willow, White Oak, and Boxelder).

DISCUSSION

Extatosoma tiaratum in captivity feeds on a broad enough variety of plants to be clearly labeled a generalist feeder by several authors' definitions. However, the rearing experiments suggest that the insect is capable of normal growth and development on a much more narrow range of host plants. Based on these results there does not seem to be a strong connection between food plant acceptance rates and insect developmental performance (Figs. 1 & 2). Insects chose species in the food preference experiments that did not result in high survival or growth rates in the growth and mortality experiments. This may be indicative of a historically generalist species on the way to becoming a specialist. In this process the insects

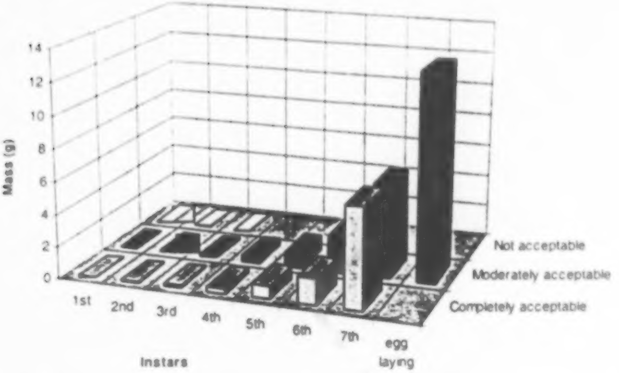

Figure 1: Average Masses (g) of Instars on Host Plants of Different Acceptability Levels (Table 1)

have undergone physiological changes and have lost their ability to successfully feed and survive on many species. However, due to the low diversity of plants other than *Eucalyptus* in their native habitat, the insects have not been under a strong selective pressure to develop an ability to discriminate among various potential food plants.

Knowledge of the acceptability of potential host plants for an insect species will enable future research to focus on why certain plants are chosen over others and the implications of these choices on survival.

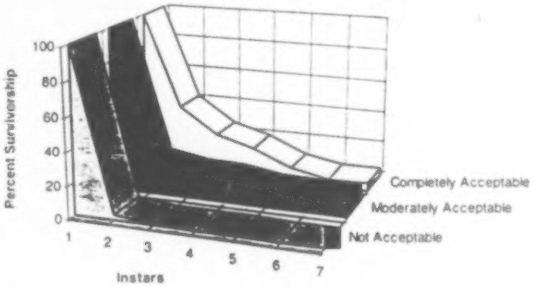

Figure 2: Instar Survivorship on Host Plants of Different Acceptability Levels (Table 1)

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REFERENCES

Carlberg, U. 1988. Food consumption in *Extatosoma tiaratum* (MacLeay) (Insecta: Phasmida). Zool. Anz. 220:195-202.

Carlberg, U. 1987. Culturing Stick and Leaf Insects (Phasmida) A Review. Z. Versuchstierkd. 29:53-54.

Korboot, K. 1961. Observations on the life histories of the stick insects *Acrophylla tessellate* Gray and *Extatosoma tiaratum* MacLeay. Vol 1:161-169.

Monitoring the Release of Acid Phosphatase in Pitcher Plant Fluid After Feeding With Insects

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Pitcher plants are carnivorous plants which digest insects in large, pitcher-like leaves which fill with rainwater. The plants secrete a variety of digestive enzymes into the pitcher fluid to digest insects. The purpose of this research is to study secretion of the enzyme acid phosphatase into the pitcher fluid.

The pH was determined, and acid phosphatase production was assayed in fed and unfed pitchers. The pH of the pitcher fluid dropped over time in both fed and unfed pitchers. Significant release of acid phosphatase into the pitcher fluid of the fed plants was observed, but little enzyme was released into the unfed pitchers. When EGTA, a calcium chelater, was included in the fed pitcher fluid, there was initially little effect, but by the seventh day after treatment, the pitchers with EGTA had significantly less enzyme activity.

INTRODUCTION

The purple pitcher plant, *Sarracenia purpurea*, is an insectivorous plant found in damp, boggy soils which are deficient in nitrates and phosphates (West, no date). This plant uses nectar glands to attract insects down into its water filled trap. Nectar is produced throughout the plant, but is concentrated around the mouth and veins on the hood (Lloyd, 1942, Joel, 1986). The pitchers can be divided into four regions. The first zone at the outer end of the leaf encompasses the nectar glands which most likely serve to attract insects toward the trap (Cipollini et al., 1994). The second zone is below the first and also contains nectar glands which serve to lure the insects farther down into the plant. Hairs in this region point downward making the footing difficult for the insect. Region three is smooth, and glands in this region produce digestive enzymes. The last region contains hairs which point upward making it difficult for the captured insect to escape.

Once insects are trapped within the fluid filled pitchers, digestive enzymes are released which break them down to release their nutrients. Several different enzymes including chitinase, protease, amylase and acid phosphatase work in combination to break down the insects (Clancy and Coffey, 1977). In this experiment, acid phosphatase was chosen as the enzyme with which to monitor secretion.

Although pitcher plants secrete acid phosphatase, it is difficult to characterize exactly which types of the enzyme are found within the pitchers, and the enzyme was not studied further. The activity that we measured may have been due to one or several enzymes. Since the pH of the pitchers is normally low, acid phosphatase activity was chosen for the assay. The assay yielded p-nitrophenol as the final product. This product was proportionate to the amount of enzyme produced in solution.

The secretion processes of plants, and the ions that are involved, have been the subject of recent experimentation. Much evidence has been found over the past decade which indicates the importance of free calcium ions in the secretion process (Bush, 1993, Poovaiah and Reddy, 1993, Bowler and Chua, 1994, Gilroy and Trewavas, 1994). Through the use of fluorescent calcium sensitive dyes, non-ratiometric dyes, and ratiometric dyes, the levels of calcium ions has been measured in the plant cells (Webb et al., 1996). Just as with animal cells, calcium ions are an integral part of the plant secretion process (Webb et al., 1996). EGTA, a calcium chelater, was used in this experiment to monitor the effects of calcium ion availability and secretion.

MATERIALS AND METHODS

Acid Phosphatase Assay. Two ml of pitcher fluid was put in a test tube, one ml of acid phosphatase buffer was added. Tubes were then incubated at 37 degrees Celsius. After 60 minutes, five ml of 0.1 M NaOH was added to the test tube to stop the reaction. The absorbance was measured on a spectronic 20 spectrophotometer (Clancy and Coffey, 1977).

pH Experiment. Six plants were randomly selected, and their pitchers were rinsed with de-ionized water. Half were randomly chosen for feeding. All live pitchers for each plant were filled with de-ionized water. Those being fed received eight fruit flies (*Drosophila melonogaster*) that were sacrificed by freezing. The initial pH of the de-ionized water was tested before being added to the plants. The pH of the pitcher fluid was determined four and six days after filling.

EGTA Experiment. Twenty-eight pitcher plants were randomly assigned to one of four treatments: (1) water without flies, (2) water with flies, (3) 1.0 mM EGTA without flies, (4) 1.0 mM EGTA with flies. Once the twenty-eight plants were assigned to a group, one from each was randomly assigned to its own block. Thus, there were seven blocks, each of which contained four plants. Three pitchers from each plant were then randomly chosen. The pitchers from each plant were thoroughly rinsed with de-ionized water and filled with their appropriate solutions. Those designated to be fed were given 10 fruit flies each. Two ml of pitcher fluid was assayed for acid phosphatase at daily intervals. After removal of fluid for each daily assay, the pitchers were drained and re-filled with the appropriate solutions. Flies that were removed from the fed pitchers while being drained were replaced so that the total number remained at ten.

The pH was tested using unpaired and paired t-tests. Data for the EGTA experiment were analyzed using repeated measures ANOVA. Block effects were not significant (P=0.15), and the data were reanalyzed to examine the main effects of feeding, EGTA, and their interactions.

RESULTS

pH Experiment. The pH of the de-ionized water added to the pitchers averaged 6.42. The pH of the fluid in the pitchers was determined four and six days after it was added to the pitchers. The average pH of the pitcher fluid for each plant is shown in Table 1.

TABLE 1. The average pH (± 1 SE) of pitcher fluid after four and six days.

Treatment	Four Days	Six Days
fed	4.8 ± 0.09	4.0 ± 0.24
unfed	4.9 ± 0.35	4.6 ± 0.07

Fed and unfed plants did not differ significantly on day 4 (t-test, P=0.73), but were close to significance by day 6 (P=0.056). The solutions in the pitchers became more acidic than the initial solution that was added to the pitchers. After six days, the pH ranged between 3.5 and 4.7.

EGTA Experiment. This experiment was set up as seven blocks, each containing one plant from each of the four treatment groups. Statistical analysis showed that there were no significant block effects, so the data were reanalyzed with the block term removed to increase the error degrees of freedom. Repeated measures ANOVA showed a significant effect of adding flies (P=0.0001), however, the overall effect of EGTA (P=0.43) and the interaction term (P=0.42) were not significant.

A significant increase in enzyme production occurred when flies were added to the pitchers. Those plants that did not receive fruit flies all produced low levels of acid phosphatase throughout the experiment. In the unstimulated plants, the amounts of p-nitrophenol produced were very similar day after day. Since the pitcher fluid was removed and replaced each day, in the absence of stimulation acid phosphatase appears to have been secreted at a constant low rate. When stimulated by flies, there was a lag period of about two days before acid phosphatase began to be secreted at enhanced levels (Figure 1). In this experiment, secretion rates leveled off between four and six days, but then increased again on day seven in the absence of EGTA. In other experiments (data not shown) acid phosphatase secretion peaked earlier, between four and six days after feeding.

Despite the fact that the overall effect of EGTA was not significant, inspection of time trends suggests a strong effect occurring on day 7. We subsequently conducted ANOVAs for each day were conducted significant effects were found for EGTA only on day 7 (P values for days 1-6 range from .46 to .93, P for day 7 = 0.0002).

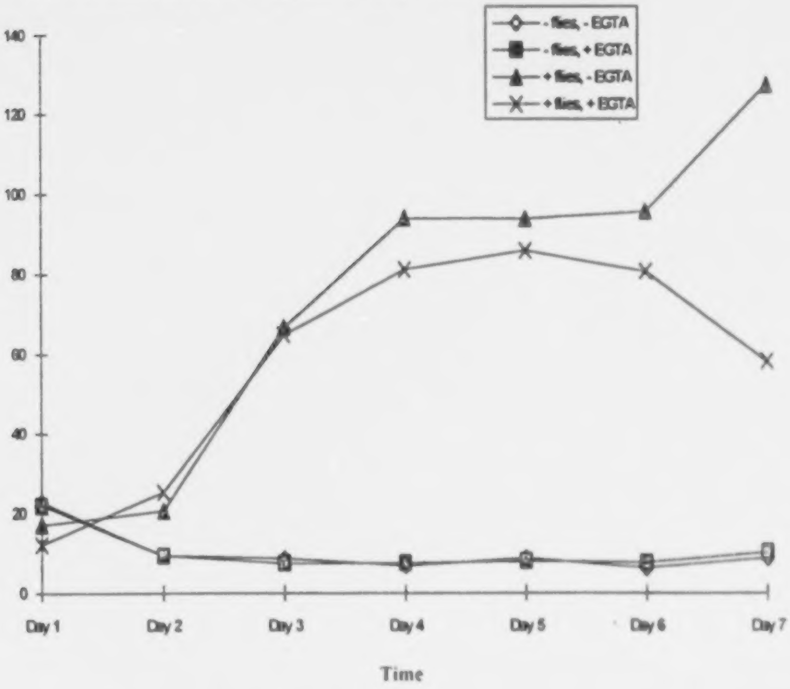

Figure 1 The Average Amount of p-nitrophenol, in nanomoles, produced over Seven Days

DISCUSSION

The pH of the pitcher fluid decreased over time, indicating that the pitcher is an acid environment into which H+ is probably actively secreted by the plant. This has been found by (Tokes et al., 1974). Most species of pitcher plants have pH's that fall between 3.0 and 4.5 (Tokes et al., 1974), and after the sixth day, our pH fell mostly within the expected range. The reason for the low pH may be to keep bacterial growth down. Although yeasts are known to be present in the pitcher fluid, bacteria are not as common, and we seldom noticed turbid pitcher fluid which would indicate excessive bacterial growth.

We found that pitchers have a low acid phosphatase activity when unstimulated, but that the stimulation of having insects in the pitchers increases the amount of acid phosphatase by approximately 5-10 fold. This has been seen in other carnivorous plants as well (Clancy and Coffey, 1977). Since calcium ions are known to be required for most cellular secretion events, we were interested in the role that the calcium ions in pitcher plant secretion. Fed plants treated with EGTA initially showed no difference from fed plants not treated with EGTA, but after seven days, a difference was apparent with treated plants secreting significantly less acid phosphatase. The reason for the delay in the EGTA effect is unknown. It may be that it took seven days for the EGTA presented externally to have an effect on the internal calcium ion concentration.

REFERENCES

Bowler, C. and Chua, N.H. 1994. Cyclic-GMP and calcium mediate phytochrome phototransduction. Cell 77, 73-81.

Bush, D.S. 1993. Regulation of cytosolic calcium in plants. *Plant Physiology* 103, *7-13.*

Cipollini Jr , D , S Newell and A Nastase 1994 Total carbohydrates in nectar of *Sarracenia purpurea L.* (Northern pitcher plant) *Am Midl. Nat.* 131 374-377

Clancy, G , Coffey, M 1977 Acid phosphatase release by the insectivorous plant *Drosera rotundifolia Can. J. Bot.* Vol 55

Gilroy, S and Trewavas, A J 1994 A decade of plant signals *Bioessays* 16, 677-682

Joel, D M 1986 Glandular structures in carnivorous plants their role in mutual and unilateral exploitation of insects, p 219-234 In B E Juniper and T R E Southwood (eds) Insects and the plant surface Edward Arnold, London and Baltimore, Maryland

Llyod, F E 1942 The carnivorous plants Reprinted in 1972 by Dover Publications, Inc , New York 352 p

Poovaiah, B W and Reddy, A S N 1993 Calcium and signal transduction in plants *Critical Reviews in Plant Sciences* 12, 185-211

Tokes, Z , W Woon and S Chambers 1974 Digestive enzymes secreted by the carnivorous plant *Nepenthes macferlanei* L *Planta* 119 39-46

Webb, A R , Mcainsh, M R , Taylor, J E , Hetherington 1996 Calcium Ions as Intracellular Second Messengers in Higher Plants 45-96 *Advances in Botanical Research* Vol 22

West, W No date Carnivorous plants Carolina Biological Supply Company Reprinted from Carolina Tips 3-4 p

Elucidating Mechanisms of Pulmonary Fibrosis: Intracelluar and Extracellular Events when the Platelet-derived Growth Factor Receptor System is Up-regulated by Air Pollution Particles and Interleukin 1-beta (IL-1β).

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Man-made particles present in urban areas are associated with increases in several inflammatory lung diseases, including asthma, bronchitis, and pulmonary fibrosis. Air pollution particles were collected from several urban sites in the U.S., Canada, and Mexico. These were tested for their ability to stimulate lung macrophages to release factors that induce the platelet-derived growth factor (PDGF) receptor system on rat lung fibroblasts in a paracrine manner. PDGF is a major mitogen for lung fibroblasts and is important in repairing tissue damage in the lung, but it is also a factor in pulmonary fibroproliferative diseases. Using Western blot analysis of rat lung fibroblast (RLF) PDGF receptors alβha (PDGF-Rα) and beta (PDGF-Rβ), we discovered that the urban particle samples induced macrophages to secrete factors that up-regulated PDGF-Rα; this has been associated with the enhanced proliferation of lung fibroblasts. The PDGF-Rβ was not increased by treatment with macrophage supernatants.

In addition, we studied the role of protein kinase C (PKC), an intracellular second messenger that appears to be involved in the up-regulation of PDGF-Rα on fibroblasts. PKC is activated by interleukin 1-beta (IL-1β), a growth factor or cytokine released by stimulated macrophages. Using cell fractionation and Western blotting techniques on RLFs, we demonstrated that the isozyme PKC alpha (PKC α) is mobilized from the cytosol to the membrane, as soon as 10 minutes after exposure to IL-1β. Determining how the receptor is induced extracellularly and intracellularly could aid in understanding the mechanisms of lung inflammation.

INTRODUCTION

A variety of inhaled agents in the environment can cause lung injury, resulting in an inflammatory response. This inflammatory response may lead to tissue repair which is mediated by cell-derived factors termed growth factors or cytokines. Over-expression of certain cytokines may cause lung fibrosis. Pulmonary fibrosis is characterized by fibroblast proliferation and increased extracellular matrix deposition (1). While bacterial infection, endotoxin, or foreign particles (organic and inorganic) cause lung inflammation, such a response attempts to build a wall around the infection or foreign particles, preventing their spread. However, it is this natural response that causes pulmonary fibrosis and several other inflammatory lung diseases (2).

Alveolar macrophages, immune cells in the lung, release cytokines or growth factors which play a crucial role in the regulation of fibroblast replication. Platelet-derived growth factor (PDGF) and interleukin 1-beta (IL-1β) are released by activated macrophages and stimulate fibroblast mitogenesis (3, 4). PDGF consists of three isoforms made from two polypeptide chains (A and B) which are linked by disulfide bonds, forming AA, AB, and BB dimers. The site for binding is provided by PDGF receptor alpha (PDGF-Rα) and PDGF-R beta (PDGF-Rβ) subunits in the cell membrane. Isoform PDGF-Rββ can only bind PDGF-BB, while PDGF-Rαβ can bind PDGF-AB and -BB. PDGF-Rαα can bind all three isoforms (5). PDGF-Rα is the more sensitive subunit, not just because it can bind both polypeptide chains, but because it induces maximal chemotaxis and mitogenesis (6, 7). In normal rat lung fibroblasts (RLF), the PDGF-Rα is barely expressed, PDGF-Rβ being the sole cell receptor (8). IL-1β causes the up-regulation of PDGF-Rα in lung fibroblasts (7).

Since residual oil fly ash (ROFA), an industrial emission source combustion particle, has been shown to cause fibrosis (9-11), other environmental pollution particles derived from industrial sources may be fibrogenic. We treated rat lung macrophages with air pollution particles *in vitro* and studied the effect of macrophage conditioned media (MØCM) on the rat lung fibroblast receptor system. Induction of the PDGF receptor system was used as a measurement of the fibrogenic potential of air pollution particles.

The major factor that induces PDGF-Rα in MØCM obtained from particle-stimulated macrophages is IL-1β (12). Since IL-1β is an established inducer of PDGF-Rα (7), the role of the second messenger protein kinase C (PKC), a multi-functional enzyme that is specific to certain cell types and cell functions, was examined in rat lung fibroblasts during IL-1β exposure. Certain isozymes, enzyme subunits, have been shown to play a role in cell proliferation. The inactive forms of the isozymes are usually located in the cytosol and are mobilized to the membrane (particulate) when activated, as shown in T-helper type II cells (13), II9 fibroblasts (14), Swiss/3T3 fibroblasts (15), and renal mesangial cells (16).

MATERIALS AND METHODS

Environmental Particle Treatment

Cell Preparation and Membrane Extraction: Rat lung fibroblasts were grown in 10% FBS-DMEM (Fetal Bovine Serum-Dulbecco's Medium) to confluence in 75 cm^2 flasks. The cells were rendered quiescent in SFDM (serum free defined medium) for 24 hours and treated with macrophage conditioned media (MØCM) collected from rat macrophages after a 24 hour exposure to pollution particles. A 0.10 X solution of macrophage medium was made up in 15 ml SFDM, as well as an IL-1β solution (positive control) and SFDM (control) solutions (Table 1). The solutions were removed after 24 hours, and the cells were rinsed with PBS (Phosphate Buffer Solution). To lyse the cells, 250 µl of lysis buffer was added to the flasks which were stored in the cold room (4° C) for 20 minutes. Western analysis was performed on collected samples; the platelet-derived growth factor receptors alpha and beta (PDGF-Rα and PDGF-Rβ) proteins were probed.

Table 1. Description of the lysate samples collected from confluent RLF treated with 0.1X MØCM

Lysate Samples
1. SFDM (Serum Free Defined Media)--15 ml
2. IL-1β (10 ng/ml)
3. MØCM (control)
4. MØCM (Washington D.C. PM)
5. MØCM (St. Louis PM)
6. MØCM (Ottawa PM)
7. MØCM (Mexico City PM)
8. MØCM (Residual Oil Fly Ash--ROFA)

PKC Assay

RLFs were prepared as stated above. Examination of the expression or mobilization of PKC α in both cytosol and membrane fraction was performed more exactly by following a cell fractionation protocol (14). Confluent, quiescent fibroblasts in T175 flasks were treated with IL-1β at six time points (0 min, 1 min, 5 min, 10 min, 30 min, 60 min). The same step of washing and aspirating with 15 ml of PBS per flask was performed. To increase the concentration of cells, two 175 cm^2 flasks were used for each time point, collecting a total of 1 ml of lysate (500 µl per flask) for fractionation experiments. One ml of lysate buffer A [25 mM Tris (pH 7.5), 2 mM EDTA, 0.5 mM EGTA, 1 mM DTT, 20 µg/ml leupeptin, 20 µg/ml aprotinin, 1 mM PMSF, and 0.2 mg/ml Triton X 100] was added, and the flasks were rocked for 20 minutes in the cold room. Cells were removed using cell scrapers. A 15 ml dounce homogenizer and pestle was used to homogenize the lysate 10 times. Lysates were centrifuged 100,000 x g for 30 minutes at 4°C in a Beckman TLA 3 fixed angle ultracentrifuge rotor. The supernatant was collected and labeled as the cytosolic fraction. One ml of buffer A supplemented with 10 mg/ml Triton X 100 was added to the remaining pellet. The suspension was sonicated for 5 seconds, rocked for 30 minutes at 4-6°C, and centrifuged at 100,000 x g for 30 minutes. The collected supernatant was labeled as membrane (particulate) fraction. In some cases, a speed vac was used to concentrate the particulate portion with the intention of gaining a stronger signal.

Western analysis was performed on both the cytosolic and particulate fractions using anti-PKC alpha (anti-PKC α). The primary anti-PKC α (1:750) in 3% milk-PBS solution was used for both cytosolic and particulate fractions (15 ml each).

RESULTS

Environmental Particle Treatment

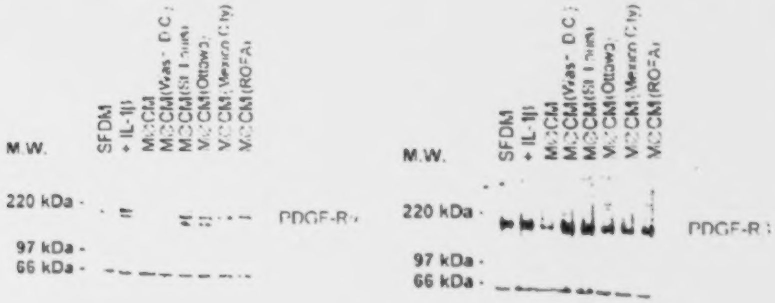
M.W.
SFDM
+ IL-1β
MØCM
MØCM(Wash. D.C.)
MØCM(St. Louis)
MØCM(Ottowa)
MØCM(Mexico City)
MØCM(ROFA)
220 kDa -
97 kDa -
66 kDa -
PDGF-Rα
M.W.
SFDM
+ IL-1β
MØCM
MØCM(Wash. D.C.)
MØCM(St. Louis)
MØCM(Ottowa)
MØCM(Mexico City)
MØCM(ROFA)
220 kDa -
97 kDa -
66 kDa -
PDGF-Rβ

Figure 1: Expression of PDGF-Rα and -Rβ after Environmental Particle Treatments. PDGF-Rα is up-regulated. PDGF-Rβ expression is constant.

Table 2: Platelet-derived Growth Factor Expression (PDGF-R) in Environmental Particle Treatment (Figure 1)

Receptor	Expression
PDGF-Rα	Increased PDGF-Rα expression for positive control (IL-1β [10 ng/ml]) and MØCM collected from St. Louis, Ottawa, Residual Oil Fly Ash, Mexico City, and Washington D.C. (in decreasing order of expression).
PDGF-Rβ	The PDGF-Rβ, while slightly variable, was not induced by the pollution particles.

PKC Assay

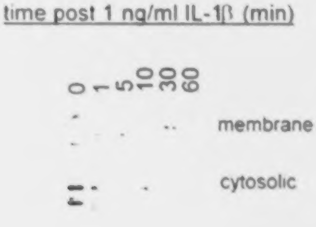
time post 1 ng/ml IL-1β (min)
0
1
5
10
30
60
membrane
cytosolic

Figure 2: PKC α expression over IL-1β time course in cytosol and membrane. Fractionated samples were exposed to anti-PKC α antibody. After 10 minutes, PKC α was mobilized from the cytosol fraction, leading to a maximum signal at 30 minutes.

DISCUSSION

Environmental Particle Discussion

In the presence of environmental pollution particles, the platelet-derived growth factor receptor (PDGF-R) system in rat lung fibroblasts is altered, especially for PDGF-R alpha (PDGF-Rα). In Figure 1, an increase in PDGF-Rα expression was observed when macrophage media (MØCM) collected from cells exposed to 10 ng/ml of interleukin 1 beta (IL-1β) and to 0.1X environmental pollution particles from cities in the U.S., Canada, and Mexico (Table 1).. Particles from St. Louis, having a high concentration of pollutive particles (17), had the greatest expression while Washington D.C. particles had the lowest (Table 2). In cities, the levels of pollution are difficult to determine. In general, based on other blots (not shown here), St. Louis and Ottawa city samples tended to induce high levels of PDGF-Rα expression, while Washington D.C. samples fluctuated in their level of expression.

Since there is barely any PDGF-Rα expressed in rat lung fibroblasts, the predominant receptor being PDGF-R beta (β), the up-regulation of PDGF-Rα after environmental particle exposure is significant. Because PDGF-Rα has the capability to bind to both polypeptide subunits of PDGF (A and B), while PDGF-Rβ only binds the B subunit, increasing the expression of such a receptor makes the cells more sensitive to PDGF. In fact, the PDGF-Rα signal elicits a more potent mitogenic response than PDGF-Rβ (7). Therefore, the response to growth factors is more immediate. While there is some variation in the expression of PDGF-Rβ, as shown in Figure 1, it can be inferred that in rat lung fibroblasts the expression of PDGF-Rβ is fairly constant.

PKC Discussion

The role of PKC α mobilization from the cytosol to membrane in PDGF-Rα expression is presently unknown. Using cell fractionation and Western blotting techniques, we showed that the subspecies, or enzyme subunit, PKC α was translocated to the membrane within 10 minutes of exposure, while a stronger signal is seen after 15 minutes (Figure 2). This is interesting because Fitzer-Attas *et al.* have shown that when PKC α is over-expressed in Swiss/3T3 fibroblasts, PDGF-Rα is down-regulated, while PDGF-Rβ remains unaffected (15). In conclusion, PKC α could be regulator of PDGF-Rα expression in rat lung fibroblasts.

Understanding both the extracellular and intracellular events during PDGF-Rα expression, a potent receptor for all isoforms of PDGF, will lead to treatments for pulmonary inflammatory diseases like pulmonary fibrosis.

BIBLIOGRAPHY

(1) Hin Phan, S. and R. S. Thrall ed., 1995. Pulmonary Fibrosis. *Lung Biology in Health and Disease*, vol. 80. Marcel Dekker, Inc.: New York, pp. 541-42.

(2) Town, G. I. and S. T. Holgate. 1991. "The Role of Inflammation in Airways Disease." Mediators of Pulmonary Inflammation. *Lung Biology in Health and Disease*, vol. 54. Marcel Dekker: NY, p. 35.

(3) Bonner, J. C., A. R. Osornio-Vargas, A. Badgett, and A. R. Brody. 1991. Differential proliferation of rat lung fibroblasts induced by the platelet-derived growth factor-AA, -AB, and -BB isoforms secreted by rat alveolar macrophages. *Am. J. Respir. Cell Mol. Biol.* 5: 539-547.

(4) Zhang, Y., T. C. Lee, B. Guillemim, M-C. Yu, and W. N. Rom. 1993. Enhanced IL-1β and tumor necrosis factor-α release and messenger RNA expression in macrophages from idiopathic pulmonary fibrosis or after asbestos exposure. *Journal of Immunology*, 150: 4188-4196.

(5) Seifert, R. A., C. E. Hart, P. E. Phillips, J. W. Forstrom, R. Ross, M. J. Murray, and D. F. Bowen-Pope. 1989. Two different subunits associate to create isoform-specific platelet-derived growth factor receptors. Journal of Biological Chemistry, 264, 8771-8778.

(6) Osornio-Vargas, A. R., P. M. Lindroos, P. G. Coin, A. Badgett, N. A. Hernandez-Rodriguez, and J. C. Bonner. 1996. Maximal PDGF-induced lung myofibroblast chemotaxis requires the PDGF alpha-receptor. *Am. J. Physiol. (Lung Cell Molec. Physiol.)* (In press)

(7) Lindroos, P. M., P. G. Coin, A. R. Osornio-Vargas, and J. C. Bonner. 1995. Interleukin-1β (IL-1β) and the IL-1β-α_2-macroglobulin complex upregulate the platelet-derived growth factor α-receptor on rat pulmonary fibroblasts. *Am. J. Respir. Cell. Molec. Biol.* 13: 455-465.

(8) Bonner, J. C., A. L. Goodell, P. G. Coin, and A. R. Brody. 1993. Chrysotile asbestos upregulates gene expression and production of α receptors for PDGF-AA on rat lung fibroblasts. *The Journal of Clinical Investigation*, 92, 425-430.

(9) Craighead, J. E., and B. T. Mossman. 1982. The pathogenesis of asbestos-associated diseases. *N. Engl. J. Med.* 306: 1446-1455.

(10) Hackett, N. A. 1983. Cell proliferation following acute fly ash exposure. *Toxicology*. 27: 273-286.

(11) Driscoll, K. E. and J. K Maurer. 1991. Cytokine and growth factor release by alveolar macrophages: potential biomarkers of pulmonary toxicity. *Toxicologic Pathol.*, 19, 398-405.

(12) Lindroos, P. M., P. G. Coin, A. Badgett, D. L. Morgan, and J. C. Bonner. 1997. Alveolar Macrophages Stimulated with Titanium Dioxide, Chrysotile Asbestos, and Residual Oil Fly Upregulate the PDGF Receptor-α on Lung Fibroblasts Through an IL-1β-dependent Mechanism. *Am. J. Respir. Cell Mol. Biol.*, 16, 282-292.

(13) Munoz, E., B. Beutner, A. Zubiaga, and B. T. Huber. 1990. IL-1 activates two separate signal transduction pathways in T helper type II cells. *The Journal of Immunology*, 144, 964-969.

(14) Ha, K-S and J. H. Exton. 1993. Differential translocation of protein kinase C isozymes by thrombin and platelet-derived growth factor. *The Journal of Biological Chemistry*, 268, 10534-10539.

(15) Fitzer-Attas, C, H. Eldar, L. Eisenbach, and E. Livneh. 1994. The expression of PDGF-α but not PDGF-β receptors is suppressed in Swiss/3T3 fibroblasts over-expressing protein kinase C-α. *FEBS Letters*, 342, 165-170.

(16) Rzymkiewicz, D. M., T. Tetsuka, D. Daphna-Iken, S. Srivastava, and A. R. Morrison. 1996. Interleukin-1β activates protein kinase Cζ in renal mesangial cells. *The Journal of Biological Chemistry*, 271, 17241-17246.

(17) Spengler, J. D., and G. D. Thurston. 1983. Mass and elemental composition of fine and coarse particles in six U.S. cities, *APCA Journal*, 33, 1162-1171.

Determination of RNA Binding Domains of the Nucleocapsid Protein of Tomato Spotted Wilt Virus

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Tomato spotted wilt virus (TSWV) is the type member of the *Tospovirus* genus, the only plant infecting members of the family Bunyaviridae. TSWV has a host range which includes more than 50 families and agriculturally causes major economic losses. The genomic RNAs of TSWV are encapsidated with multiple copies of a nucleocapsid (N) protein. Viral RNAs must be encapsidated for replication and transcription to occur. Thus, the N protein's RNA binding properties are being characterized to further determine its role in TSWV replication.

The N3 and N4 regions of the nucleocapsid protein along with the entire N protein have been cloned, expressed, and purified. Gel shift mobility assays were performed to determine binding of the ^{32}P labeled single-stranded RNA to full length N, N3, and N4 regions. The N4 region, but not the N3 region, has a binding domain. Also exhibiting RNA binding ability was the full length N protein.

INTRODUCTION

Tomato spotted wilt virus (TSWV) is the type member of the *Tospovirus* genus, the only plant infecting members of the Bunyaviridae family. TSWV has a host range which includes more than 50 different plant families, many important to agriculture. Temperate and tropical regions suffer major economic losses from this virus sometimes losing 50-90% of crops (1).

Several species of thrips (Thysanoptera: Thripidae) transmit TSWV. Thrips acquire *tospoviruses* only while in their larval stage, but remain viruliferous throughout their lives. TSWV likely replicates in the cells of their thrips vectors. Since thrips host range includes many important economic crops, and they have high fecundity and develop pesticide resistance readily, it is of great interest to engineer TSWV resistance in plants.

Bunyaviridae is the largest single family of negative strand viruses. General features which unite this family include a virion structure with a host-derived lipid envelope enclosing three genomic RNAs, each of which is encapsidated with many copies of the nucleocapsid (N) protein. Most members of this family have arthropod vectors and infect vertebrates. Because of the similarities of genomic structure, vector relationships, and virion morphology, information related to the molecular biology of TSWV could be relevant to the formation of control strategies for the entire family, thereby not only improving agriculture, but aiding medicinal science as well.

TSWV's genome includes three segments of negative or ambisense single-stranded RNA with complementary terminal sequences that allow for formation of non-covalently closed circles. Each is coated with many copies of the N protein to form nucleocapsids. The N protein/ RNA complex is vital for RNA replication. It is postulated that the N protein may regulate events in the viral life cycle (2). Two viral glycoproteins (G1 and G2), which are thought to play a role in receptor-mediated

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uptake of the virus in its thrips vector, project from the virion surface.

For TSWV, the bacterially expressed full length N protein and its amino- and carboxy- terminal halves have been shown to bind RNA (3). To determine specific binding domains of the protein, quarters of the N protein, approximately 7-8 kDa, are being expressed for use in binding studies. The quarters are referred to as N1, N2, N3, and N4 (Figure 1). The center section composed of N2 and N3 will also be expressed and is referred to as Nmid. The purpose of this research is to characterize the N protein's RNA binding properties to further elucidate its role in TSWV replication. By determining the roles of the N protein, virologists may be better able to subvert infection of TSWV. The hantavirus is the only other member of the Bunyaviridae where the N protein/ RNA complex has been studied.

MATERIALS AND METHODS

Binding Study with the N3 and N4 Regions

Previous attempts by K. Richmond and E. Eyestone (personal communication K. Richmond) to clone the full length N protein, N1, N2, N3, and N4 regions were examined through a process of expression in BL21(DE3) host cells, purification using metal-chelate affinity chromatography, and detection using a 0.1% Coomassie stain and a Western Blot analysis with the N polyclonal antibody. Work was continued with the N3 and N4 regions which had been previously cloned directly into the pET-15b (Novagen) protein expression vector.

K. Richmond and E. Eyestone had transformed the full length N, N1, N2, N3 and N4 pET-15b plasmids into *Esherichia coli* DH5-α non-expression cells to allow for ease in cloning and, then, into *E. coli* BL21(DE3) expression cells. Protein expression was induced with isopropylthio-β-D-galactoside (IPTG) at a final concentration of 1mM in 50 mL of Luria Broth. Bacterial cells were grown in a shaking incubator at 37°C. Time points at 1, 3, and 6 hours were taken after induction of N3 and N4 proteins to monitor expression. Cells were collected four to five hours after induction by centrifugation at 4000xg for 15 minutes in preparation for purification on a Nickel-Nitrilotriacetic acid (Ni-NTA) column.

The pET system carries a sequence of six histidine residues that are expressed at the amino-terminal end of the target protein. The histidine side chains bind with the divalent nickel ions chelated to the NTA resin. A pH gradient can be used to wash and elute proteins off of the Ni-NTA column, since reducing the pH will protonate the amino acid side chains of the histidine residues involved in metal binding (5).

N3 and N4 regions were purified under denaturing conditions. To prepare for column purification, the bacterial cells were suspended in 1 ml Buffer B (8M urea, O.1 M NaH_2PO_4, 0.01 M Tris-HCl, pH 8.0) and set on ice for one hour. The suspension was centrifuged at 10,000 xg for 10 minutes, and the supernatant collected. The Ni-column was pre-equilibrated with 600μl of Buffer B. The column was then loaded with 600μl of the supernatant and spun down for two minutes at 700xg. The column was washed twice with 600μl of Buffer C (8M urea, 0.1M NaH_2PO_4, 0.01M Tris-HCl, pH 6.3), and then eluted twice with 200μl of Buffer E (8M urea, 0.1M NaH_2PO4, 0.01M Tris-HCl, pH 4.5). After each wash and elution, the column was spun at 700 xg for two minutes. Additional time was allowed for any liquid which did not pass through the column after two minutes. Samples were run on a 17.5 % SDS-PAGE stacking gel, and the gel was stained overnight in 0.1% Coomassie blue. Gels were destained with a 5:4:1 mixture of water:methanol:acetic acid. A Western blot analysis was performed with the N polyclonal antibody to indicate that the protein of interest had been eluted.

N3, N4, and the full length N protein were expressed on a larger scale in 175ml of Luria broth and purified on the Ni-NTA column in six fractions. Because previous elution of proteins had background, a more stringent wash (8M urea, 0.1M NaH_2PO_4, 0.01M Tris-HCl, pH 5.9) was added after the initial wash at pH 6.3. The samples were run on a 17.5% SDS- PAGE gel, and the gel was stained overnight in 0.1% Coomassie blue. Protein volumes were reduced using Centricon-3 concentrators (Amicon) which have a molecular weight cutoff of 3 kDa. A Bradford Assay using BSA standards was performed to determine protein concentrations (4).

The binding abilities of the N3 and N4 regions were determined through the use of a gel shift assay. Protein binding can be observed through a shift in mobility of the RNA when it complexes with protein. These complexes can be differentiated through electrophoresis on an agarose gel. Binding reactions consisted of 1μl of ^{32}P labeled single-stranded RNA (1:4 dilution), 0.5μl of RNasin (an RNase inhibitor), 1.5μl of binding buffer (10mM NaCl, 2mM KCl, 5mM $MgCl_2$, 50uM EDTA, 2mM DTT, 25 U RNasin), 1µl volumes of proteins to be assayed for binding and 11µl of sterile water. The N3, N4, and full length N test proteins were estimated to be at a concentration of 0.75µg/µl. Previously expressed full length N protein and the amino-half were used as a positive control. The total reaction volume was brought up to 15µl using diethylpyrocarbonate (DEPC) treated water. DEPC is an inactivator of ribonucleases. The reactions occurred for 45 minutes in a 30°C water bath and products were then loaded onto a 2% agarose gel. The gel ran for two hours at 60V in a horizontal apparatus. The gel was dried onto filter paper and then exposed to X-ray film.

Cloning of the Nmid and N2 regions

Primers designed with restriction enzyme sites *Pst1*, *Nde1*, and *BamH1* (New England Biolabs) were used in PCR amplification of the Nmid region and the N2 region (see Figure 1). PCR products were digested with *Pst1* and *BamH1* restriction enzymes. Initially, digests were run on an agarose gel to determine purity. Appropriate bands were cut from the gels and purified with a Prep-A-Gene kit (Bio-Rad Laboratories).

The Nmid and N2 inserts were then ligated into a vector in 10 µl reactions using T4 DNA ligase. Three vectors were used in three attempts at ligation: 1) pBluescript KS+ (Stratagene) and puc 119, 2) pBluescript KS+ and pET15b, and 3) pBluescript KS+. All vectors exhibit ampicillin resistance. The use of pBluescript KS+ was favored because it is, specifically, a cloning vector and because it has blue/white color selection.

Four attempts were made to transform the subclones into DH5-α *E. coli* competent cells. Controls used in transformations included DH5-α *E. coli* competent cells alone on a 2xYT (yeast, sodium chloride, and triptone) agar plate, competent cells alone on an ampicillin coated 2xYTplate, and undigested vector on an ampicillin coated 2xYT plate.

Selected colonies were grown overnight in 5mL of 2xYT broth at 37°C and purified using alkaline lysis. The selected subclones were then digested with *Nde1* and *BamH1* restriction enzymes. RNase was added to each reaction. The digests were run on an agarose gel to check for the appropriate insert.

RESULTS

Binding Study with the N3 and N4 Regions

Previously cloned N1 and N2 regions (cloned by K. Richmond and E. Eyestone) did not test positive on a Western blot using the N polyclonal antiserum. However, a band was detected for N1 on a 0.1% Coomassie stained 17.5% SDS-PAGE gel. Elution of the expressed full length N, N3, and N4 regions from Ni-NTA columns was confirmed using a Western Blot analysis with the polyclonal N antiserum and a 17.5% SDS-PAGE stacking gel stained in 0.1% Coomassie blue (see Figure 2). Significant background bands were apparent on both the Coomassie stained SDS-PAGE gels and on the Western blots. These bands are believed to be from *E. coli* because the polyclonal N antibody was produced using a recombinant full length N protein in *E. coli* competent cells. The more stringent wash was used in the elution of the full length N protein, N3 and N4 in both the small and large scale expressions to reduce the background bands. The Bradford Assay used to determine the amount of concentrated proteins gave inconsistent results. There were at least two readings taken for each protein at its various concentrations. The values for each concentration were consistent with slight fluctuations (± 2pg/µL). However, the readings for 1µl of concentrated protein varied significantly from those taken for 10µl of concentrated protein. For the binding study, the concentrations of the N3, N4, and full length N protein were assumed to be at 0.75µg/µl.

The RNA binding assay indicates that the N4 region, but not the N3 region, has a binding domain (Figure 3). Binding of N4 to RNA significantly retarded the migration of RNA through the gel. Also exhibiting RNA binding ability were the N proteins from both a previous and recent expression. The amino-terminal half of the N protein has been shown in the past to retard RNA migration (3). Because this was not seen, it would appear that there was an insufficient amount of the amino-terminal half protein added to the binding reaction and, thus, a shift did not occur. Unretarded RNA, apparent on the agarose gel, indicates an imbalance in the ratio of RNA to protein. The concentrations of the proteins determined by the Bradford assay appeared to be overestimated despite the use of the more conservative value.

The results of the gel shift assay support a previous study of two other members of the Bunyaviridae by Gött et al. (1993). The carboxy-terminal domains of Puumala virus strain CG 18-20 (PUU) (aa residues 327 to 433) and Hantaan virus strain 76-118 (HTN) (aa 335-429) were positively identified to bind RNA. These two ends share the highest degree of identity. The amino-terminal domains of PUU and HTN N did not bind RNA at all and share only 53% identity (6). So, it would appear that there is a putative conserved sequence within this region partially responsible for the formation of nucleocapsids.

Cloning of the Nmid and N2 Regions

Nmid and N2 regions were successfully PCR amplified. However, attempts to clone these regions using pBluescript KS+, pET-15b, and puc119 vectors were unsuccessful. All controls, with the exception of the pET-15b undigested, showed that the competent cells and plasmid were good. Analysis of digested DNA collected from certain colonies showed no insert in any of the colonies chosen. Sixty-three colonies were tested. It is possible that the poor recovery of restriction enzyme digested Nmid region using a Prep- A-Gene DNA purification kit created less than optimal ratios of the components of the ligation reactions. Subsequent sequencing of the N2 clone has shown that an additional T was moving the open reading frame out of place (3).

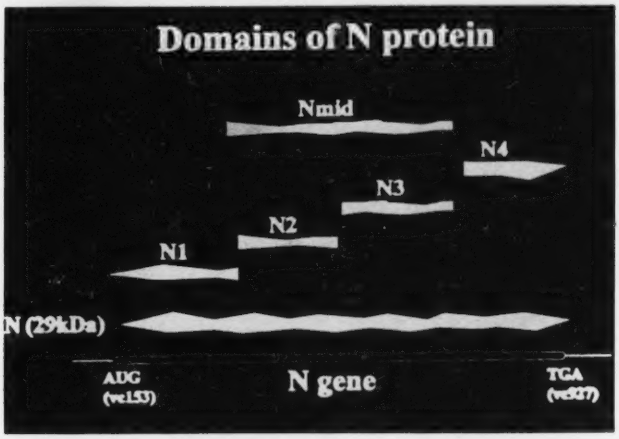

Figure 1. Regions of the nucelocapsid protein which will be expressed and purified for use in gel shift mobility assays.

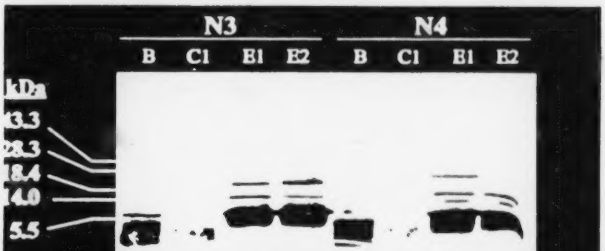

Figure 2. WESTERN BLOT ANALYSIS. Positive identification of eluted N3 and N4 protein regions from Ni-column purification. Fractions below N3 and N4 are as follows: (B) is the flow-through of induced cell lysate, (C1) is the flow-through of wash one of column, (E1/E2) are the elutions of protein from column.

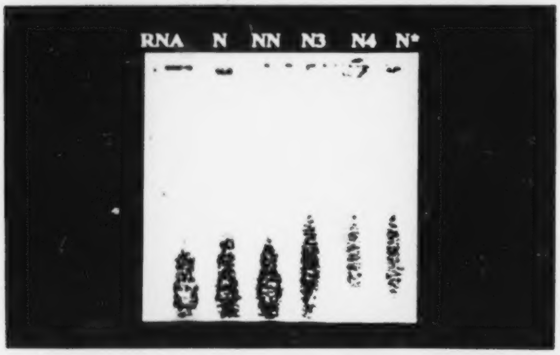

Figure 3. **BINDING ASSAY.** Binding assay reactions were loaded on a 2% agarose gel and electrophoresed for 2 hours at 60V. All lanes contain a single strand ^{32}P labeled RNA with the following additions: Lane (1) water, (2) full length N protein, (3) amino- half of entire N protein, (4) N3 region, (5) N4 region, (6) full length N protein recently expressed.

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REFERENCES

1. German, T.L., Ullman, D.E., Moyer, J.W. 1992. *Tospoviruses*: Diagnosis, Molecular Biology, Phylogeny, and Vector Relationships. *Annu. Rev. Phytopathol.* 30:315-348.

2. Ishihama, A. and Barbier, P. 1994. Molecular Anatomy of viral RNA-directed RNA polymerases. *Arch. Virol.* 134:235-258.

3. Personal communication K. Richmond

4. Bradford, M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem.* 72: 248-254.

5. Arnold, F.H. 1991. Metal-Affinity Separations: A New Dimension in Protein Processing. *Biotechnol.* 9: 151-156.

6. Gott, P. et al. 1993. RNA Binding of Recombinant Nucleocapsid Proteins of Hantaviruses. *Virol.* 194: 332-337.

Characterization of an Auxin-Resistant Mutant of *Arabidopsis thaliana*

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To increase our understanding of the genes controlling plant growth, we are investigating the mechanism of action of the plant hormone auxin using the model plant *Arabidopsis thaliana*. The focus of our investigations is the physiological characterization of the *Arabidopsis* gene *axr5* (auxin-resistant 5). AXR5 is a gene that plays a role in the effects of the plant hormone auxin in *Arabidopsis* plant cells. We have shown that root growth of *axr5* mutant plants is resistant to the natural auxin indole-3-acetic acid (IAA), and that the hypocotyls of dark-grown *axr5* plants are approximately 2 millimeters longer than those of wild-type plants. We also have preliminary results which show that there is no difference in lateral root number between *axr5* mutants and normal, wild-type plants. Further physiological characterization of *axr5* mutant plants will help us to understand the role of the AXR5 gene in the cells of *Arabidopsis* plants.

INTRODUCTION

Auxin is a hormone important for the growth and development of plants. It causes plant cell elongation, division and differentiation (Salisbury and Ross, 1992). Among its many effects, auxin has specifically been shown to be involved in root elongation, lateral bud and root development and internode cell division and elongation (Fosket, 1994). The specific concentration of auxin determines whether these processes are inhibited or promoted. Despite the knowledge of auxin's effects, much remains unknown about this hormone. The mechanism of auxin action remains poorly understood and is of particular interest in this paper.

As in other parts of the plant, the concentration of auxin within the roots determines whether root growth will be inhibited or promoted. At elevated concentrations of exogenous auxin, root growth is inhibited. At least part of this auxin inhibition may be due to the fact that auxin stimulates cells to produce ethylene and ethylene inhibits cell elongation (Salisbury and Ross, 1992). Auxin also plays a role in lateral root development. As the root system develops, side branches grow off the main root. The development of lateral buds is induced by auxin (Fosket,1994). Auxin affects a plant's shoot system as well. The hypocotyl begins right below the point at which the cotyledons (seed leaves) attach and ends at the embryonic root. It is comparable to the stem in mature plants. Auxin also affects this shoot system's growth and development.

Arabidopsis thaliana, commonly referred to as mouse-ear cress, is a useful plant in which to study auxin. It is experimentally a good model organism because it is small, grows quickly, and has a small genome, which makes cloning of genes simple. Also, the knowledge gained in *Arabidopsis* can be applied to other more economically useful plants (Koornneef, 1994).

A genetic approach to the study of auxin was taken in this experiment. Plants with a mutation that disrupts the normal auxin action were analyzed and characterized physiologically and genetically. Physiological characterization involves examination of the mutant plants' structure and comparison to normal, wild-type plants in order to determine differences that may be caused by the mutation. Genetic characterization involves genetic mapping, that is, determination of the exact position of a gene on a chromosome.

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The *axr5* mutant was isolated in the Estelle lab at Indiana University by Jim Britton and Anna Ruesink (Hobbie, personal communication). The *axr5* (auxin-resistant 5) mutation is defined by one allele. It is a dominant mutation which makes plants resistant to auxin. Genetic analysis has determined the AXR5 gene to be located on chromosome four (Hobbie, unpublished results). Genetic mapping with visible markers has determined the AXR5 gene to be approximately three map units away from HY4 on the short arm of chromosome 4 (Carvan et al., unpublished results).

This paper will focus on the physiological characterization of *axr5* mutant plants. Because of the various effects of auxin, root growth elongation, lateral root formation and hypocotyl elongation of *axr5* mutant plants were studied. Physiological characterization indicates what specific processes the gene is important for. Any physiological difference between mutant plants and wild-type plants suggests that the mutation in the AXR5 gene caused the difference. Thus, the AXR5 gene is necessary for the normal function of that process.

MATERIALS AND METHODS

For all experiments, *Arabidopsis* seedlings were grown on ATS media, containing 0.7% agar, 1.0% sucrose and nutrient solution (Wilson et al., 1990). They were grown in a Percival Scientific growth chamber set on a 16 hour light/ 8 hour dark cycle, at 20^0 Celsius and light intensity of 70-100 µEinstein m^{-2} s^{-1}.

Root Growth Assay

A root growth assay of *axr5* mutant and normal, wild-type seedlings for the following hormones was done - the auxins: indole-3-acetic acid (IAA), 2,4-dichlorophenoxyacetic acid (2,4-D) and others: 6-furfurylaminopurine (kinetin) and abscisic acid (ABA). *axr5* and wild-type seeds were sterilized and spread on ATS plates without hormones, then placed in the growth chamber in the vertical orientation for 4 days. Plates of varying concentrations of the particular hormones were made by adding stock hormone solution to ATS media. Within a laminar hood, 12 *axr5* seedlings and 12 wild-type seedlings were transferred using sterile forceps to each plate containing a specific hormone concentration, and the root tips were marked. The plates were put back in the growth chamber in the vertical orientation for 3 days. The root growth from the point marked was measured in millimeters with a ruler under a dissecting microscope.

Lateral Root Growth

The lateral root growth of *axr5* and wild-type seedlings was studied according to the following procedure. *axr5* and wild-type seedlings were sterilized and spread on ATS plates without hormones. The plates were put into the growth chamber in the vertical orientation for 4 days. Approximately 10 seedlings were transferred to 150 mm petri plates with ATS and the root tips were marked. The plates were returned to the growth chamber in the vertical orientation for 12 days. The lateral roots were counted under a dissecting microscope. A lateral root was described as a sharp outgrowth protruding from the side of the main root.

Hypocotyl Elongation

Characterization of hypocotyl elongation in dark-grown seedlings (etiolation) was done according to the following procedure. *axr5* and wild-type seedlings were sterilized and spread on ATS plates without hormones at 4°C for 2-4 days. The plates were then wrapped in 3 layers of aluminum foil and placed within a cardboard box also covered with aluminum foil to prevent any light from reaching the plates. The covered box was placed in the growth chamber for 7-8 days depending on the experiment. After this time period, the hypocotyls of approximately 60 *axr5* seedling and 60 wild-type seedlings were measured with a metric ruler.

RESULTS

Root Growth Assay

In order to determine the resistance of *axr5* mutant plants to different types of hormones, root growth assays were done. The root growth of *axr5* and wild-type seedlings were compared at various hormone concentrations. In each experiment, the elongation of

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seedlings on hormone-containing media is expressed relative to the elongation of the same genotype on hormone free media.

The root growth results of IAA, natural auxin, show that as the hormone concentration increases, the percent root elongation decreases (Figure 1a). The results also show that *axr5* is more resistant to IAA than wild-type, and the elongation differences between *axr5* and wild-type at the 10^{-7}, 10^{-6} and 10^{-5} M concentrations are significant.

Similar results were obtained for root growth on the synthetic auxin 2,4-dichlorophenoxyacetic acid (2,4-D) (Fig 1b). The results show that from 10^{-10} to 10^{-6} M concentrations, *axr5* is more resistant to 2,4-D than wild-type. The elongation differences between the two genotypes are significantly large.

The effects of the cytokinin 6-furfurylaminopurine (kinetin) on root growth were also measured. The results show that as kinetin concentration increases, percent elongation generally decreases in both genotypes. The results for the *axr5* mutant were not consistent; in 2 experiments *axr5* was slightly resistant to cytokinin compared to wild-type (Fig 1c) and in a third experiment *axr5* was slightly sensitive to cytokinin compared to wild-type (Fig 1d).

Root growth assay results on abscisic acid (ABA) show that as concentration increases, percent elongation decreases (Fig 1e). The results also show no significant difference in response between *axr5* and wild-type seedlings.

Lateral Root Growth

Preliminary results of lateral root study of *axr5* and wild-type plants shows no significant difference in number of lateral roots (Figure 2). Wild-type plants show an average of 20.2 lateral roots per seedling and *axr5* plants show an average of 21.3 lateral roots per seedling after 16 days growth on hormone-free medium.

Hypocotyl Elongation

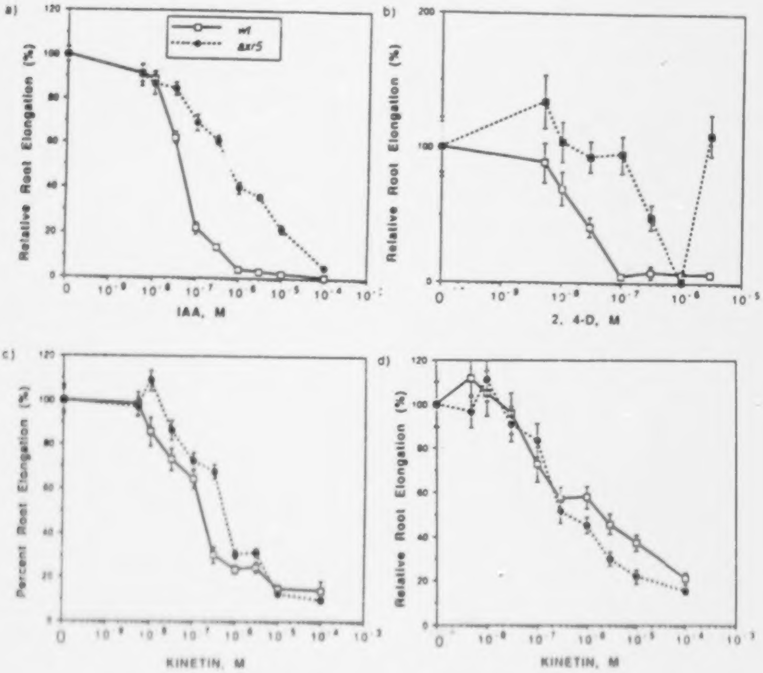
The results of hypocotyl elongation in dark-grown *axr5* and wild-type seedlings show a consistent difference in hypocotyl length (Figure 3). The results of every trial show that *axr5* hypocotyls are significantly longer than wild-type hypocotyls after 7 or 8 days. Anova Single Factor statistical analysis shows p values for the first, second and third trial respectively to be 5.3×10^{-7}, 2.8×10^{-26} and 4.7×10^{-14} with alpha 0.05.

DISCUSSION

Physiological characterization of *axr5* mutant plants shows that the AXR5 gene is important for the plant's response to auxin. Root growth assays show that *axr5* mutant plants are significantly more resistant to the natural auxin IAA and to the synthetic auxin 2,4-D than are wild-type plants. Comparing the concentrations of IAA that reduced root elongation by 50%, about 5×10^{-8} M for wild-type and 7×10^{-7} M for *axr5*, shows that *axr5* is approximately 14 times more resistant to IAA than wild-type. This may indicate that the *axr5* mutation is involved in the signal transduction pathway of auxin in root growth and development. Root growth assays on other classes of hormones, cytokinins and abscisic acid, show no significant difference in root growth elongation between *axr5* and wild-type seedlings. This indicates that the AXR5 gene may be involved in an auxin-specific pathway.

Analysis of lateral root formation showed no significant differences between *axr5* and wild-type plants in number of lateral roots produced after 16 days. This suggests that the AXR5 gene is not involved in the process of lateral root development. However, these results are preliminary so no definite conclusions can be made about lateral roots and the AXR5 gene. Other auxin resistant mutants, such as *axr1*, *aux1*, and *axr4*, all have decreased lateral root production in comparison with wild-type (Hobbie and Estelle, 1995).

The hypocotyl elongation results show a definite difference between hypocotyl elongation in *axr5* and wild-type plants, indicated by the small standard error calculations and the small p values from the Anova statistical analysis. Since other auxin resistant mutants had shorter hypocotyls and *axr5* mutant plants are shorter, the longer *axr5* hypocotyl results were unexpected. They suggest that there may be a defect in the auxin signaling pathway specifically for hypocotyl elongation in *axr5* mutant plants. This defect increases the elongation of hypocotyls, which is very different from other auxin mutants in



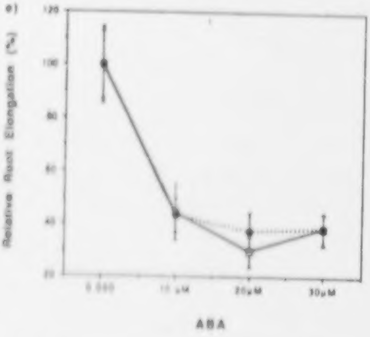


Figure 1. Relative percent root elongation of *axr5* and wild-type seedlings grown on different concentrations of various hormones. a) IAA b) 2,4-D c) kinetin 1 d) kinetin 2 e) ABA. Results based on mean measurements of approximately 10 seedlings at each hormone concentration, +/- the standard error bars shown.

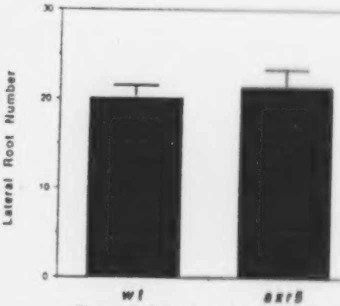


Figure 2. Lateral root number of axr5 and wild-type seedlings.

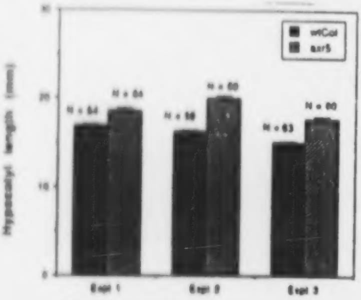


Figure 3. Hypocotyl length of axr5 and wild-type dark-grown seedlings

which hypocotyl elongation is decreased. It is also possible that the brassinosteroid pathway is involved. Hypocotyl etiolation is thought to be controlled by brassinosteroids (Arteca, 1996), and this etiolation difference in *axr5* mutants may indicate some connection between the auxin pathway and the brassinosteroid pathway.

Further physiological characterization of *axr5* plants can add to the information known about the AXR5 gene. Root growth assays on different synthetic auxins, including the benzoic acids, picolinic acids and naphthoxy acids, can be done to further narrow down which auxins *axr5* plants are resistant to. Other classes of hormones, including gibberellins and ethylene, can also be studied for effects on roots of *axr5* seedlings. Extensive lateral root studies should be continued to more accurately quantify the lateral root numbers in *axr5* and wild-type seedlings. Also, hypocotyl elongation could be further studied to determine if brassinosteroids may be involved in the hypocotyl elongation phenotype, perhaps by making double mutants between *axr5* and mutants in the brassinosteroid pathway.

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REFERENCES

Arteca, R.N. (1996) Physiological Effects of Brassinosteroids. In *Plant Growth Substances: principles and applications*. New York: Chapman & Hall, pp.82-85.

Fosket, D.E. (1994) Light, Hormones, and Cell Signaling Pathways. In *Plant growth and development: a molecular approach*. San Diego: Academic Press, Inc., pp.299-304

Hobbie, L. and Estelle, M. (1995) The *axr4* auxin-resistant mutants of *Arabidopsis thaliana* define a gene important for root gravitropism and lateral root initiation. *The Plant Journal*. 7, 211-220.

Koornneef, M. (1994) Arabidopsis Genetics. In *Arabidopsis*. New York: Cold Spring Harbor Laboratory Press, pp.89-120.

Salisbury, F.B. and Ross, C.W. (1992) Hormones and Growth Regulators: Auxins and Gibberellins. In *Plant Physiology 4th ed.* Belmont: Wadsworth Publishing Company, pp.357-381.

Wilson, A.K., Pickett, F.B., Turner, J.C. and Estelle, M. (1990) A dominant mutation in *Arabidopsis* confers resistance to auxin ethylene and abscisic acid. *Molecular General Genetics*. **222**, 377-383.

Comparison of Microbial Consortia and Environmental Conditions of Two Granite Outcrop Plant Communities

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The unique vegetational communities adapted to survival in the rapidly fluctuating environmental conditions of granite outcrops in the southeastern United States have been studied for more than fifty years. These studies include several ecological surveys at Arabia Mountain Nature Preserve, DeKalb County, Georgia. The studies were focused primarily on the surface vegetation, macrofauna, and environmental conditions of distinctive communities that develop as soil accumulates in depressions on the granite. In 1990, Dr. Sandra T. Bowden and Dr. Patricia M. White began an investigation of the microbial communities in the soils of two of the types of plant communities on Arabia Mountain. The two plant communities were designated S for communities with *Sedum smallii* as the only vascular plant represented and AP for communities dominated by mixed annual and perennial herbs and occasional seedlings of woody plants. These two communities are on the same area of the mountain, but they are not connected by water drainage or seepage. They differ in floristic and edaphic characteristics and offer an interesting pair of soil ecosystems in which to explore microbial diversity and environmental factors that may influence microbial biomass and community structure.

We report the results of studies similar to those of Bowden and White that we conducted during 1996-1997. The purpose of this research is to assess local environmental conditions, microbial biomass, and community structure, as well as to provide baseline information for future investigation of the effects of seasonal environmental fluctuations and perturbations on these microbial communities. Our future interests include several basic questions about the general biology and ecology of soil microorganisms–their interactions with each other and with plants, their roles in soil formation and the cycling of nutrients, and the transfer of genes among them.

Traditional microbiological techniques, though valuable in the pursuit of certain types of information, provide a very limited picture of soil microbial communities *in situ*. It has been estimated that only one-tenth of one percent of all microbes living in the soil can be grown as laboratory isolates because of the selective nature of culture media and other cultivation conditions (5). In an effort to study soil microbial communities *in situ* and gain a more accurate picture of their biomass and functional organization, several molecular techniques have been developed, including the use of phospholipid fatty acid profiles, nucleic acid probes, and 16S ribosomal RNA analysis. It has been determined that membrane phospholipids do not persist in the environment following the death of organisms; they are rapidly degraded (7). Therefore, PLFA analysis of whole soil lipid extracts can be used to estimate the biomass and develop a profile of the functional groups of microbes in the soil, determinations that are not possible with classical isolation methods alone.

The total lipid extracted from soil samples is separated into fractions for analysis of the phospholipid fatty acids (PLFA) by capillary gas chromatography and mass spectroscopy (GC-MS). By comparison of these profiles to the distinctive PLFA profiles of organisms with specific physiological characteristics and functional roles in ecosystems, it is possible to infer the presence of representatives of these functional groups of microbes in soil samples that have complex community structure and extremely limited culturability (6). Biomass estimates are based on the total moles % PLFA of a soil sample multiplied by the moles % total PLFA of a microbial cell standard, (one cell of *Escherichia coli*). Whether the microbial communities in the soils of the two plant communities differ in structure can be inferred from cluster analysis of principal component PLFA from extracts of soil samples collected at various times in the same communities and from the profiles of fatty acids that appear to be indicative of the presence of certain groups of microbes in complex communities.

Our general hypothesis is that the soil environments of the two plant communities selected for this research differ in physical and chemical characteristics; therefore, the microbial communities in these soils will differ in biomass and community structure. If the structure and biomass of microbial communities in S and AP soils are different, the PLFA profiles will reflect these differences.

MATERIALS AND METHODS

Environmental measurements: At the field site, soil depth and temperature were measured at regular intervals along a transect running perpendicular to the slope of the outcrop. Air temperature and relative humidity were measured at the time of sample collection. pH was measured electrometrically in slurries of soil with distilled water. Fresh, weighed soil samples oven dried to constant weight at 70°C were used to determine percent moisture; the same dried samples were reduced to ash in a muffle furnace to determine the percent organic content.

Lipid extraction and PLFA analysis: . With sterile technique, 25-gram soil samples were collected, transported to the laboratory on ice, and lyophilized for lipid extraction and PLFA analysis. The total soil lipid extract was prepared by the Bligh and Dyer method (1). The polar phospholipids were separated by solvent fractionation and silicic acid column chromatography (4). Fatty acid methyl esters were derived by mild alkaline methanolysis of the polar lipid fraction to produce fatty acid methyl esters (FAMES) for identification by GC-MS with Hewlett-Packard instruments (2,3,4). Moles percent tables, cluster diagrams, scatter plots, and chromatographs of FAMES were used in the analysis of community structure and biomass. Signature lipids were used comparatively to assess differences in microbial community structure in samples from S and AP communities.

RESULTS

The data from PLFA analysis and environmental measurements are presented in Figure 1 and Tables 1 and 2.

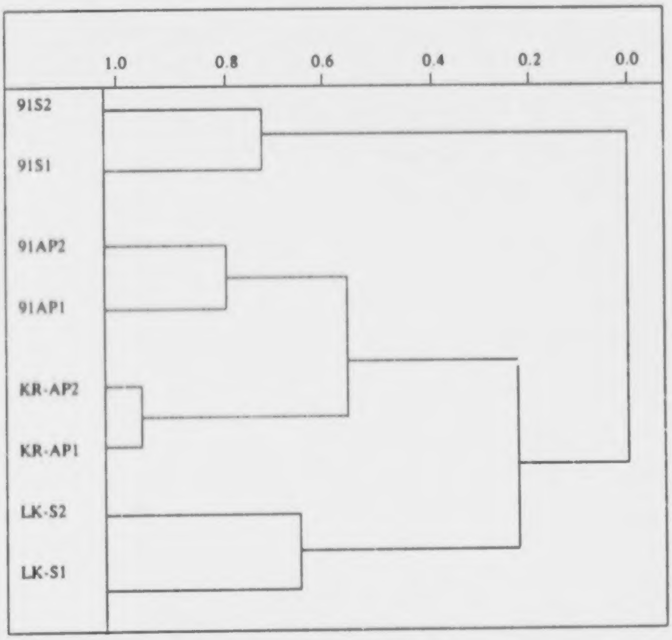

Figure 1. Cluster Analysis of PLFA Data

Table 1. Soil Temperature, S and AP Communities

	Temperature (°C) May/June 1996	Temperature (°C) May 1991
S	Range: 43 - 46	Range: 20 - 22
	Mean: 44.5*	Mean: 21***
A P	Range: 34 - 43	Range: 18 - 24
	Mean: 38.5**	Mean: 22***

* Average of 4 samples
** Average of 6 samples
*** Average of 9 samples

Table 2. Soil Environmental Data

Community	Depth (cm.) range/mean June 1996	Depth (cm.) range/mean May 1991	pH June 1996	Moisture % June 1996	Moisture % May 1991	Organic Content % June 1996
S	0.7-1.7/1.2*	0.15-3.8/1.18+	4.02*	16.5*	5.66***	4.81*
AP	2.9-4.5 / 3.7**	0.2-12.6/4.67+	3.84**	22.0**	36.0***	7.84**

* Average of 2 samples
** Average of 3 samples
*** Average of 6 samples
+ Average of 9 samples

DISCUSSION

In Figure 1, the cluster analysis of PLFA data from samples obtained in 1991 (by another student team) and in 1996 (designated LK and KR samples) reveals strong similarity between principal component fatty acids in sets of AP samples (designated 91AP1 and 2; KR-AP1 and 2). All AP samples show the highest degree of similarity to each other (similarity coefficient=0.55). In contrast, the LK S1 and 2 samples show more similarity to each other than to AP samples (similarity coefficient=0.25), but little similarity to the 91S sample. In summary, with the exception of the 91S sample, which clearly stands apart, the S samples cluster more closely to each other than to AP samples, indicating differences in microbial community structure between S and AP soils. Differences in soil temperature and moisture in the S community between 1991 and 1996 may account for differences in community structure at the time of sampling. It should be noted that if a "control" soil sample from an unrelated plant community had been analyzed by PLFA profile along with S and AP samples, all samples from both S and AP communities very likely would have clustered even more closely.

The 1996 AP community samples contained greater mole percentages of the fatty acids i15:0, cy19:0, 12me16:0, 16:1w5c, 10me16:0, and a17:0, which describe a broad spectrum of organisms, including Gram positive bacteria, actinomycetes, and fungi. The 1996 S community samples contained greater percentages of 18:1w9c, 12me18:0, i17:0, and 24:0, which, when taken as a group, suggest more eukaryotic than prokaryotic influence, with greater involvement of Gram negative bacteria. In summary, 1996 samples from the AP community contain more Gram positive eubacteria and actinomycete members, whereas the 1996 S community appears to contain more Gram negative bacteria, as well as some actinomycetes and eukaryotic microorganisms (7). Therefore, these aspects of the PLFA profiles support the hypothesis that the microbial communities of the two soils differ in structure. The calculated biomass of each of the 1996 S and AP samples may not be significantly different, though the S values were slightly higher than the AP values.

The different environments of the two communities are likely to correlate with variations in microbial community structure. As seen in Table 2, organic content and soil depth differ significantly between the two communities. The average soil temperature (Table 1) and pH (Table 2) were approximately the same for both communities, although the AP community showed a greater range of temperature values, probably due to increased plant cover and soil depth. Moisture percentages varied widely depending on the weather conditions of the sampling day. The differences in depth may affect microbial community structure in part because of a likely soil atmospheric oxidation/reduction potential gradient established by increasing soil depth. For this reason, the AP community may have the ability to support a larger anaerobic component and a greater variety of other microbes. The large discrepancy in organic content between the two soils may also contribute to differences in community structure. The soil of the AP community, with its greater variety of plant life, very likely contains a greater variety of compounds released by living roots and by the decomposition of dead plants. These compounds could enrich the soil and possibly support a microflora different from that of the S community. Also, there may be a correlation between the monotypic flora of the S community and the structure of the soil microbial community beneath it.

Based on the information discussed above, it is reasonable to conclude that the S and AP microbial communities are different in structure in the samples we analyzed, although the microbial biomass of the two soils is similar. Subsequent studies are necessary to determine correlations between specific environmental factors in these two soils and the diversity of the microbial communities within them. Further studies also should investigate the effects of plants, site perturbation, and contamination on the microflora.

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REFERENCES:

1. Bligh, E.G. and W.J. Dyer. 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol. *37*:911-917.
2. Christie, W.W. 1989. Gas chromatography and lipids. The Oily Press, Ayr, Scotland.
3. Findlay, R.H. and D.C. White. 1983. Polymeric beta-hydroxyalkanoates from environmental samples and *Bacillus megaterium*. Appl. Environ. Microbiol. *45*:71-78.
4. Guckert, J.B., C.P. Antworth, P.D. Nichols, and D.C. White. 1985. Phospholipid, ester-linked fatty acid profiles as reproducible assays for changes in prokaryotic community structure of estuarine sediments. FEMS Microbiol. Ecol. *31*:147-158.
5. Perfilev, B.V., and D.R. Gabe. 1969. *Capillary Methods of Investigating Microorganisms*. Oliver and Boyd, Edinburgh, U.K.
6. Thompson, I.P., M.J. Bailey, R.J. Ellis, and K.J. Purdy. 1993. Subgrouping of bacterial populations by cellular fatty acid composition. FEMS Microbiol. Ecol. *102*:75-84.
7. Vestal, J.R., and D.C. White. 1989. Lipid Analysis in Microbial Ecology. Bioscience. *39*:535-541.

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Characteristics and Purification of *Agkistrodon contortrix laticinctus* Venom

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Electrophoretic titration curves were used to determine optimal conditions for the separation of the crude venom (from *Agkistrodon contortrix laticinctus*) with High Performance Liquid Chromatography (HPLC). The optimal pH for hemorrhagic separation was 8.0. The venom was separated by using a Waters HPLC/DEAE column, a 0.02 M Tris-HCl buffer (pH 8.0), and a 0.5 M NaCl Tris-HCl gradient at a pH 8.0; the separation resulted in 9 peaks. A hemorrhagic assay was used to determine the hemorrhagic activity of peaks 5-7 and the specific hemorrhagic activity (0.709, 2.94, and 10.0 respectively) of the purified peaks from crude venom. A minimal hemorrhagic dose (MHD) assay was performed for crude venom and the hemorrhagic fractions obtained from high performance liquid chromatography (HPLC). An antihemorrhagic assay was performed to find the counteracting antihemorrhagic factor(s) involved in blocking the effects of the hemorrhagic factor(s). The antihemorrhagic assay titers for the hemorrhagic peaks were observed to be 8192 for peak 6 and 512 for peak 7. The purified hemorrhagins can used to make monoclonal antibodies and metalloproteinase inhibitors. These antibodies can used in a western blot to compare individual venom protein characteristics from the three subspecies of the Copperheads (*A. c. laticinctus* - the Broad-banded Copperhead, *A. c. contortrix* - the Southern Copperhead, and *A. c. pictigaster* - the Trans-Pecos Copperhead) and aid in the purification of metalloproteinases.

INTRODUCTION

Agkistrodon contortrix laticinctus (the Broad-banded Copperhead) belongs to the family Viperidae and is a relatively docile snake. It can be found in lower-land areas and associated with leaf-covered to wooded terrain throughout central Texas, central Oklahoma, and south-central Kansas. Snake venom has acidic and basic components, with the majority being acidic for *A. c. laticinctus*. Snake venom is also a complex mixture of organic and inorganic molecules which cause hemorrhage, edema and myonecrosis (Schwartz *et al.*, 1984; Tu, 1983). The venom of the Broad-banded Copperhead (*A. c. laticinctus*) is somewhat hemolytic and myotoxic, causing hemorrhage, pain, swelling, breathing difficulty, vomiting, gangrene, necrosis, headaches, and unconsciousness. Despite all of the horrible symptoms, the Broad-banded Copperhead's venom is rather sub-lethal; few people die each year from *A. c. laticinctus* envenomation. However, amputation and loss of function could occur. Snake venoms are different, even for the species as reported by Huang *et al.*, (1992). Martinez et al. (1989) reported geographical variation in venom of snakes from the different species using the enzyme linked immunosorbant assay (ELISA). Adame *et al.* (1990) used three pooled and 20 individual venom samples from different localities in Utah and Arizona to show geographical variation in the antigenicity of the great basin rattlesnake (*Crotalus viridis lutosus*). Anaya *et al.* (1992) reported intrapopulation variation in venom proteins in prairie rattlesnakes (*C. v. viridis*).

It is a purpose of this study to start a comparison analysis between the venoms of three copperhead subspecies (*A. c. laticincts*- the boad-banded copperhead, *A. c.contortrix*- the southern copperhead and *A. c. pictigaster* the trans-pecos copperhead) by HPLC profiles, hemorrhagic and antihemorrhagic assays, and electrophoretic titration curves. Further studies will involve the production of monoclonal antibodies from the hemorrhagic toxins of these copperheads that could be used in the purification of metalloproteinases from these and other snake venoms. Since metalloproteinases are involved in many diseases, there has been interest in designing inhibitors for these proteinases for use as therapeutic agents. Mammalian metalloproteinases are found in low levels (1-10 µg per gram of wet tissue), are difficult to extract and less stable than venom metalloproteinases. The high degree of sequence and structural similarities between snake venom proteinases and mammalian metalloproteinases initiated the use of venom metalloproteinase as models for proteinase inhibitor design (Botos *et al.*, 1996).

MATERIALS AND METHODS

Venom

A. c. laticinctus venom was obtained from three snakes (two female and one male), and maintained at the Biomedical Research Laboratory Serpentarium, Department of Biology, Texas A&M University-Kingsville, Kingsville, TX, USA. The collected venom was stored at -20 °C.

Electrophoretic titration

An electrophoretic titration curve was done using 7.0 µg of *A. c. laticinctus* crude venom with a Pharmacia Phast System with a LKB 3-9 IEF gel. The gel was developed by the development unit - PHASTSYSTEM- Separation and Control Unit and Development Unit (Serial No. 132289; Pharmacia LKB Biotechnology Inc., using silver nitrate as the stain. The electrophoretic titration curve was used to determined the optimal conditions for separation of crude *A. c. laticinctus* venom by HPLC.

Protein separation by anion exchange chromatography

A total of 17.6 mg of crude venom was separated by anion exchange high performance liquid chromatography with a Waters HPLC-Pak DEAE 5PW column (7.5 x 75 mm, part # 088044, Waters Division of Millipore, Millipore Corporation, at a flow rate of 1.0 ml/min for 60 min. Absorbance was measured at 280 nm. Buffers used were 0.02 M Tris-HCl buffer, pH of 8.0 with a 0.5 M NaCl gradient.

Hemorrhagic assay/Minimal hemorrhagic dose (MHD)

A related hemorrhagic assay procedure described by Omari-Satoh *et al.* (1972) was used. Crude *A. c. laticinctus* venom and its fractions were injected intracutaneously into a back of a deiliated rabbit to determine hemorrhagic activity and MHDs (MHD is defined as the amount of protein needed to create a ten millimeter hemorrhagic spot). Crude venom and fractions were diltued to concentrations of 0.150 mg/ml or less. A total of 0.1 ml was injected. The rabbit was sacrificed after 24 hrs and the skin was removed to measure the hemorrhagic spots. The hemorrhagic specific activity was determined by dividing the size of the hemorrhagic spot by the total protein injected. The MHD is determined by the amount of protein needed to produce a 10 mm hemorrhagic spot.

Antihemorrhagic Assay

Two MHDs of the HPLC hemorrhagic fractions were mixed with crude doubling dilutions of opossum serum and incubated at 37°C for 1 hr. One hundred microliters of each of the incubated mixtures were injected into a depilated rabbit. The rabbit was sacrificed after 24 hr and the skin removed. The reciprocal of the highest dilution of serum blocking the minimal hemorrhagic dose was taken as the titer.

RESULTS

Electrophoretic titration curve of crude venom

Figure 1 is an electrophoretic titration curve (ET) of crude *A. c. laticinctus* venom on a IEF 3-9 gel for the Pharmacia PhastSystem. Approximately 10 bands are shown in Figure 1. The IpH of venom proteins and the optimal conditions for HPLC using anion exchange were determined by ET curve. The IpH of each protein is located on the origin of the ET curves. The surface charges (y axis) of the proteins was also determined at different pH. At pH 8.0, most of the proteins in *A. c. laticinctus* venom are negatively charged; suggesting that this particular venom is acidic. The optimal pH for separation in ion exchange chromatography is pH 8.0.

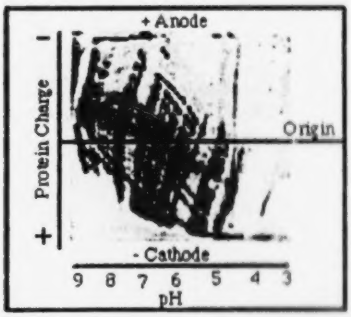

Figure 1. A Pharmacia PhastSystem electrophoretic titration curve of crude *A. c.*

laticinctus venom. A total of 7.0 µg of venom was applied to a 3-9 IEF gel. Silver nitrate was used to stain the gel.

High performance liquid chromatography chromatogram

The chromatogram (Fig. 2) yielded 9 peaks by anion exchange chromatography at pH 8. The hemorrhagic peaks (5-7) eluted from the acidic portion of the ET curve. The specific hemorrhagic activity increases as the negative charge of the proteins increases. Peaks 1 and 2 make up the basic portion of the crude venom and do not have hemorrhagic activity. The other acidic peaks (3-4 and 8-9) were not hemorrhagic. Peak 7 yields the highest specific hemorrhagic activity.

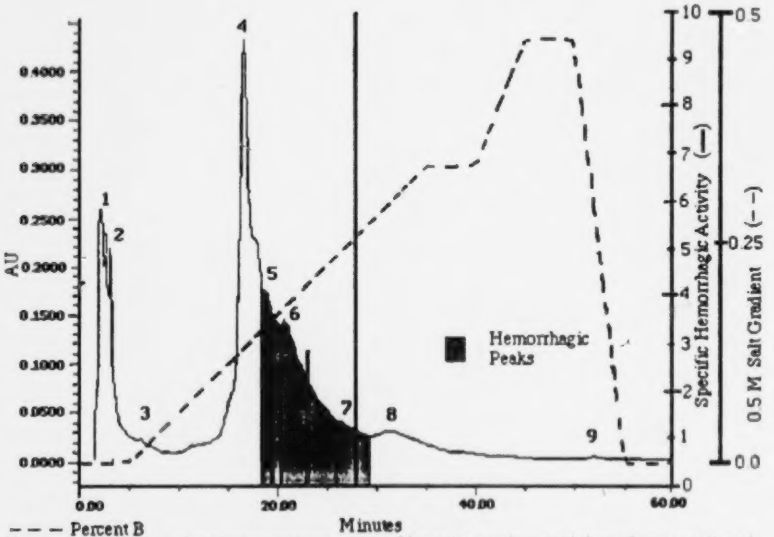

Figure 2. Crude *A. c. laticinctus* venom separated by anion exchange high performance liquid chromatography with a Waters HPLC-Pak DEAE 5PW column (7.5 x 75 mm, part # 088044, Millipore, at a flow rate of 1.0 ml/min for 60 min. The sample injected was 250 µl of a 70.5 mg/ml concentration of crude *A. c. laticinctus* venom and the absorbance was measured at 280 nm. The buffers used were 0.02 M Tris-HCl buffer, pH of 8.0 with a 0.5 M NaCl gradient. Peaks 5-7 were the hemorrhagic peaks.

Hemorrhagic, (MHD), and Antihemorrhagic assay

Table 1 shows the specific hemorrhagic activity of fractinated *A. c. laticinctus* venom. Peaks 1-4 and 8-9 were not hemorrhagic. The specific hemorrhagic activity for peaks 5-7 and crude venom were 0.709 mm/µg, 2.94 mm/µg, 10 mm/µg, and 2.38 mm/µg, respectively. Antihemorrhagic titer from opossum serum obtained for peak 6 and 7 were 8196 and 512 and crude venom titer was 128.

Table 1. Hemorrhagic Activity of *A. c. laticinctus* venom

Peak No.	MHD 1 (µg)	Specific Acitvity (mm/µg) 2	Opossum serum titer 3
1-4	-	-	-
5	14.1	.709	-
6	3.40	2.94	8196
7	1.00	10.0	512
8-9	-	-	-
crude	4.20	2.38	128

- Experiment not executed.
1 Minimal Hemorrhagic Dose that causes a 10 mm hemorrhagic spot.
2 The specific hemorrhagic activity calculated by (mm)/total protein injected (µg).
3 The recipricol of the highest dilution of serum (*D. virginiana*) neutralizing the MHD is the titer.

DISCUSSION

Crude *A. c. laticinctus* venom was separated by ET and yielded 10 bands which have IpH ranging between 4 to 9. *A. c. laticinctus* venom has both basic and acidic proteins and could be separated on both an anion and cation exchange column. At pH 6.5, *A. c. laticinctus* venom has the greatest charge distribution, which would be the optimal pH for separating proteins on ion exchange chromatography. Those proteins in a pH environment greater than 6.5 would migrate toward the anode and those with a pH of less than 6.5 migrate to the cathode. In this study a DEAE column was used to fractionate *A. c. laticinctus* venom using a 0.02 M Tris, pH 8 buffer. The reason for selecting pH 8 and DEAE column was for comparison with other venoms which were fractionated at these same conditions.

Nine peaks were observed by HPLC using an anion exchange column. Peaks 5-7 were hemorrhagic and were in the acidic part of the chromatogram in Fig. 2. Peak 7 was the most hemorrhagic peak with a MHD of 1 µg and was neutralized by opossum serum at a dilution titer of 512. The results in this study were consistent with Bjarnason and Tu (1978). *C. atrox* venom has many hemorrhagic toxins (HT) and all have been reported to be acidic proteins. The HT also had metalloproteinase activity. HT-a was the most hemorrhagic but the least proteolytic, which suggests that they may have different affinities for different substrates.

Snake metalloproteinases from venom resemble proteinases in cancer cells (Botos *et al.*, 1996). The metalloproteinase abundantly found in snake venoms can be used to design metalloproteinase inhibitors for cancer cells and neutralize hemorrhage in snakebite victims. Metalloproteinases cause hemorrhage by digesting the cellular matrix around capillaries which allows the blood to escape into the surrounding tissue. A similar process occurs with metastic tumors. Tumor cells penetrate capillaries by metalloproteinase digestion and take up residence in the surrounding tissue. Metalloptroteinases contain zinc in both the cancer cell and snake venom which cleaves through healthy tissue (Botos *et al.*, 1996). An experimental drug, Batimastat, was observed to interact with a metalloproteinase (Ht-d) isolated from the venom of *C. atrox*. The research proved that Batimastat bound to the structure of Ht-d, preventing the metalloprotinease from initiating capillary destruction. The interaction between the venom metalloproteinase and Batimastat gives hope for the design of new drugs that will aid in the fight of pathological conditions such as corneal ulceration, arthritis and cancer. Human metalloproteinases are available; however, snake venom enzymes are useful in the study of such pathological conditions since they are stable, readily available and easily cloned. Therefore, it is essential to purify metalloproteinases from a variety of snake venoms to further understand the mechanism of how these destructive metalloproteinase work. Understanding metalloproteinases will allow the design of new drugs which will fight the war on deadly diseases.

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LITATURE CITED

Adame, B. L., J. G. Soto, D. J. Secraw, J. C. Pérez, J. L. Glenn and R. C. Straight. 1990. Regional variation of biochemical characteristics and antigeneity in Great Basin rattlesnake (*Crotalus viridis lutosus*) venom. Comp. Biochem Physiol. pp. 1-7.

Anaya, M., E. D. Rael, C. S. Lieb, and J. C. Pérez. 1992. Antibody detection of venom protein variation within a population of Prairie Rattlesnakes (*Crotalus viridis viridis*) Journal of Herpetology 26,473-482.

Bjarnason, J. B., and A. T. Tu. 1978. Hemorrhagic toxins from western diamondback rattlesnake (*Crotalus atrox*) venom: isolation and characterization of five toxins and the role of zinc in hemorrhagic toxin. Biochem. 17:3395-3404.

Botos, Istuan; Scapozza, Leonardo; Zhaug, Dachuan; Liotta, Lance A.; Meyer, Edgar F. (1996) Batimastat, a potent matrix metalloproteinase inhibitor, exhibits an unexpected mode of binding. *Biochemistry*.

Huang, S. Y., Pérez, J. C., Rael, E. D., Lieb, C., Martinez, M., S. A. Smith (1992) Variation in the Antigenic charateristics of venom from the Mojave Rattlesnake (*Crotalus Scutulatus Scutulaus*). Toxicon 30, 387-396.

Martinez, R. A., Huang, S. Y. and Pérez, J. C. (1989) Antigenic Relationships of Fractionated Western diamondback rattlesnake (*Crotalus atrox*) hemorrhagic toxins and other ratttlesnake venoms as indicated by monoclonal antibodies. Toxicon 27, 239-245.

Omori-Satoh, T., S. Sadahirom, A. Ohsaka, and R. Murata. 1972. Purification and characterizaton of an antihemorrhagic factor in the serum of *Trimeresurus flavoviridis*, a crotalid. Biochem. Biophys. Acta 285:414-426.

Schwartz, M. W., W. R., Pool and A. L. Bieber. 1984. Mojave rattlesnake (*Crotalus scutulatus scutulatus*) venom: enzyme activities and purification of arginine ester hydrolases. Toxicon 22, 327.

Tu, A. T. (1983) Local tissue damaging (hemorrhage and myonecrosis) toxins from rattlesnake and other pitviper venoms. *J. Toxic Toxin Rev.* 2: 205.

THE PURIFICATION AND CHARACTERIZATION OF *CROTALUS VIRIDIS OREGANUS* VENOM

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The Pacific Mountain rattler, *Crotalus viridis oreganus*, belongs to the family Viperidae. Poisonous snakes such as the *C. v. oreganus* release venom that have hemorrhagic properties. Hemorrhagic proteins break the blood vessels, producing extensive hemorrhaging into the tissue spaces. Yet, certain animals have a natural resistance to poisonous snakes. Hemorrhagins in snake venoms must be purified to study the mechanism of venom neutralization in resistant animals. Electrophoretic titration was used to determine the conditions for ion exchange chromatography of *C.v. oreganus* venom using high performance liquid chromatography (HPLC). The *C. v. oreganus* venom was fractionated into 12 peaks and hemorrhagic activity was measured for each peak and crude venom. Peaks 5-12 exhibited hemorrhagic activity. The most hemorrhagic peaks was 7 and was neutralized by opossum serum. Opossum serum neutralized all hemorrhagic fractions and crude *C. v. oreganus venom.* The objective of this was to purify snake hemorrhagins which can be neutralized by opossum serum. The hemorrhagins will be used to produce monoclonal antibodies which will be useful in studying venom neutralization from different snake species.

INTRODUCTION

Snake venoms are complex mixtures of enzymes and toxins which cause immediate hemorrhage, edema, and myonecrosis (Swartz *et al.*, 1984; Tu, 1983). Each type of snake venom is different. Even within the same species quantitative and qualitative differences can be found between two venoms. There are also many similiarites found in toxins isolated from snakes in different families (Huang *et al.*, 1992, Anaya *et al.*, 1992, and Adame *et al.*, 1990).

Poisonous snakes use their venom for capturing and digesting prey. The envenomated animals suffer from hemorrhaging, swelling, and necrosis which is caused by a variety metalloproteinases. The metalloproteinases in snake venoms are the main contributing factor which cause hemorrhage. McKay *et al.*, (1970) reported that the hemorrhagic toxins (metalloproteinases) disrupt the basement membrane and cause endothelial cell lysis. Many of the venoms in the new world snakes are rich in metalloproteinases.

Even though venom causes medical emergencies in humans, a few warm-blooded animals have a remarkable degree of resistance. Antihemorrhagins are found in the sera of these resistant animals and neutralize a wide variety of hemorrhagins in many snakes (Pérez, *et al.*, 1978b; Catanese and Kress, 1992; and Ovadia *et al*, 1977b). Pérez *et al.* (1978a) reported that gray woodrats (*Neotoma micropus*) were able to withstand 121 times more *C. atrox* venom than white laboratory mice. The North American opossum (*Didelphis virginiana*), Mexican ground squirrel (*Spermophilus mexicanus*), hispid cotton rat (*Sigmodon hispidus*), and the gray woodrat (*Neotoma micropus*) all have a natural resistance to snake envenomation (Kilmon, 1976; Werner and Vick, 1977; and Pérez *et al.*, 1978b). The resistance to hemorrhage in certain animals is the result of antihemorrhagins found in their sera which neutralize hemorrhagins in snake venom nonspecifically.

Soto *et al.*, (1989) reported that the antihemorrhagic activity in sera from resistant animals neutralizes hemorrhagins from different snake venoms. Forty-seven different venoms from the Crotalidae, Viperidae, Elapidae, and Hydrophidae were tested for their hemorrhagic activity. The hemorrhagic activity was found in 80% of the Crotalidae, 50% of the Viperidae, 10% of Elapidae, and none in Hydrophidae venoms tested. Crude opossum and woodrat sera neutralized hemorrhagic activity of all hemorrhagic venoms tested. This is surprising since there are many hemorrhagins in a single venom. All hemorrhagins (seven) from western diamondback rattlesnakes (*C. atrox*) are neutralized by antihemorrhagins found in opossum (*Didelphis virginiana)* sera (Soto *et. al*, 1989). Recently four other hemorrhagic toxin genes from *C. atrox* (Ht-a, Ht-b, Ht-c, and Ht-d) have been cloned and sequenced and shown to share significant homology with Ht-e (Hite *et al.*, 1992b). This information suggests a common epitope theory. If opossum serum neutralizes all hemorrhagin then there must be a common sequence on snake venom hemorrhagins which are recognized by antihemorrhagins found in opossum serum.

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Monoclonal antibodies were used to study the antigenic nature of venoms (Normura *et al.*, 1982). Martinez*et al.* (1989) produced a monoclonal antibody (CA-P-8) from a hemorrhagic peak 8 of *Crotalus atrox* venom. The CA-P-8 monoclonal antibody completely neutralized hemorrhagic HPLC fractions 6, 7 and 8 from *C. atrox* venom. Crude venoms of *C. adamanteus*, *C. scutulatus scutulatus* and *C. virids lutosus* cross reacted with CA-P-8 via an *enzyme*-linked immunosorbent assay (ELISA). This study showed that these venoms share common epitopes, and therefore; are antigenically related.

Not all hemorrhagic toxins are antigenically related since hemorrhagic fractions 10 and 15 from *C. atrox* venom did not react with CA-P-8. Therefore, it is necessary to produce a panel of antibodies which would be useful in identifying cross-reacting antigens from venoms of different species and venoms of the same species, but from different geographical locations. The purpose of this study is to purify *C. v. oreganus* hemorrhagins which are neutralized by opossum serum. The purified hemorrhagins will be used to produce monoclonal antibodies needed to further study the mechanism of venom neutralization.

METHODS AND MATERIALS

Venom

C. v. oreganus venom was obtained from a snake captured in Washington and housed in the serpentarium at Texas A&M University-Kingsville. Crude venom was stored at -90 °C until used. Crude venom was diluted to 35.5 mg/ml with a 0.02 M Tris-HCl buffer, pH 8.0. The venom solution was centrifuged (Beckman Instruments, Inc., Avanti™30 centrifuge) for 5 min at 2,400 rpm, filtered (Millex-HV,0.45µm, Lot # H2SM98164, catalog # SLHV025NB), and then stored at - 20°C.

Electrophoretic titration

Electrophoretic titration was used to measure the IpH, and surface charge of crude venom proteins. This information would be useful in selecting the proper purification protocol. A Pharmacia PhastSystem with IEF 3-9 PhastGel™ was used to run an electrophoretic titration. The separation procedure followed was obtained from the Pharmacia PhastSystem instruction manual. After the pH gradient of 3-9 was established, the gel was then rotated clockwise 90°. The venom sample (7 µg) was applied perpendicular to the pH gradient across the middle of the gel and stained with silver nitrate.

Chromatography

C. v. oreganus venom was fractionated by anion exchange chromatography using Waters high performance liquid chromatography system with Millennium 2010 software. A total protein of 8.8 mg of snake venom was injected into DEAE column and eluted with a 0.02 M Tris buffer containing 0.5 M NaCl at pH 8.0. The fractionation required 60 min with a flow rate of 1 ml/min. The absorbency was measured at 280 nm. The column was a Waters Protein Pak DEAE 5PW (7.5x7.5mm); part #: 088044; obtained from Waters Division of Millipore of the Millipore Corporation; 34 Maple Street; Milford,Ma 01757).

Hemorrhagic and minimum hemorrhagic dose assay

A modified hemorrhagic assay described by Omari-Satoh *et al.* (1972) was used to determine hemorrhagic activity. Hemorrhagic activity was determined by intracutaneous (dorsal) injection into a depilated rabbit. Before injection the fractions were diluted to a concentration of 150 µg/ml to prevent excessive hemorrhage. This insured that no more than 15 µg of *C. v. oreganus* venom was injected into the back of a rabbit. The crude venom control was tested in the same manner. The rabbit was sacrificed 24 hr later. The sample was considered hemorrhagic if the diameter of the hemorrhagic spot was 10 mm. The minimal hemorrhagic dose (MHD) was determined for crude venom and each hemorrhagic fractions. The MHD is defined as the concentration of venom which will cause a 10 mm diameter hemorrhagic spot. Hemorrhagic activity is the diameter of the hemorrhaigic spot in mm. Specific hemorrhagic activity is the diameter of the hemorrhagic spot (mm) divided by total venom protein injected (µg).

Antihemorrhagic assay

Two minimal hemorrhagic doses (MHD) of HPLC fractions were mixed with crude doubling dilutions of opossum serum and incubated at 37°C for 1 hr. One hundred microliters of each of the incubated mixtures were injected into a deplitated rabbit. The rabbit was sacrificed after 24 hr and the skin removed. The reciprocal of the highest dilution of serum blocking the minimal hemorrhagic dose was taken as the titer.

RESULTS

Electrophoretic titration of crude C.v.oreganus venom

Fig. 1 is an electrophoretic titration (ET) curve of crude *C.v.oreganus* venom run on an IEF 3-9 gel. *C.v.oreganus* venom is clearly a heterogeneous mixture of proteins with different IpH and surface charges. The surface charge of each protein can be read on the y axis and IpH can be read from the origin (x axis). The proteins had maximum surface charge distribution at pH 8 as measured by their migration toward the anode (+). Most of the proteins had an IpH less than 7 which mean that *C.v.oreganus* venom is predominately acidic.

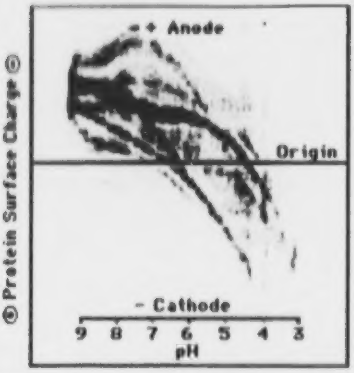

Fig.1 Electrophoretic titration for *Crotalus viridis oreganus* crude venom. A Pharmacia PhastSystem IEF 9-3 gel was used to run an electrophoretic titration. A pH of 3-9 was established. The gel was run with 3.5 µl of a 2 mg/ml *C.v. oreganus* venom sample and stained with silver nitrate.

Chromatogram Profile

C.v.oreganus venom consist of basic and acidic proteins and all hemorrhagic proteins were acidic proteins. Twelve peaks were eluted, of which peaks 5-12 were hemorrhagic. Peaks 6 and 7 were the most hemorrhagic and had a specific activity of 10 mm/µg. Proteins in peak 1 are basic proteins and proteins in peaks 3 through 12 are acidic proteins.

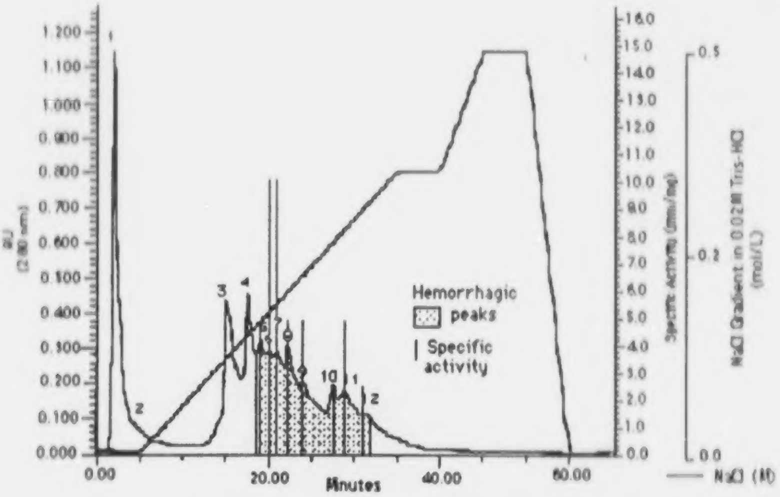

Fig. 2 Fractionation of *Crotalus viridis oreganus* crude venom using High Performance Liquid Chromatography (HPLC). *C.v.oreganus* venom fractionated by anion exchange chromatography using Waters HPLC system with Millennium 2010 software. A total protein of 8.88 mg of venom was injected into Waters protein Pak 5PW DEAE 7.5x7.5 mm column and eluted with a 0.02 M Tris-HCl buffer containing 0.5 M NaCl at pH 8.0.

Hemorrhagic, Minimum Hemorrhagic Dose and Antihemorrhagic Assay

As shown in Fig. 2, the shaded area represents hemorrhagic peaks and are in the acidic region of the venom HPLC profile. Table 1., illustrates the hemorrhagic activity for peaks 5-12. Both peaks 6 and 7 show the most hemorrhagic specific activity (10mm/µg). Peak 6 had an antihemorrhagic titer of 16, whereas, peak 7 had an antihemorrhagic titer of 8. It took the least amount of antihemorrhagic serum to neutralize peak 10 (titer of 64).

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Table 1. Hemorrhagic and Antihemorrhagic Activity of the*Crotalus viridis oreganus* Venom

Peak no.	Dilution ¥	MHD § (µg)	Amount Δ injected (ml)	Specific Activity (mm/µg) †	Antihemorrhagic titer ¶
5	17.25	2	0.1	5	32
6	31.7	1	0.1	10	16
7	31.1	1	0.1	10	8
8	14.1	2	0.1	5	16
9	9	2	0.1	5	16
10	4.55	4	0.1	2.5	64
11	8.15	2	0.1	5	**
12	1.67	3.9	0.1	2.6	**
crude venom	8.88	4	0.1	2.5	16

¥ Dilution made to obtain an MHD.

§ Minimum hemorrhagic dose is the concetration of protein, which causes a 10 mm hemorrhagic spot.

Δ Amount of sample injected into a rabbit.

† This is the activity (mm)/ MHD or total protein injected (µg). This was also the total amount of protein injected.

¶ The reciprocal of the highest dilution of serum blocking the MHD was taken as the titer.

** There was not enough venom sample to determine antihemorrhagic titer.

DISCUSSION

C.v.oreganus venom is a complex heterogeneous mixture of both acidic and basic proteins; however, all hemorrhagic proteins were acidic. Ten percent of the proteins from *C.v.oreganus* venom are basic proteins. Of the hemorrhagic proteins (peaks 5-12), peak 6 and 7 had the highest specific activity (10 mm/µg). Metalloproteinases in the Crotalidae and Viperidae venom are the factors causing hemorrhage in the envenomated victim. Such evidence suggest that peaks 6 and 7 are metalloproteinase. The MHD for both peaks 6 and 7 is 1µg which result in a 10 mm hemorrhagic spot. Even though peaks, 6 and 7, had the same specific hemorrhagic activity, they were not neutralized at the same rate with opossum serum. A higher concentration (lower dilution) of opossum serum was required to neutralize peak 7. Peak 6 required a opossum serum dilution of 1/16 for neutralization, whereas, the neutralization of peak 7 required a 1/8 dilution. The difference in neutralization rate suggest that peak 6 and 7 are therefore different and not neutralized at the same rate. The interpretation of the data must be with caution since we were dealing with crude opossum serum and only partially purified venom. Hemorrhagic proteins from peak 10 were the least hemorrhagic and require the smallest amount of opossum serum (highest dilution 1/64) to neutralize peak 10. Further studies are required to determine if the least hemorrhagic proteins are easiest to neutralize.

Martinez *et al.* (1989) demonstrated that monoclonal antibodies can be used to detect common epitopes among different venom proteins. Monoclonal antibodies were used to screen venoms with common epitopes, thus showing an antigenic relationship between these venoms. Perez *et al* . (1989) used two different monoclonal antibodies, *C. atrox* peak 8 (CA-P-8) and *C. atrox* subclone 5 (CA-5+) produced against two *C. atrox* venom hemorrhagic fractions to show the antigenic relationship between venoms. *C.v.oreganus* was one of the seven crude venoms tested. *C.v.oreganus* proteins reacted with CA-5+, indicating that some of these proteins had similar epitopes, thus establishing an antigenic relationship between crude *C.v.oreganus* proteins and those proteins found in peak 5 of *C. atrox*.

Further studies will involve purification of*C.v.oreganus* venom toxins which are hemorrhagic and are neutralized with opossum serum. These hemorrhagins will then be used to produce monoclonal antibodies. The monoclonal antibodies could be also used in affinity chromatography for purification of hemorrhagins. In addition, monoclonal antibodies can be used to study the mechanism of neutralization of venoms. The production of a panel of monoclonal antibodies would be useful in the identification of cross reactivity of different species of snake venoms. This information would be useful to the medical practitioner in treating snakebite victims more effectively and to the herpetologists interested in evolutionary aspects of biology.

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REFERENCES

Adame, B. L., Soto, J. G., Secraw, D.J., Perez, J. C., Glenn, J. L. and Straight, R. C. (1990) Regional variation of biochemical characteristics and antigenity in great basin rattlesnake (*Crotalus viridis lutosus*) venom. *Comp. Biochem. Physiol.* **97B**, 95-101.

Anaya, Michael, Eppie D. Rael, Carl S. Lieb, John C. Perez, and Richard J. Salo. (1992) Antibody detection of venom protein variation within a polpulation of the rattlesnake *Crotalus v. viridis*. *Journal of Herpetology*. **26** (4), 473-482.

Catanese J. J., and L. F. Kress. 1992. Isolation from Opossum Serum of a Metalloproteinase Inhibitor Homologous to Human a1B-Glycoprotein. Biochemistry 31:410-418.

Haung, S., J. C. Perez, E. D. Rael, C. Lieb, M. Martinez and S. A. Smith. (1992) Variation in the antigenic characteristics of venom from the Mojave rattlesnake (*Crotalus scutulatus scutulatus*). *Toxicon* **30** (4): 387-396.

Hite, L. A., Shannon, J. D., Bjarnason, J. B. and Fox, J. W. (1992b) Sequence of a cDNA clone encoding zinc metalloproteinase hemorrhagic toxin e from *Crotalus atrox*: evidence for signal, zymogen and disintegrin-like structures. *Biochemistry* **31**: 6203-6211.

Kilmon, J. A. (1976) High tolerance to snake venom by the Virginia opossum, *Didelphis virginiana*. *Toxicon* **14**, 337.

Martinez, R., A., Huang, S., Y. and J.C. Perez. (1989) Antigenic relationships of fractionated western diamondback rattlesnake (Crotalus atrox) hemorrhagic toxins and other rattlesnake venoms as indicated by monoclonal antibodies. Toxicon **27**, 239-245.

McKay, D. G., Moroz, D., deVries, A., Csavossy, I. and Cruse, V. (1970) The action of hemorrhagin and phospholipase derived from *Bipera palaestinae* venom on the microcirculation. *Lab. Invest.* **22**: 387-399.

Normura, M., Imai, M., Nakamura, T., Miyakawa, Y. and Mayumi, M. (1982) Demonstration of two distinct antigenic determinants on human alpha-foetoprotein by monoclonal antibodies. *Molec. Immun.* **19**, 1691.

Omori-Satoh, T., S. Sadahirom, A. Ohsaka, and R. Murata. (1972) Purification and characterizaton of an antihemorrhagic factor in the serum of *Trimeresurus flavoviridis*, a crotalid. Biochem. Biophys. Acta 285:414-426.

Ovadia, M. and, E. Kochva. 1977a. Neutralization of Viperidae and Elapidae snake venoms by sera of different animals. Toxicon 15:541.

Perez, J., Haws, W. and Hatch, C. (1978a) Resistance of woodrats (*Neotoma micropus*) to Crotalus atrox venoms. *Toxicon* **16**: 199-211.

Perez, J., Haws, W., Garcia, V. and Jennings, B. M. III. (1978b) Resistance of warm-blooded animals to Western diamondback rattlesnake (*Crotalus atrox*) venom. *Toxicon* **17**: 375-383.

Soto J. G., Perez , J. C., Lopez M. M., Martinez M., Quintanilla-Hernandez T. B., Santa-Hernandez M.S., Turner K., Glenn J. L., Milton S. A. (1989) Comparative enzymatic study of HPLC-fractionated *Crotalus* venoms. *Comp. Biochem. Physiol.* **93B**, 847-855.

Swartz, M. W.; Pool, W. R.; and Biber, A. L. (1984) Mojave rattlesnake (*Crotalus scutulatus scutulatus*) venom, enzyme activities and purification of arginine ester hydrolases. *Toxicon* **22**: 327-338.

Tu, A. T. (1983) Local tissue damaging (hemorrhage and myonecrosis) toxins from rattlesnake and other pit viper venoms. *J. Toxic Toxin Rev.* **2**: 205.

Werner, M. and Vick, A. (1977) Resistance of the opossum (*Didelphis virginiana*) to envenomation by snakes of the family Crotalidae. *Toxicon* **15**, 29.

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The Purification and Characterization of *Agkistrodon piscivorus leucostoma* Venom

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The Western cottonmouth (*Agkistordon piscivorus leucostoma*) is a poisonous, semi-aquatic snake which belongs to the Viperidae family and resides in the Southwestern United States. Cottonmouths are believed to be very aggressive snakes and use their venom for capturing and digesting prey. The Western cottonmouth venom is hemorrhagic. Most hemorrhagins are metalloproteinases which digest matrix proteins surrounding the endothelium of the capillaries. This causes the destruction of the endothelium and the escape of red blood cells and plasma into the surrounding tissue. The hemorrhage process is very similar to metastasis in tumors in which collagenase IV and other metalloproteinses digest proteins in the capillary matrix. Venom metalloproteinases make excellent models for studying tumor metastasis. Purification of venom metalloproteinases are essential to studying the mechanism of tumor metastasis as well as hemorrhage in snakebite victims. Electrophoretic titration was used to predict optimal conditions for separation of venom by ion exchange chromatography. The venom was fractionated by high performance liquid chromatography (HPLC) and each fraction was analyzed for hemorrhagic activity. Seven fractions were collected. Fractions 4, 5, 6, and 7 showed hemorraghic activity, and fraction 7 had the highest specific hemorrhagic activity. Their minimal hemorrhagic dose (MHD) were also determined and used to find the antihemorrhagic activity of the *Didelphis virginiana* (Virginia opossum) serum when combined with venom.

INTRODUCTION

Snake venoms are composed of many toxins which cause medical emergencies when humans are envenomated. Snakebites by rattlesnakes, cottonmouths, and copperheads usually cause immediate swelling, edema, and pain and if left untreated, will cause necrosis and possibly amputation of the affected area. Huang and Pérez (1980) reported that hemorrhage is one of the most prominent symptoms when an animal is envenomated by snakes from the Crotalidae and Viperidae families. *A. p. leucostoma* venom is hemorrhagic and hemotoxic. Hemorrhagic toxins (metalloproteinases) disrupt the basement membrane and cause lysis of endothelial cells (McKay *et al.*, 1970). Mortality rate in the United States, due to envenomation of *A. p. leucostoma* is not significant, but permanent tissue damage may occur through edema, hemorrhage and necrosis. Metalloproteinases not only cause the escape of red blood cells (hemorrhage) but also cause the escape of tumors cells from the capillaries which is known as metastasis. Purification of venom metalloproteinases are important in the study of hemorrhage and tumor metastasis. Tumors have metalloproteinases in low concentration and are difficult to purify. There are many structural and sequence homologies between venom and mammalian metalloproteinases. These similiarities make snake hemorrhagins excellent models for designing metalloproteinase inhibitors (Botos, *et al.*, 1996).

The extracellular matrix digestion with matrix metalloproteinases is a critical component of many physiological and pathological conditions. The physiological and pathological processes may only differ by the way in which extracellular matrix digestion is regulated. While the physiological roles of mammalian metalloproteinases are to digest extracellular matrix in a controlled manner during tissue remodeling, differentiation, and wound healing, many pathological conditions are caused by uncontrolled matrix degradation. Uncontrolled matrix degradation results in excessive tissue destruction, disruption of matrix boundaries and loss of matrix function. Examples of pathological metalloproteinase expressions are envenomation from snakebites and invasiveness by a variety of human tumors (breast, colon, thyroid, hepatocellular, lung and prostate cancers).

All proteinases in circulation are subject to the influence and regulation by plasma proteinase inhibitors. Intrinsic enzymes, such as clotting factors, and extrinsic enzymes, such as hemorrhagic toxins have little activity if they are neutralized by inhibitors (Travis and Solvesen, 1983). The α-2-macroglobulin is a major metalloproteinase inhibitor (Starkey and Barrett, 1977, Werb *et al.*, 1974). Bjernson and Tu (1978) reported five hemorrhagic toxins (HT-a, HT-b, HT-c, HT-d, and HT-e) in *Crotalus atrox* venom. The proteolytic activities of

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hemorrhagic toxins HT-c and HT-c/d toward the large molecular weight gelatin type I and collagen IV were completely inhibited by α-2-macroglobulin. The activity of HT-a on the same protein substrate was not significantly inhibited. This is interesting since HT-a is the most hemorrhagic protein.

Studies have been done in which several animal sera were shown to neutralize the effects of snake metalloproteinases (Kilmon 1976; Werner and Vick 1977; and Pérez *et al.*, 1978). *D. virginiana*, (Virginia opossum) was first reported by Kilmon (1976) and then by Werner and Vick (1977) to have a remarkable, natural resistance to snake venom. Pérez *et al.* (1978) reported *Neotoma micropus* (gray woodrats) to be resistant to the hemorrhagic activity of the Diamondback rattlesnake (*C. atrox*) venom. The purpose of this study was to purify and characterize the *A. p. leucostoma* venom and to determine the neutralization characteristics of the Virginia opossum serum on *A. p. leucostoma* venom.

MATERIALS AND METHODS

Venom/snake

A. p. leucostoma was originally collected from Lafayette, Lousiana and is presently housed in Texas A&M University Kingsville Serpentarium. The snake currently weighs 611 g and is 88 cm in length. The venom was collected, centrifuged using a Beckman Avanti™ 30 Centrifuge at 3,500 rpm for 5 min, and filtered using a Millipore MillexHV 0.45μm filter unit. The venom was stored at -90°C.

Sera

The opossums were obtained from the Animal Control Center of Kleberg County, TX. Sera was collected from *D. virginiana* by heart puncture. The blood was stored at -4°C for 24 hr and then centrifuged using a Beckman Avanti™ 30 Centrifuge at 3,500 rpm for 10 min. After centrifugation the opossum serum was collected and stored at -90° C until used.

Electrophoretic titration

Electrophoretic titration of the crude venom was conducted to determine the optimal conditions for separation of venom by ion exchange chromatography. The pH gradient (3-9) was established using a Pharmacia PhastSystem with an IEF 3-9 gel. *A. p. leucostoma* venom (7 μg) was applied to the gels and rotated 90°. Electrophoresis was conducted as outlined in the Pharmacia manual and the gel was stained with silver nitrate.

Anion exchange chromatography

A. p. leucostoma venom was fractionated using a method described by Soto *et al.* (1989). Two-hundred-and-fifty microliters of venom, 38.8 mg/ml were injected into a Waters HPLC System using a Waters Protein-Pak™ 5PW-DEAE column (7.5 x 75 mm). The elution buffers used to establish a salt gradient were 0.02 M Tris-HCl, pH 8, and 0.02M Tris-HCl, pH 8 containing 0.5 M NaCl. The absorbance of the venom fractions collected was monitored at 280 nm using a Waters 484 tunable absorbance detector. Each fraction was collected and the absorbance was taken using an LKB Biochrom Ultraspec II at 280 nm. All the fractions were stored at -20°C.

Hemorrhagic assay and minimal hemorrhagic dose

Crude *A. p. leucostoma* venom and fractions collected were tested for hemorrhagic activity. A modified method of Omori-Satoh *et al.* (1972) was used to measure hemorrhagic activity. New Zealand rabbits were injected intracutaneously with 0.1 ml of 150 μg/ml of each venom fraction collected. The rabbit was sacrificed 24 hr later, and the diameter of the hemorrhagic spots (hemorrhagic activity) were measured. The minimum hemorrhagic dose (MHD) was determined for crude venom and each fraction. MHD is defined as the minimum amount of venom which causes a 10 mm hemorrhagic spot. The specific activity was determined by dividing the hemorrhagic activity by the amount of total protein (mg) injected.

Antihemorrhagic assay

The method described by Huang and Pérez (1980) was used to determine the antihemorrhagic activity of *D. virginiana* sera. The MHD for each fraction were combined with equal amounts of various serial dilutions of sera and incubated for 1 hr at 25°C. A volume of 0.1 ml for each solution was injected intracutaneously into the back of depilated rabbits. The rabbits were sacrificed after 24 hr and the diameter of the hemorrhagic area was measured.

RESULTS

Electrophoretic titration of crude *A. p. leucostoma* venom

Figure 1 is an electrophoretic titration (ET) curve that was obtained using crude *A. p. leucostoma* venom. The proteins in the ET curve were mainly acidic since most of the IpH were below 7. Multiple bands in Figure 1 indicate that *A. p. leucostoma* venom is a heterogenous mixture of proteins. The maximum surface charge distribution for venom proteins was in the range of 7 through 8.5. The titration curve also indicated that most of the proteins could be optimally separated by HPLC using an eluding buffer above pH 7 and anion exchange (+) column since most proteins had a maximum surface charge distribution at this pH.

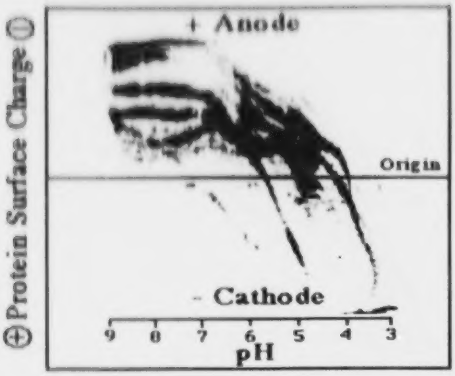

Figure 1. Electrophoretic titration for crude *A. p. leucostoma* venom. A Pharmacia Phast System with LKB IEF 3-9 gel was used for titration. A pH gradient of 3-9 was established. Three-and-one-half microliters of *A. p. leucostoma* venom sample (2 mg/ml) were injected in the system and then developed by silver nitrate staining. Optimal separation of proteins in HPLC were obtained using a buffer pH 8.

HPLC chromatogram

A. p. leucostoma venom was fractionated using the Waters HPLC System. Figure 2 illustrates that there were a total of seven peaks collected. The proteins in the first peak were in the basic region of the HPLC chromatogram while the proteins in fractions 2-7 were in the acidic region. The most acidic protein would have greatest affinity for the DEAE matrix (+) and would be eluted last. The basic proteins in peak 1 had a positive charge and were eluted with the void volume. None of the proteins in peak 1 were hemorrhagic. The acidic proteins in peaks 4-6 were hemorrhagic. The hemorraghic activity and specific hemorrhagic activity of every hemorrhagic peak collected from HPLC fractionation is tabulated in Table 1 and shown in Figure 2. The most hemorrhagic fraction was peak 6 with an MHD of 2 µg. The fraction with the highest specific activity was peak 6 with a specific activity of 5 mm/µg. Both peaks 4 and 5 had the lowest specific hemorrhagic activity which was 1 mm/µg.

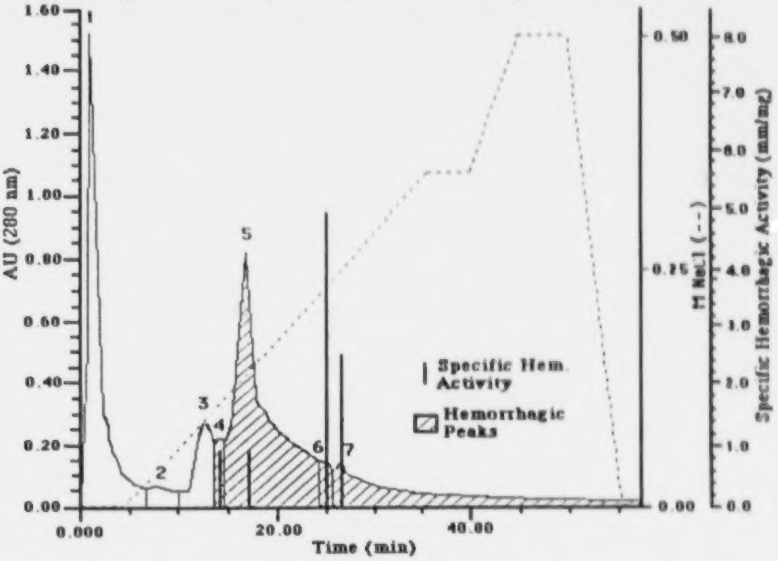

Figure 2. Fractionation of *A. p. leucostoma* crude venom using high performance liquid chromatography (HPLC). Two-hundred and fifty microliters of crude *A. p. leucostoma* venom (38.8 mg/ml) in 0.02 M Tris-HCl, pH 8 buffer were injected into a Waters HPLC System containing a Waters Protein-Pak 5PW-DEAE (7.5 x 75mm) column. The absorbance was detected at 280 nm.

Sera antihemorrhagic titer

The opossum serum antihemorrhagic titers are tabulated in Table 1. The titer is the reciprocal of the highest dilution of *D. virginiana* sera which neutralizes an MHD. Peaks 5 and 6 had the highest antihemorrhagic titer of 256. Antihemorrhagic titer of 128 was obtained for peak 4. It required more opossum sera to neutalize peak 4 than it took to neutralize peaks 5 and 6. Titers for peaks 1-3 were not obtained since they were not hemorrhagic.

TABLE 1. Hemorrhagic assay on each fraction collected of *A. p. leucostoma* venom and the capacity of *D. virginiana* sera to neutrilize *A. p. leucostoma* venom.

Peak No. *	Total Protein Injected (μg) @	Hemorrhagic Activity (mm) ¥	Specific Activity (mm/μg) §	Minimum Hemorrhagic Dose (μg) ¤	Antihem. Titer (serum) ‖
1	15.0	0 £	0	0	0
2	15.0	0	0	0	0
3	15.0	0	0	0	0
4	15.0	12	0.80	10.0	128
5	15.0	12	0.80	10.0	256
6	12.3	16	1.30	2.00	256
7	3.90	10	2.56	3.90	ø
crude *A.p.l.*	10	10	1.00	10.0	256

* The venom peaks collected from HPLC.

@ The amount of protein that was injected into the back of a rabbit.

¥ Hemorrhagic activity is defined as the diameter (mm) of the hemorrhagic area.

§ The specific activity was determined by dividing the hemorrhagic activity by the total protein (mg) injected.

¤ The MHD is defined as that amount of venom resulting in a 10 mm hemorrhagic area.

‖ The antihemorhagic titer is defined as the reciprocal of the highest dilution of *D. virginiana* sera which neutralizes an MHD.

£ The peak was not hemorrhagic.

ø There was not enough sample to determine antihemorrhagic titer.

DISCUSSION

The results demonstrate that electrophoretic titration is an excellent technique to determine the optimal conditions for protein separation by ion exchange chromatography. The titration curve provided useful information about the characteristics of *A. p. leucostoma* venom. The multiple bands indicated that crude *A. p. leucostoma* venom is a complex mixture of proteins. The venom proteins in the ET curve had the greatest surface charge distribution in a pH range of 7 to 8. A buffer with a pH of 8 and DEAE (+) column would be an excellent matrix for separation of crude *A. p. leucostoma* venom. The ET curve and the HPLC chromatogram clearly indicate that the venom was composed of both acidic and basic proteins. Both figures show *A. p. leucostoma* venom has more acidic than basic proteins. The IpH of the proteins can be measured from the titration curve at the points where the surface charge on the proteins is zero. Proteins with an IpH of 7 or less are acidic proteins.

The chromatogram obtained from HPLC fractionation shows seven peaks of which four were hemorrhagic. Proteins in Peak 1 at pH 8 have positive charges and are basic. These non-hemorrhagic proteins eluted with the void volume. Peak 1 proteins along with proteins in peaks 2 and 3 were not hemorrhagic. Proteins in peaks 4-7 were acidic and showed hemorrhagic activity. All the hemorrhagic fractions were acidic proteins which was consistant with the findings of Bjarnason and Tu (1978). All but one hemorrhagic protein (Ht-b) isolated from *C. atrox* venom were acidic (Bjarnason and Tu, 1978). Hemorrhagic proteins are metalloproteinases which disrupt the basement membrane and cause escape of red blood cells into the surrounding tissue.

The venom fractions collected, which had a measureable hemorrhagic activity, were neutralized with serial dilutions of *D. virginiana* sera. Pérez *et al.* (1978) reported that a number of warm-blooded animals have antihemorrhagic factors which allow for greater survival when bitten by a poisonous snake. The results from this study and other studies made by Kilmon (1976), Werner and Vick (1977), and Pérez *et al.*, (1979) strongly indicate that *D. virginiana* has a remarkable antihemorrhagic resistance to various venomous snakes. The neutralization capacity of *D. virginiana* serum on peaks from crude *A. p. leucostoma* venom was determined. Fractions 5 and 6 had the highest antihemorrhagic titer of 256 which means these fractions were easily neutralized. The hemorrhagic activity of peak 6 was higher than peak 5 but neutralized with opossum serum at the same rate. More opossum serum (a titer of 128) was required to neutralize peak 4 even though it had the same hemorrhagic activity as peak 5. It is important to notice that the most hemorrhagic fractions required less opossum serum for neutralization.

McKay *et al.*, (1970) reported that hemorrhagic toxins in snake venoms are metalloproteinases which break the basement membrane in cells and cause the lysis of

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endothelia cells. These hemorrhagic metalloproteinases have high degree of similarity with metalloproteinases that are found in tumor cells which make them excellent models for studying cancer (Botos, *et al.* 1996). The metalloproteinases found in tumor cells interact with the basement membrane causing proteolysis which initiates the metastatic cascade (Stetler-Stevenson *et al.*, 1993). Hemorrhagic toxins (metalloproteinases) in venom are very abundant and makes venom an excellent source of metalloproteinases. Metalloproteinases in venom and in tumors of mammals work in a very similar way. Antihemorrhagic factors in the opossum serum neutralize the venom metalloproteinases and prevent hemorrhage. These same antihemorrhagins could also prevent metastasis of tumors. Thus, it is of extreme importance to purify the metalloproteinases in venom and antihemorrhagins in opossum serum to determine the mechanism of neutralization. Once this mechanism is understood then the metastasis cascade could also be inhibited. Thus, the next step of this study is to continue the purification of hemorrhagic fraction until pure metalloproteinases can be obtained to determine the structure of the protein.

REFERENCES

Bjarnason, J. B. and Anthony T.Tu (1978) Hemorrhagic toxins from Western diamondback rattlesnake (Crotalus atrox) venom: isolation and characterization of five toxins and the role of zinc in hemorrhagic toxin e. Biochemistry **17**, 3395-3404.

Botos, Istuan; Scapozza, Leonardo; Ahaug, Dachuan; Liotta, Lance A.; Meyer, Edgar F. (1996) Batimastat, a potent matrix metalloproteinase inhibitor inhibitor, exhibits an unexpected mode of binding. Biochemistry

Huang, S. and J.C. Perez (1980) Comparitive study on hemorrhagic and proteolytic activities of snake venoms. Toxicon **18**, 421-426.

Kilmon, J.A. (1976) High tolerance to snake venom by the Virginia opossum, *Didelphis virginiana*. Toxicon **14**, 337-340.

McKay, D. G., Moroz, D., deVries, A., Csavossy, I. and Cruse, V. (1970) The action of hemorrhagin and phospholipase derived from Bipera palaestinae venom on the microcirculation. Lab. Invest. **22**: 387-399.

Omori-Satoh, T., Sadahiro, S. Ohsaka, A. and Muraia, R. (1972) Purification and characterization of an antihemorrhagic factor in the serum of *Trimeresurus flavoviridis*, a crotalid. Biochem. biophys. Acta **285**, 414.

Pérez, J. C., Garcia, V.E., and Huang, S.Y. (1984) Production of Monoclonal Antibody Against Hemorrhagic Activity of *Crotalus atrox* (Western Diamondback Rattlesnake) Venom. Toxicon. 22, 967-973.

Pérez, J. C., Haws W. C., and Hatch C. (1978). Resistance of Woodrats (*Neotoma Miropus*) to Crotalus Atrox Venom. Toxicon **16**: 199-211.

Pérez, J. C., Pichyangkul, S., and Garcia, V. E. 1979 The resistance of three species of warm- blooded animals to western diamondback rattlesnake (Crotalus atrox) venom. Toxicon **17**, 601-607.

Soto, J. C., J. C Perez, M. M. Lopez, M. Martinez, T. B. Quintanilla-Hernandez, M. S. Santa- Hernandez, K. Turner, J. L. Glenn, S. A. Minton. (1989) Comparitive enzymatic study of HPLC-fractionated Crotalus venoms. Comp. Biochem. Physiol. **93B**, 847-855.

Starkey, P. M. and Barrett, A. J. (1977) a 2-Macroglobulin is a physiological regulator of proteinase activity. In: Proteinases in Mammalian Cells and Tissues, Barrett, A.J. (ed.) Northe-Holland, New York, 663-692.

Stetler-Stevenson, William G., Aznavoorian, Sadie and Liotta, Lance A. (1993) Tumor Cell Interactions with the Extraecllular Matrix During Invasion and Metastasis. Annu. Rev. Cell Biol. **9**, 541-73.

Travis, J. and Salvesen, G. S. (1983) Human proteinase inhibitors. Ann. Rev. Biochem **52**, 655-709.

Werb, Z., Burleigh, M. C., Barrett, A. J. and Starkey, P. M. (1974) The interaction of α-2-macroglobulin with proteinases. Biochem. J. **139**, 359-368.

Werner, M. R. and Vick, A.J. (1977) Resistance of the opossum (*Didelphis virginiana*) to envenomation by snakes of the family Crotalidae. Toxicon **15**, 29.

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Purification and Characterization of *Crotalus viridis lutosus* Venom

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Crotalus viridis lutosus (Great Basin rattlesnake) is a member of the Viperidae family. The *C. v. lutosus* venom is classified as a hemorrhagic venom. The purpose of this study is to investigate the hemorrhagic ability of *C. v. lutosus* venom. An electrophoretic titration curve was used to determine optimal conditions for high performance liquid chromatography (HPLC). A total of 11 peaks were collected from DEAE fractionation, and each fraction was tested for hemorrhagic activity. Peaks 4-11 were hemorrhagic and the specific hemorrhagic activity of each were determined. Peaks 6 and 7 resulted in the highest specific hemorrhagic activities which were both 6.67 mm/μg. All hemorrhagic fractions and crude venom were neutralized by crude *Didelphis virginiana* (Virginiana opossum) serum. The long range goal of this research is to purify snake hemorrhagins which are neutralized by opossum serum and sera from animals with a natural resistance to snake venom.

INTRODUCTION

Crotalus viridis lutosus (Great Basin rattlesnake) is a member of the pit viper group and subfamily Crotalidae. The Great Basin rattlesnake is one of nine recognized subspecies of western rattlesnakes (Klauber, 1956). Mainly dominating in the west, it ranges from the Rockies to Sierras, including southeastern Oregon, northern California, southern Idaho, central Nevada, and western Utah . The hemorrhage produced by these rattlesnakes is one major symptom in bite-manifestation of Crotalid and Viperid snakes (Masahiko *et al.*, 1995). Human envenomation by *C. v. lutosus* may include clinical signs of edema, eccymosis, hemorrhage, defibrination, hypotension, local necrosis and, very rarely, death. Soto *et al.* (1989) reported that the antihemorrhagic activity in sera from resistant animals neutralizes hemorrhagins from different snake venoms. The venom of this subspecies contains several enzymatic activities relatively common to rattlesnake venoms, i.e. L-amino acid dehydrogenase, hide powder azure protease, phosphodiesterase, and phospholipase activities (Aird *et al.*, 1988).

Adame *et al.* (1990) reported latitudinal distribution of specific hemorrhagic activity and enzyme linked immunoadsorbent (ELISA) activity using monoclonal antibody (CA-P-8). In this study CA-P-8 monoclonal antibody was used to screen *C. v. lutosus* from different localities. The antibody recognized the most hemorrhagic fraction in pooled venom from the northeast and northcentral Utah but failed to react against venom from southern Utah.

As harmful as venom may be to humans, there are a few animals that display an unusual resistance to snake venoms. Perez *et al.* (1978a) reported that gray woodrats (*Neotoma micropus*) were able to endure 121 times more *Crotalus atrox* venom than Balb/c mice. The Virginiana opossum (*D.virginiana*), Mexican ground squirrel (*Spermophilus mexicanus*), hispid cotton rat (*Sigmodon hispidus*), and the gray woodrat (*Neotoma micropus*) all have a natural resistance to snake envenomation (Kilmon, 1976; Perez *et al.*, 1978b). The resistance of certain mammals to hemorrhagic venoms appears to be due to the presence of antihemorrhagic factors in the sera (Perez *et al.*, 1978b; Pichyangkul and Perez, 1980; Menchaca and Perez, 1981; and Garcia and Perez, 1984).

The goal of this study was to purify hemorrhagic toxins in *C. v. lutosus* venom and determine which fractions react with crude opposum serum.

MATERIALS AND METHODS

Venom collection

C. v. lutosus venom was obtained from the VA Hospital in Salt Lake City, Utah. The venom was centrifuged and filtered using a Millipore Millex® HV 0.45 µm filter unit. The venom was stored at -90°C.

Serum collection and preparation

The serum from *D. virginiana* was collected by heart puncture. The serum was centrifuged at 3,500 rpm for 10 min at 4°C on a Beckman Avanti™ 30 Centrifuge and stored at -90°C.

Electrophoretic titration curve

A volume of 3.5 µl of a 2 mg/ml *C. v. lutosus* venom sample was separated by electrophoretic titration using a Pharmacia Biotech PhastSystem. A pH gradient of 3-9 was established on a polyacrylamide IEF 3-9 PhastGel. The gel was rotated 90° and venom sample applied. The gel was then stained with silver nitrate. The same electrophoretic titration procedure was followed for other hemorrhagic factors that would be further purified.

Fractionation by High Performance Liquid Chromatography (HPLC)

Two hundred and fifty microliters of crude *C. v. lutosus* venom (41.2 mg/ml) was injected into a Waters Protein-Pak DEAE 5PW (7.5 x 75 mm) HPLC column. Fractions were eluted using a 0.02 M Tris-HCl buffer, pH 8.0, and 0.5 M NaCl over a period of 60 min with a flow rate of 1 ml/min. A Waters 484 tunable absorbance detector was used to detect the absorbance at 280 nm of the fractions. Millennium software v.2.15 on a Digital Venturis 466 computer was used to control the pumps and store the data obtained. Fractions were stored at -20°C.

Hemorrhagic assay

A hemorrhagic assay was performed to determine the minimal hemorrhagic dose for crude *C. v. lutosus* venom and for the fractions collected (Omori-Satoh *et al.*, 1972). Fractions were diluted to concentrations of no more than 150 µg/ml, of which 0.1 ml was injected subcutaneously onto the back of a depilated New Zealand rabbit to test for activity. After 24 hr, the rabbit was sacrificed. The hemorrhagic spots were measured and the specific activity calculated for each fraction. The MHD is defined as that concentration of venom which causes a 10 mm hemorrhagic diameter. The specific hemorrhagic activity was determined by dividing the hemorrhagic activity (mm) by the total protein injected.

Antihemorrhagic assay

Equal amounts of the MHD of crude and fractionated venom were mixed with serial dilutions of opossum serum (*D. virginiana*) and incubated for 1 hr at 23°C. The back of a New Zealand rabbit was depilated and 0.1 ml was injected. The rabbit was sacrificed after 24 hr. The antihemorrhagic activity was taken as the reciprocal of the highest dilution of serum which neutralized the MHD.

RESULTS

The electrophoretic titration curve (figure 1) indicates that *C. v. lutosus* venom is acidic and the IpH and protein surface charges can be measured. The IpH range was 3-6 and can be observed on the x axis at the origin. Differences in the surface charge are view on the y axis.

Figure 2 shows the hemorrhagic fractions as well as the specific activity of each fraction. Eleven fractions were collected by anion exchange chromatography and eight of these were hemorrhagic. All hemorrhagic fractions were acidic proteins. Proteins in fraction one have a positive charge and eluted with the void volume on a DEAE column. These proteins are basic and were not hemorrhagic, as opposed to the other 10 that have negative charges. From this chromatogram, it can be concluded that *C. v. lutosus* venom is complex mixture of mainly acidic proteins.

Table 1 lists the hemorrhagic activity and specific activity for each of the fractions collected by HPLC. As seen on this table, fractions 4-11 were determined to be hemorrhagic. Fractions 6 and 7 had the highest specific activity of 6.67 mm/µg and the lowest MHD, 1.5 µg.

Serum from the *D. virginiana* was tested for its neutralizing ability on the crude *C. v. lutosus* venom, as well as the hemorrhagic fractions. *D. virginiana* sera neutralized all hemorrhagic fractions and crude *C. v. lutosus* venom. Crude venom is neutralized by a titer of 128 while the fractions with the highest hemorrhagic specific activity (fractions 6 and 7) are neutralized by a titer of 4 and 16, respectively.

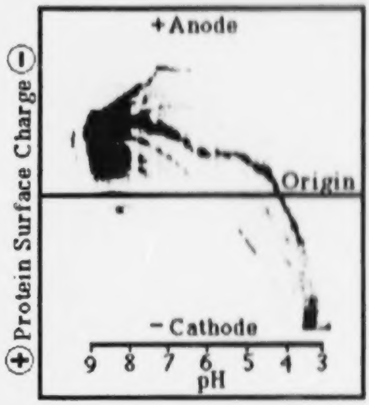

Figure 1. Electrophoretic titration curve for crude *C. v. lutosus* venom. Three and one half microliters of a 2 mg/ml venom sample was applied to a Pharmacia Biotech PhastSystem on a polyacrylamide IEF 3-9 PhastGel. The gel was stained with silver nitrate. From the electrophoretic titration curve, it can be seen that the pH range for the buffer is approximately in the range of 6-8 and a DEAE column should be used. The intensity of the protein surface charge at various pH can be seen.

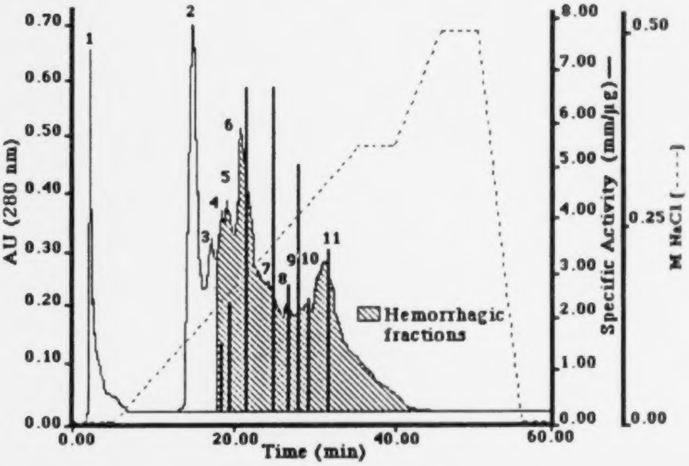

Figure 2. Determination of hemorrhagic and specific hemorrhagic activity for the fractions collected for *C. v. lutosus*. The venom sample was fractionated by anion exchange chromatography. Two hundred and fifty microliters of venom (41.2 mg/ml) was injected into a Waters Protein-Pak DEAE 5PW (7.5 x 75 mm) HPLC column. The fractions were eluted with 0.02 M Tris-HCl, pH 8.0 and 0.5 M NaCl gradient was used. The collection required 60 min with a flow rate of 1 ml/min and an absorbance of 280 nm. A total of 11 fractions were collected. A hemorrhagic assay was performed on the fractions collected by the Waters HPLC System through an anion exchange column. Peaks 4-11 were determined to be hemorrhagic as indicated by shaded area. The specific hemorrhagic activity of each was determined by dividing the hemorrhagic activity by the total protein injected, represented by solid line.

TABLE 1. SPECIFIC HEMORRHAGIC ACTIVITY, MINIMAL HEMORRHAGIC DOSES, AND ANTIHEMORRHAGIC TITER FOR *C. V. LUTOSUS* VENOM

Venom Sample §	Specific Activity (mm/µg) *	MHD (µg) £	TITER ¥
Crude	0.48	2.1	128
Fractions 1-3 •	0	0	0
Fraction 4	1.67	6.0	8
Fraction 5	2.50	4.0	4
Fraction 6	6.67	1.5	4
Fraction 7	6.67	1.5	16
Fraction 8	2.86	3.5	32
Fraction 9	5.00	2.0	4
Fraction 10	2.50	4.0	8
Fraction 11	3.22	3.1	Δ

§ The venom samples correspond to the crude *C. v. lutosus* venom, as well as the hemorrhagic fractions (Figure 2).

* Specific activity was calculated by dividing the 10 mm spot produced by the total protein injected.

£ The MHD is the total protein required to produced a 10 mm spot.

¥ The antihemorrhagic titer is defined as the reciprocal of the highest dilution of animal sera that neutralizes a MHD.

• Fractions 1-3 were not hemorrhagic.

Δ Not enough sample to determine the antihemorrhagic titer.

DISCUSSION

Electrophoretic titration was the method used for determining optimal conditions for separation by ion exchange chromatography. Not only does this method predict the pH range and column to be used, but it allows us to see if the proteins are acidic or basic, whether the proteins are heterogeneous, the intensity of the surface charge of proteins at the various pH, and the isoelectric point of the different proteins can also be predicted. Some of the same conclusions can be reached by separation of the protein by ion exchange chromatography but would require repeated runs to obtain optimal separation. Basic and acidic proteins were observed in Fig. 2. Protein in peak 1 were eluted with the void volume since they are basic proteins and have a positive charge at pH 8 and do not bind to DEAE matrix. Peaks 2 through 11 were eluted with various salt concentrations. Peak 2 has weak negative charge and elutes first, and peak 11 is the most negative charged protein and has the greatest affinity for the matrix. In the study, it was concluded that *C. v. lutosus* venom is heterogenous and mainly acidic (figures 1 and 2). These findings confirm the work of Adame *et al.* (1990) in which venom from three different geographical regions were fractionated by HPLC/DEAE chromatography. The specific hemorrhagic activity of the snakes in northern Utah was greater than specific activity in Southern Utah.

Eight out of 11 fractions collected by HPLC were hemorrhagic (figure 2). The specific activities of each of the hemorrhagic fractions were determined (table 1). Fractions 6 and 7 have the highest specific activities, 6.67 mm/µg, and have the same MHD, 1.5 µg. Each hemorrhagic peak (MHD) were neutralized by crude *D. virginiana* serum with varying titers (table 1). Although fractions 6 and 7 have the same specific activities and MHD, the antihemorrhagic titers used to neutralize the venom were different. Fraction 6 was neutralized by a titer of 4, while fraction 7 by a titer of 16. The results of this substantiate the findings of numerous investigators who reported that opossum neutralizes all hemorrhagic venoms and venom fractions (Kilmon 1976, Perez *et al.*, 1978a & b, Soto *et al.*, 1989, Menchaca and Perez 1981, and Pichyangkul and Perez 1980).

C. v. lutosus hemorrhagic fractions purified in this study will be used to construct an affinity column to purify antihemorrhagins in opossum serum. Once purified hemorrhagins and antihemorrhagins are obtain the mechanism of venom neutralization will be studied in resistant animals. Understanding the mechanisms in which antihemorrhagins neutralize snake venom, could be used in snakebite treatment.

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REFERENCES

Adame B. L., Soto J.G., Secraw D. J., Perez J. C., Glenn J. L., and Straight R. C. (1990) Regional variation of biochemical characteristics and antigeneity in Great Basin rattlesnake (*Crotalus viridis lutosus*) venom. *Toxicon* 97B, 95-101.

Aird S. A., Seebart C. S., and Kaiser I. (1988) Preliminary fractionation and characterization of the venom of the Great Basin rattlesnake (*Crotalus viridis lutosus*). *Herpetologica* 44, 71-85.

Garcia V. and Perez J. C. (1984) The Purification and characterization of antihemorrhagic factor in woodrat (*Neotoma micropus*) serum. *Toxicon* 22, 129-137.

Kilmon J. A. (1976) High tolerance to snake venom by the Virginia opossum, *Didelphis virginiana*. *Toxicon* 14, 337.

Klauber L. M. (1956) Rattlesnakes: Their Habits, Life Histories and influence on Mankind. Vol I. Berkely: University of California Press.

Masahiko Iha (1995) The primary structure of a hemorrhagic factor, HR2b. *Toxicon* 33, 229-239.

Menchaca J. and Perez J. C. (1981). The purification and characterization of an antihemorrhagic factor in opossum (Didelphis virginiana) serum. *Toxicon* 19, 623-632.

Omori-Satoh T., Sadahiro S., Ohsaka A. and Muraia R. (1972) Purification and characterization of an antihemorrhagic factor in the serum of *Trimeresurus flavoviridis*, a crotalid. *Biochim. biophys. Acta* 285, 414.

Perez J. C., Haws W. C., and Hatch C. (1978a) Resistance of woodrats (*Neotoma micropus*) to *Crotalus atrox* venom. *Toxicon* 16, 199-211.

Perez J. C., Haws W. C., Garcia V. E., and Jennings B. M. III (1978b) Resistance of warm-blooded animals to snake venom. *Toxicon* 16, 375-383.

Pichyangkul S. and Perez J. C. (1980) Purification and characterization of a naturally occurring antihemorrhagic factor in the serum of the hispid cotton rat (*Sigmodon hispidus*). *Toxicon* 19, 205-215

Soto J. G., Perez J. C., Lopez M. M., Martinez M., Quintanilla-Hernandez T. B., Santa-Hernandez M. S., Turner K., Glenn J. L., Milton S. A. (1989) Comparative enzymatic study of HPLC-fractionated Crotalus venoms. *Comp. Biochem. Physiol.* 93B, 847-855.

The Use of Electrophoretic Titration Curves as a Tool in Predicting the Separation of Crude *Crotalus atrox* Venom by High Performance Liquid Chromatography

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The Western Diamondback rattlesnake, *Crotalus atrox*, is found in the southwestern portion of the United States. It is the second largest rattlesnake in North America and is extremely aggressive. Venom from *C. atrox* is one of the most studied venoms. The venom has been reported to contain seven hemorrhagins which consist mainly of metalloproteinases. These metalloproteinases are responsible for the degradation of the endothelium cells in capillaries which allows blood to escape into surrounding tissue. Metalloproteinases that have been isolated from *C. atrox* venom can be used to explore the binding specificity of anti-tumor drugs. This study used electrophoretic titration to predict the best protocol for high performance liquid chromatography (HPLC) on crude *C. atrox* venom. Preliminary results indicate that individual venom samples are different and may contain less than seven hemorrhagins as originally reported for pooled *C. atrox* venom. If the venom composition is different the symptoms of venom envenomation may differ. Results of electrophoretic titration indicated that the best pH for separating *C. atrox* venom was a pH of 8.0 with a DEAE-anion exchange column. Twenty-one peaks were obtained and fourteen were hemorrhagic, with peak 8 having the highest specific hemorrhagic activity. The isolation of these hemorrhagins are essential for developing better treatment and in developing metalloproteinase inhibitors.

INTRODUCTION

The Western Diamondback rattlesnake, *Crotalus atrox*, is native to the southwestern United States and Mexico. Venoms from the Crotalidae family of snakes are among the most hemorrhagic. Snake venom is used for the capture and initial digestion of prey. Venom is composed of a mixture of proteins, many of which are toxic. Metalloproteinases in venom cause destruction of endothelium cells in capillary beds allowing blood to be discharged into surrounding tissue. The current medical treatment for snakebites involves the administration of antivenin which has often resulted in causes complicating anaphylactic symptoms in the victim. Bajarnson and Tu (1978) reported that *C. atrox*, Western Diamondback rattlesnake, has five hemorrhagins in pooled venom. Even though venom is hemorrhagic, it has been discovered that several warm-blooded animals possess a natural resistance to venom of snakes from the Crotalidae family (Perez *et al.*, 1979, 1992). To understand the mechanism of resistance, one must first understand the toxic properties of venom. A fundamental requirement in studying venom is purification.

Electrophoretic titration (ET) is a powerful tool that can be used to predict the appropriate pH and type of column for further separation of venom by high performance liquid chromatography (HPLC). In electrophoretic titration a uniform polyacrylamide gel provides a porous network through which the venom will migrate in an electric field at different pH. Proteins are amphoteric molecules whose charge can be manipulated by changes in pH. At the isoelectric point, the proteins will carry a net neutral charge and will not migrate. At a pH less than the IpH, the protein will carry a positive charge and will migrate toward the cathode. Proteins subjected to a pH greater than their IpH will carry a negative charge and will migrate to the anode. The migration of proteins in a pH gradient (electrophoretic titration) can be used to predict the optimal conditions for purification of venom by HPLC. In ion exchange chromatography, a complex mixture of proteins, such as venom, can be separated on the basis of charge. A pH should be selected in which the proteins have a maximum difference in surface charge. Electrophoretic titration is an excellent tool for selecting the proper pH for ion exchange chromatography.

MATERIALS AND METHODS

Venom

Venom for this study was obtained from a pooled venom sample of snakes held at the Texas A&M University-Kingsville Serpetarium. The typical yield of venom for a captive Western Diamondback rattlesnake is 1.0 mL of venom per snake. The average size of a Western Diamondback rattlesnake at the TAMUK Serpetarium is 1.5 m. All venom collected was frozen at -90°C after receipt.

Electrophoretic titration curve

One milligram of crude *Crotalus atrox* was dissolved into 1 mL of deionized water. The solution was then centrifuged for 5 min at 7000 rpm (IEC Clinical Centrifuge). The supernatant was filtered through a 0.45μm micron versapor filter. Electrophoretic titration was implemented on a Pharmacia Biotech Phast System. A pH gradient (3.0-9.0) was established using an IEF 3-9 polyacrylamide gel (Pharmacia Biotech). The gels were rotated 90° clockwise and then the venom sample was applied to the gel. Electrophoretic titration curves were performed for crude *C. atrox* venom and the for the collected fractions from further purification procedures. The total protein applied for crude venom was 0.01 mg. The total protein applied to the IEF gel for peak 8 (Fig. 2) was 0.00418 mg and for fraction 11 (Fig. 5) the total protein applied to the gel was 0.00003 mg. The proteins were allowed to migrate for 20 min at 200V. The gel was then stained with a 0.4% silver nitrate solution using the Pharmacia Biotech Developer. All separation and developing techniques were implemented as outlined in the Pharmacia Biotech Manual Phast Gel Silver Kit 11-B-080-09.

High performance liquid chromatography (HPLC)

A *C. atrox* venom sample was fractionated by anion exchange high performance liquid chromatography (HPLC). The total protein injected into the HPLC system was 15 mg. The two buffers used were 0.02 M Tris-HCl, pH 8.0, and 0.02 M Tris-HCl containing 0.5M NaCl, pH 8.0. The column chosen for separation based on results from electrophoretic titration was a Protein Pak DEAE 5PW (7.5X75mm) HPLC column manufactured by Water Division of Millipore Corporation. The total run time was 60 min. The fractions with a low absorbancies were lypholized to concentrate the protein.

Hemorrhagic activity

A modified method of Omori-Satoh *et al.* (1972) was used. The fractions were diluted to a concentration of 0.15 mg/mL and 0.1 mL was injected by a subcutaneous (dorsal) injection administered on New Zealand adult rabbits. The controls were: 0.02 M Tris-HCl buffer A ,pH 8.0, 0.02 M Tris-HCl buffer B, pH 8.0, (0.5 M NaCl), 2.5 μg crude *C. atrox* venom (1 MHD). An MHD is the amount of protein injected that will produce a 10 mm hemorrhagic spot. The mice were sacrificed after 24 hr and hemorrhagic spots were measured. Specific hemorrhagic activity was determined by dividing the diameter of the hemorrhagic spot by the total protein concentration of venom injected.

RESULTS

Several bands were visible on the IEF gel for crude *C. atrox* venom. Each band indicated that the venom is composed of proteins which have different mobilities at varying pH (Fig 1). The best separation is evident at a pH range between 7.0 and 8.0. Between pH 7 and 8, the majority of proteins contain a negative charge and have migrated toward the anode. The maximum surface charge distribution was observed at a pH of 8.0 which indicated that an anion exchange column (DEAE) at a pH of 8.0 would provide optimal separation.

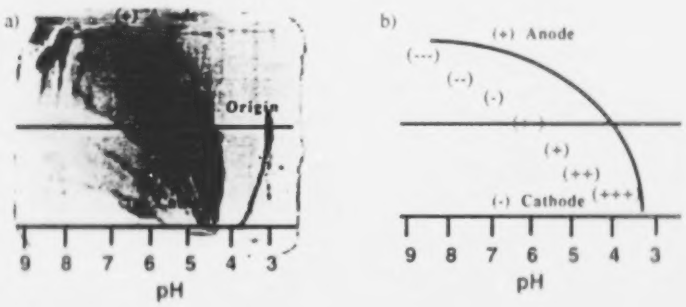


Figure 1. a) Electrophoretic titration curve of *C. atrox* venom using an IEF 3-9 polyacrylamide gel (Pharmacia BioTech). A total of 0.01 mg of protein was applied to the gel, and placed into the Pharmacia Phast System for separation and development. b) Model of surface to charge ratio of proteins as they are altered by changes in pH. As the pH is decreased, the surface charge becomes more positive and migration proceeds toward the cathode.

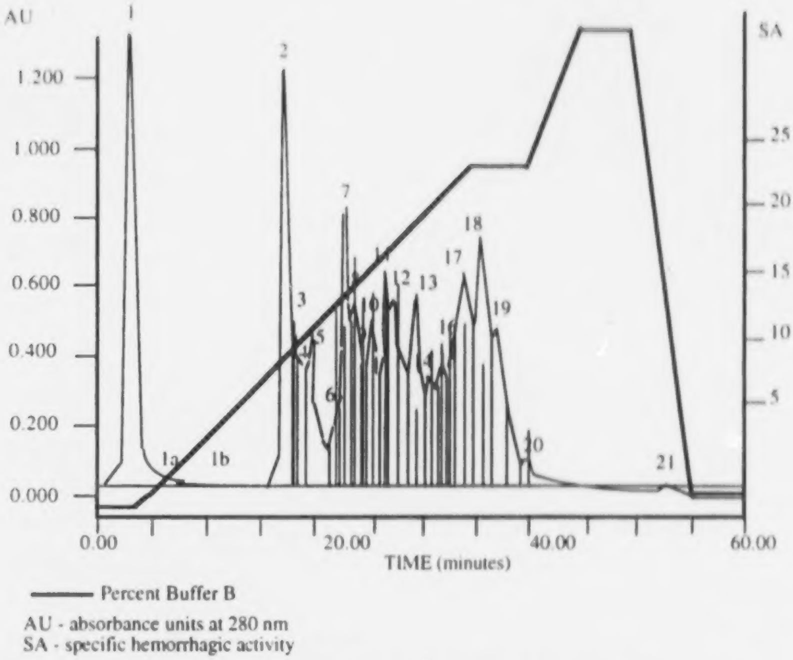


Figure 2. Anion exchange high performance liquid chromatography profile on crude *Crotalus atrox* venom. The total protein injected into a 0.02 M Tris-HCl buffer, pH 8.0 was 15 mg. A 0.5 M NaCl gradient was utilized to elute those proteins with a greater affinity for the stationary phase. The column used for separation was a Protein Pak DEAE 5PW (7.5X75mm) HPLC column manufactured by Waters Division of Millipore Corporation with a run time of 60 min. Specific hemorrhagic activity is denoted by the vertical lines.

The twenty-one fractions were collected and specific hemorrhagic activity was then measured. Of the twenty-one peaks, peaks 3, and 6-19 were hemorrhagic. The peak with the highest specific hemorrhagic activity is peak 8 which produced a 2.25 cm hemorrhagic spot. An evident distinction between the two titration curves is the shifting of peak 8's curve to the right. This shift is a result of differences in the isoelectric pH ranges of the proteins contained in peak 8. Peak 8 (Fig. 2) was more acidic; therefore, it is composed of proteins that could be better separated at a lower pH. From the electrophortic titration curve, the optimal range for further purification of peak 8 was a pH range between 6.0 and 7.5. At a pH of 7.3 it would appear that the fraction would contain few positively charged proteins as the gel had few bands that migrated toward the anode (Fig. 4). The electrophoretic titration curve indicated that the components of peak 8 were highly acidic. Acidic proteins containing negative charges could be further purified by using an anion exchange column.

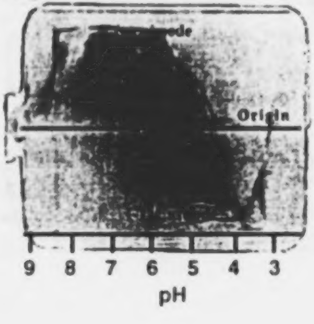
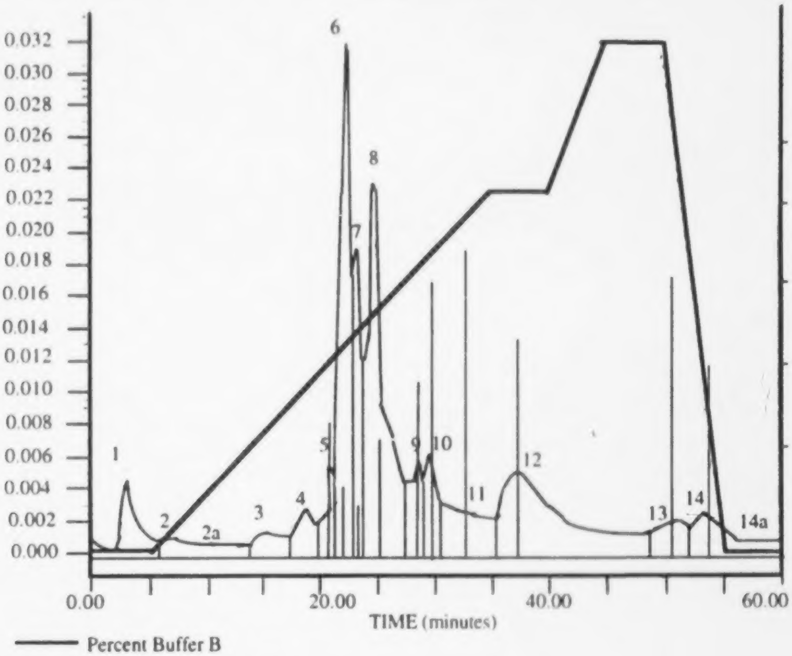


Figure 4. Electrophoretic titration curve of peak 8 using an IEF 3-9 Polyacrylamide gel (Pharmacia BioTech). Peak 8 was the fraction with the highest specific activity and the most hemorrhagic fraction. The total protein applied to the IEF 3-9 gel was 0.00418 mg. The gel was then placed into the Pharmacia Phast System for separation and development (Phast Silver Kit Instruction Manual 11-B-080-09).

Peak 8 was further fractionated at a pH of 7.3 utilizing a 0.02 M Tris-HCl buffer. The HPLC profile for this separation provided 14 fractions (Fig 5.) Of the 14 fractions, 10 were hemorrhagic. The venom fraction with the greatest specific activity was number 11. The fraction with the greatest specific activity was not a peak, but was a valley, that was collected separately during the initial fractionation. The concentration of fraction 11 was quite low and via spectrophotometric measurements it equaled only 0.006 mg/mL. Due to the low concentration the venom was lypholized prior to evaluation by electrophoretic titration.



AU - absorbance units at 280 nm
SA - specific hemorrhagic activity

Figure 5. High performance liquid chromatography profile on peak 8. The total protein injected into the HPLC system was 0.100 mg. The elution buffers included a 0.02 M Tris-HCl buffer, pH 7.3, and a 0.02 M Tris-HCl buffer with 0.5 M NaCl as a gradient used to aid in elution of the proteins containing a greater surface charge ratio. The column used for separation was a Protein Pak DEAE 5PW (7.5X75mm) HPLC column manufactured by Waters Division of Millipore Corporation. Hemorrhagic activity is denoted by the vertical lines. The peak with the highest specific hemorrhagic activity is not a peak but the valley collected as fraction 11.

By lypholization, the components of fraction 11 became more concentrated. The fraction was then reconstituted in 100μL of deionized water. Electrophoretic titration was then performed on fraction 11 (Fig.6) and provided a protocol for the further purification of this fraction. The electrophoretic titration of fraction 11 showed one distinct band. Again as expected the IpH of the proteins in this fraction have shifted to the right, indicating that the proteins in this fraction are more acidic. This results was expected because of the position of the fraction 11 on the HPLC profile (Fig.5).

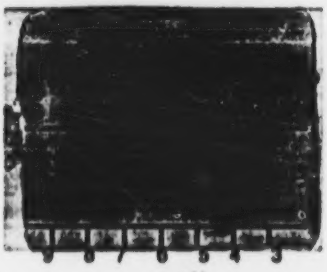


Figure 6. Electrophorectic titration curve of fraction 11 using an IEF 3-9 Polyacyramide gel (Pharmacia BioTech). Fraction 11 (Fig.5) was the fraction with the highest specific activity and the most hemorrhagic fraction. The total protein applied to the IEF 3-9 gel was 0.00009 mg. The gel was then placed into the Pharmacia Phast System for separation and development (Phast Silver Kit Instruction Manual 11-B-080-09).

DISCUSSION

ET is an excellent indicator of the results of HPLC. As an analytical tool, ET has become an invaluable asset in predicting the separation protocol of crude *C. atrox* venom by ion exchange chromatography. ET provides a method for evaluation of the surface charge ratio of the components of crude venom. By assessing the varying surface charge of proteins, the optimal protocol for purification can be determined. By reviewing the migration pattern of the bands an optimal range for separation can be visualized. In addition, ET provides a great deal of supplementary analytical data. By assessing the electrophoretic titration curve, one can extract not only the optimal method for purification, but also, the acidity or basicity of a sample at a given pH. It is also relatively simple to ascertain the pI of the sample. The purity of a sample can likewise be determined by the number of bands present in the gel. Electrophoretic titration can also be used in conjunction with other types electrophoresis such as two-dimensional electrophoresis to further identify components of interest. The use of electrophoretic titration has become an important procedure in the purification scheme of crude *C. atrox* venom. The use of this powerful tool aids in predicting isolation of a "pure" hemorrhagic toxins that can be further studied. Following each purification procedure, ET was useful in selecting the next HPLC purification protocol. The purification of proteins is essential in understanding their function. With a purified protein, models can be constructed and the function of the protein can be determined. ET provides a method for determining optimal separation procedures when the choice of separation is dependent on the charge of the proteins.

Once a hemorrhagic factor is isolated, the mechanism for its activity can be reviewed. It is essential in the purification of the toxins that specific activity is not lost as this ensures that the toxins isolated have not be denatured, and that they are still capable of causing proteolytic activity. Acquiring a "pure" toxin will enable not only the production of monoclonal antibodies which can be used to find better treatment for the victims of snakebites, but it will also provide a means to study the proteolytic activity of metalloproteinases. The isolation of the hemorrhagic factors, anti-hemorrhagic factors, and the production of monoclonal antibodies will allow for study of the mechanism of the proteolytic properties of venom. Understanding the mechanism of activation or inhibition of metalloproteinases will also aid in the comprehension of proteolytic properties of some cancers.

ACKNOWLEDGEMENT

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LITERATURE CITED

Bjarnson, J.B. and Tu, A.T. (1978) Hemorrhagic toxins from western diamondback rattlesnake (*Crotalus atrox*) venom: isolation and characterization of five hemorrhagic toxins. *Biochemistry* 17, pgs. 3395-3404.

Bohinski, Robert C. 1987. *Modern Concepts in Biochemistry* 5th Edition, Allyn and Bacon, Inc., Boston, MA pgs. 113-173.

Rael, E.D. and Jones, L.P. (1983) Electrophoretic variants of Mojave rattlesnake (*Crotalus scutulatus scutulatus*). *Toxicon* Vol. 21, pgs. 57-65.

Soto, J., Perez, J., Lopez, M., Martinez, M.,Quintanilla-Hernandez, T., Santa-Hernandez, M., Turner, K., Glenn, J., Straight, R., and Minton, S., (1989) Comparative Enzymatic Study of HPLC-Fractionated Crotalus Venoms *Comp. Biochem. Physiol.* Vol.93B, No. 4, pgs.847-855.

S.Y. Huang, J.C. Perez, E.D. Rael, C. Lier, M. Martinez and S. A. Smith, (1992) Variation in the antigentic characteristics of venom from the Mojave rattlesnake (*Crotalus scutulatus scutulatus*). *Toxicon* Vol. 30, No. 4, pgs 387-395.

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Development of a Rapid Detection Method for Determining Bacterial Guild Structure in Mining-Impacted Freshwater Sediments

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Heavy metal contamination of lakes and streams is a common result of mining activity. Understanding how biological communities respond is critical for developing strategies to minimize the impact of such disturbances. We are developing methods to identify major functional groups of bacteria that may reside in metal contaminated freshwater sediments. These techniques use Denaturing Gradient Gel Electrophoresis (DGGE) of PCR amplified ribosomal gene fragments to discriminate among taxa likely to influence metal biogeochemistry. In addition to providing information on the ecology of these environments, our techniques may reveal bacterial strains or consortia that may prove useful in bioremediation.

BACKGROUND

The Coeur d' Alene river valley of northern Idaho was the site of a silver mine from the late 1800s through the 1960s. During this time there were few regulations on mining procedures and as a result, the south fork of the Coeur d' Alene river in addition to adjoining lakes were inundated with ore rich in trace elements. Within the delta where the Coeur d' Alene river enters Coeur d' Alene lake, total metals comprise approximately 15% of the sediment by dry weight. Many of these metals such as zinc, lead, and cadmium are at such high levels that they may pose a threat to many organisms should they leach into the water column. Microbial biogeochemistry plays a major role in the cycling of these metals. Environmental changes such as dredging or anoxic conditions resulting from eutrophication have the potential to alter microbial reductive activities allowing higher and potentially dangerous concentrations of these metals to move into the water column. Due to the danger posed by these sediments as well as their use as a model for understanding metal biogeochemistry, this system has been chosen to visualize how biological communities respond to these disturbances and determine strategies to minimize the impact of such disturbances.

To assist in this study we are developing methods to identify major functional groups of bacteria that may reside in these metal contaminated sediments. With advances in technology, new and better procedures for determining the composition and location of microorganisms within complex microbial communities is now possible. Sequencing, flow cytometry, and denaturing gradient gel electrophoresis are some of the newer techniques providing additional information and insight into these diverse populations. While it is estimated that cell culture can only isolate and characterize approximately 20% of naturally occurring bacteria, these molecular techniques can potentially identify all microorganisms within these communities (Muyzer, De Waal, and Uitterlinden 1993).

Denaturing gradient gel electrophoresis (DGGE) compares the melting properties of double stranded DNA fragments isolated from organisms. The technique exploits the differences in hydrogen bonding that occurs between these discrete sequence fragments. Melting characteristics are determined by the base pair composition of these fragments, with G-C rich sequences giving a higher melting point due to the extra hydrogen bond shared between these bases. DGGE uses a formamide/urea mixture instead of an elevated temperature to break the hydrogen bonds and denature the DNA. By creating a polyacrylamide gel with a gradient of increasing denaturant it is possible to physically separate different DNA sequences based on melting temperature (Fisher, Lerman 1983). As the DNA moves through the gel it reaches a point at which the denaturant breaks the hydrogen bonds and the double stranded DNA fragment partially disassociates causing a restriction in its movement through the polyacrylamide matrix. This results in the formation of a band that corresponds to the melting domain of the DNA fragments.

In addition to providing a method of identifying organisms, DGGE relates other types of information as well. Because DGGE can utilize nearly any region of an organism's DNA it is possible to adjust the sensitivity and scope of this procedure (Costes, Girodon, *et.al* 1993). This technique could provide information on a variety of problems ranging from detecting point mutations within genes to classifying and understanding populations of organisms. In this case, we are developing techniques that utilize DGGE of PCR amplified ribosomal gene fragments to ascertain the distribution of functional groups of bacteria that are likely to influence metal biogeochemistry within the heavy metal contaminated sediments of the Coeur d' Alene river delta.

MATERIALS AND METHODS

DNA extraction and PCR: *Bacillus subtilis* (ATCC 6051), *Burkholderia cepacia* (ATCC 25416), *Escherichia coli* (DH5-α), *Desulfovibrio desulfuricans* (ATCC 7757), *Methylobacterium thermoautotrophicum* (ATCC 29096), *Clostridium sporogenes* (ATCC 3548), *and Methanobacterium organophilum* (ATCC 27886) were used as standard strains and positive controls. DNA was extracted from these standard strains using a revised Marmur procedure (Johnson *et al.* 1994). Community DNA was isolated from bacteria inhabiting the environmental sediment samples using an extraction method developed in our laboratory (Harrington *et al.* Submitted 1997). DNA from a small region of the 16s ribosomal gene was amplified using specially designed PCR primers. The oligonucleotides; primer 1 (32-mer) 5'-AGTGGCGAGCTCAGTGCCAGCAGCC-GCGGTAA-3' and primer 2 (53-mer) 5'-AAACTCAAAGGAATTGCCC-CCCGTGCCCCCGCCCCGGCGGCCGCCGGCGGGCG-3' (Gibco BRL), were used to amplify the 533 to 907 region (*E. coli*) and attach a GC clamp to the PCR product. The primers include Not I and Sac I restriction sites to allow the primers to be utilized in cloning experiments.

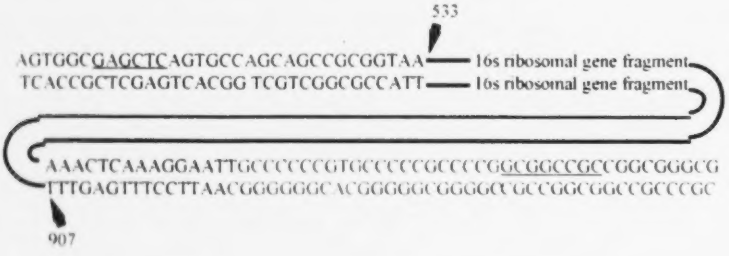
533
AGTGGCGAGCTCAGTGCCAGCAGCCGCGGTAA
16s ribosomal gene fragment
TCACCGCTCGAGTCACGG TCGTCGGCGCCATT
16s ribosomal gene fragment
AAACTCAAAGGAATTGCCCCCCGTGCCCCCGCCCCGGCGGCCGCCGGCGGGCG
TTTGAGTTTCCTTAACGGGGGGCACGGGGGCGGGGCCGCCGGCGGCCGCCCGC
907

Figure 1: PCR product of *E. coli* standard showing the region of amplification, primer attachment, location of Sac I and Not I restriction sites, and GC clamp.

The concentration of the extracted DNA was determined by 260/280 nm spectrophotometric analysis. One unit of *Thermus aquaticus* DNA polymerase (Perkin Elmer) was added to 100 mM of primer 533 and 907, 2.5 mg BSA (Gibco BRL), 400 pmol dNTP, 150 mM magnesium chloride (Gibco BRL), 10X PCR buffer (Gibco BRL), and double distilled water in PCR tubes layered with mineral oil to prevent desiccation. The 50 µl samples were incubated in the 480 Thermocycler (Perkin Elmer) at 94° C for one minute followed by four cycles of 94° C for 30 s, 65° C for 30 s, and 72° C for 30 s. These cycles were followed by three cycles at 94° C, 60° C, and 72° C each for 30 s. The last cycle was repeated 25 times extending each cycle five seconds. The amplified material was then tested on a 1.0% agarose gel using a 1 Kb ladder and a negative control to confirm the presence of the 400 bp PCR products.

DGGE: The denaturing gradient gel apparatus (DGENE BIO-RAD) was operated under the following parameters. Temperature was maintained at 60° C with a thermally regulated 0.5X TAE (40 mM Tris base, 20mM sodium acetate, 1mM EDTA) buffer (BIO-RAD) throughout the experiments. Acrylamide stock solutions (6.5% acrylamide and 37.5:1 ratio of acrylamide-bisacrylamide) containing 30% or a 70% concentration of denaturant (7 M urea and 40% deionized formamide constitute a 100% concentration) were used to form 30% to 70% denaturing gradient gels. The gels were run for 6 hours at 300 V (~150 mA). Gels were loaded with 10 µl of PCR amplified DNA from the standard strains and 20 µl from the environmental samples. After electrophoresis the gels were removed from the apparatus and stained in glass distilled water containing ethidium bromide (0.05 µg/ml) for 30 minutes. The gels were transilluminated with UV light and then photographed with Polaroid™ 665 film.

DISCUSSION

Before this rapid detection method may be employed to study complex microbial communities it must be completely developed and tested. Several procedures and protocols have already been developed and are continuing to be optimized for use in this detection method. Our methods to extract community DNA from mining impacted sediments are providing template DNA for PCR experiments in high yields and purity. PCR primers and reaction protocols are yielding the appropriate size fragments from numerous bacterial groups as is evident by the smears exhibited in lanes 9-13 of the denaturing gradient gel.

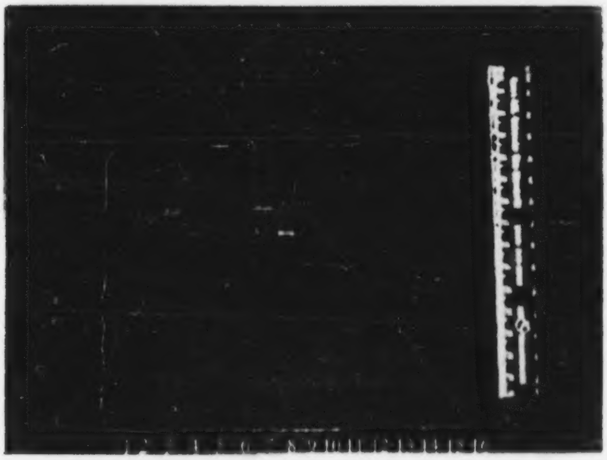

Figure 2: PCR-DGGE analysis of environmental samples: Lanes: 1 and 2, blank; 3, *B. subtilis*; 4, *B. cepacia*; 5, *C. sporogenes*; 6, *D. desulfuricans*; 7, *E. coli*; 8, *M. organophilum*; 9 to 13, environmental samples; 14 to 16, blank.

After multiple experiments, the parameters for resolving PCR products by DGGE have been refined. Work on transferring the DGGE gels to nitrocellulose membranes is currently underway. We have designed a sulfate reducing bacterial (SRB) probe which should hybridize to a portion of the 16s ribosomal gene fragment. The oligonucleotides will carry a chemiluminescent marker and are designed to recognize a majority of the bacteria that comprise this functional group (Risatti *et al.* 1995). After probing the membranes we hope to determine the distribution of SRB in these sediments. In addition, we plan to develop probes for iron reducing bacteria (IRB) and methane producing bacteria (MPB) to provide information on the major functional groups of bacteria that influence metal biogeochemistry in this environment.

This molecular detection method has the potential to provide results from sediment samples in approximately 48 hours; a rate far faster than conventional characterization techniques. It also has the advantage of examining nearly all of the bacterial strains in the environment as opposed to only those that are culturable. Besides its use for determining population

Purification and Biochemical Characterization of Antibacterial Antibiotics Produced by Soil *Streptomyces*

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Antibacterial antibiotics produced by strains of *Streptomyces* isolated from soil samples were characterized using a modified Kirby Bauer antibiotic sensitivity screening procedure. Frozen spore suspensions of both narrow and broad spectrum antibiotic producing strains were inoculated into liquid culture and incubated with vigorous aeration for two weeks at 28 C. The resulting culture medium contained soluble antimetabolites that inhibited the growth of the same profile of bacteria as the original isolates did on the agar medium. The antimetabolites were purified by Sephadex column chromatography. The column fractions were assayed for antibiotic activity by transferring fractions to sterile filter disks employed in the Kirby Bauer assay. Chromatography data for one strain (ALD13) indicated activity in multiple fractions. These suggest that the strain produce more than one molecular species with antimicrobic activity. Further purification and characterization studies utilizing high performance liquid chromatography and nuclear resonance are planned.

BACKGROUND

Antibiotics are secondary metabolites produced by certain types of microorganisms, especially fungi and bacteria. In natural environments these antibiotics help the producing microorganisms compete against other organisms for limited resources. Clinically useful antibiotics have selective toxicity, that is they inhibit or kill certain types of microorganisms but are harmless to humans. Because of this they were considered medical miracles when discovered over half a century ago. The first antibiotic, penicillin was discovered by Sir Alexander Fleming in 1929 and became commercially available in the early 1940's. Streptomycin, the first "broad spectrum antibiotic was discovered by Selman Waksman in the mid 1940's. Since then hundreds of different antibiotics have been discovered and many are used to treat infectious diseases of man. For a time it was believed that the currently available antibiotics would continue to be effective. The reality turns out to be much different. Pathogenic microorganisms that once were destroyed by these antibiotics have now mutated and become resistant to many of these drugs. Recently there has been a revival of the search for new antibiotics and this area of research is being more generously funded.

Over fifty of the currently used antibiotics, (e.g., tetracycline and erythromycin) for the treatment of infectious disease in human as well as in veterinary medicine are produced by species of the soil bacterium *Streptomyces*. These bacteria are found in almost any soil and are relatively easy to isolate.

METHODS

The procedure that was followed for the preliminary isolation of the *Streptomyces* bacteria from soil samples was as follows:

- Soil samples were collected from the upper inch of top soil from various locations.
- The soil samples were dried at 37 C for one week.
- One gram of soil sample was diluted in 99 ml of sterile deionized water.
- A decimal serial dilution was performed.
- One tenth (0.1) ml portions of the 10^{-4}, 10^{-5}, and 10^{-6} dilutions were spread onto the surface of starch agar culture medium and incubated for two weeks.
- *Streptomyces* colonies were identified under a dissecting microscope and spores picked from the colonies using an inoculating loop moistened with sterile water. The *Streptomyces* spores were then streaked onto another starch agar plate and incubated at 28 C for 7-10 days.
- Agar plugs removed from the streak plate are employed in a modified Kirby Bauer assay to detect antibiotic production. The Kirby Bauer "test" microorganism was E. coli JM 103
- The Kirby Bauer plates were incubated for 24 hours and any zones of inhibition present indicate production of an antibiotic by the *Streptomyces* isolate.
- Once the antibiotic producing strain is identified, a 25% glycerol spore suspension is collected from the streak for use as long term storage at -20 C as well as for an inoculum for a broth culture.

The broth culture is then incubated in a water bath as 28 C and shaken at 280 rpm for 2 weeks. The broth is centrifuged and the supernatant passed through a vacuum filter membrane resulting in the removal of cellular debris. This filtered supernatant liquid was the 103rting material for the following assays that were performed in the process of biochemically characterizing the antibiotic molecule.

Gel column chromatography was employed for determining some of the properties of the antibiotic molecule. Five ml syringe barrels were used for the columns. The chromatographic column stationary phase gels employed were: Sigma's Sephadex G-10, a size separation gel that excludes molecules under 700 daltons; Sigma's Sephadex IRA 904, a strongly basic anion exchange gel; and Sigma's Amberlite 200, a strongly acidic cation exchange gel.

Tris Buffer (0.01M) was used and all columns were treated the same. The columns were first eluted with the Tris Buffer, then with 1M NaCl in 0.01M Tris Buffer, followed by a final wash of 0.01M Tris Buffer. One drop column fractions were collected onto sterile 12mm Whatman filter disks. These disks were then placed on Kirby Bauer plates inoculated with E. coli JM 103 as the test bacteria. In addition to gel column chromatography, this supernatant was treated with heat and with a series of different digestive enzymes and chemicals. An equal portion of both supernatant and enzyme were combined and treated under the same conditions.

The following experimental treatments were conducted on the culture supernatant containing antibiotic activity:

- Protenase K (a proteolytic enzyme routinely employed to remove proteins from nucleic acid preparations) at 55 C.
- Pancreatin (a digestive enzyme mixture containing amylase, tyrsin, lipase, ribonuclease and protease), at 40 C.
- Urea (with the intention of breaking H bonds if they were there). at 70 C.
- Finally, since many biological molecules are sensitive to alkali or acid, the pH of the supernatant was adjusted with the addition of HCl and NH_4OH.

These results are illustrated in the following tables (1 through 5).

RESULTS

TABLE 1. Effect of Proteinase K Treatment on the Antibiotic Activity of ALD13 Culture Supernatant vs. E. coli JM103 in the Kirby Bauer Disk Diffusion Assay

Additions to KB Disks	Diameter (mm) of Inhibition Zone
Culture Supernatant Alone (75 ul)	11
Culture Supernatant (37.5ul) Plus Proteinase K (37.5ul)	9
Proteinase K Alone (75ul)	0

TABLE 2. Effect of Pancreatin Treatment on the Antibiotic Activity of ALD13 Culture Supernatant vs. E. coli JM 103 in the Kirby Bauer Disk Diffusion Assay

Additions to KB Disks	Diameter (mm) of Inhibition Zone
Culture Supernatant Alone (75 ul)	12
Culture Supernatant (100 ul) Plus Pancreatin (100 ul)	11
Pancreatin Alone (100 ul)	0

TABLE 3. Effect of Heat Treatment on the Antibiotic Activity of ALD13 Culture Supernatant vs E. coli JM 103 in the Kirby Bauer Disk Diffusion Assay

Additions to KB Disks	Diameter (mm) of Inhibition Zone
Culture Supernatant Alone (75 ul)	12
Culture Supernatant (100 ul) @ 65 C for 2 hr.	11

TABLE 4. Effect of 6.0M Urea Treatment on the Antibiotic Activity of ALD13 Culture Supernatant vs. E. coli JM 103 in the Kirby Bauer Disk Diffusion Assay.

Additions of KB Disks	Diameter (mm) of Inhibition Zone
Culture Supernatant Alone (75 ul)	10
Culture Supernatant (75 ul) Adjusted to 6.0M Urea	9
6.0M Urea Alone (75 ul)	0

TABLE 5. Effect of Combined 6.0M Urea Plus Heat Treatment on the Antibiotic Activity of ALD13 Culture Supernatant vs. E. coli JM 103 in the Kirby Bauer Disk Diffusion Assay

Additions to KB Disk	Diameter (mm) of Inhibition Zone
Culture Supernatant Alone (75 ul)	10
Culture Supernatant (75 ul) @ 65 C for 2 hr.	9
Culture Supernatant (75 ul) Adjusted to 6.0M Urea @ 65 C for 2 hr.	0

DISCUSION

The antibiotic was somewhat retained on the anion exchange column, not retained on the G-10 size column, and completely retained on the cation exchange column.

Considering these results, we elected to investigate the antibiotic activity on a size column designed to retain molecules larger than 700 daltons. The next size in this Sephadex series is G-25 which excludes molecules 5000 daltons or larger and retains molecules below that limit.

The antimetabolite activity was not retained on the G-25 column. This data suggests that the antibiotic has a high molecular weight. The average weights of the currently known antibiotics are below 700 daltons. The apparent large size of ALD13 make it very unusual.

An alternative size determination method using millipore ultra filtration will be performed to support the data collected using the G-10 and G-25.

As evident in Table 1 by the size of the inhibition zones, treatment of the supernatant with Proteinase K at temperatures commonly used for nucleic acid preparations did not significantly diminish the antibiotic activity. This indicates that the antibiotic is not composed of or attached to a protein.

Treatment of the supernatant with Pancreatin also failed to destroy the antibiotic activity. Pancreatin contains a wide range of digestive enzymes yet none are capable of curtailing the antibiotic response. The only digestive enzyme group not represented is cellulase, which as the name suggests digests cellulose. Plans have been made to test this enzyme on the supernatant in the near future.

Table 3 illustrates the stability of the antibiotic at temperatures of 65 C for 2 hours. This treatment of heat just by itself would have degraded many proteins however again the supernatant is unaffected.

Results of Table 4 are similar to the previous treatments done, enough urea was added to the supernatant to bring the urea concentration to 6.0M and again no decrease in the size of the inhibition zone.

However when urea is added to the supernatant to a concentration of 6.0M and heated for two hours the antibiotic activity is destroyed. Urea treatment was used because it has the ability to break H bonds. However because it was a combination of heat and urea that destroyed the activity it could be pH related.

The last experiment that was run(not illustrated in tables) was to lower the pH of the supernatant to pH2 and raise it to 10. While the pH 2 had no adverse affects on the activity the pH 10 was also able to destroy the activity.

At this time no actual molecular sructure for the antibiotic has been suggested from the previous tests however the process is ongoing.

ACKNOWLEDGEMENTS

The author wishes to express appreciation to Dr. Frances Weaver and Dr. Linda Betz for their suggestions and ideas.

REFERENCES

Travis, John., Reviving the Antibiotic Miracle?. Science Vol. 264, April 1994 American Assoc. for the Advancement of Science, pp. 360-362.

Stinson, Stephen C., Drug Firms Restock Antibacterial Arsenal. Chemical and Engineering News, Sept.,23,1996 pp. 75-92.

Benson, Harold J., 1994, Microbiological Applications 6th Edition. Wm. C. Brown Publishers., Dubuque, Iowa.

The Microbial Activity in Saltmarsh Tidal Creek Waters Determined by Oxygen Metabolism

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The role of substrates and grazers in the control of bacterioplankton were examined in a North Inlet tidal creek, in a 9-month study. The influence of substrates was examined by adding glycine or ammonium to the creek waters. The role of grazers was examined by size-fractioning the plankton by passing water samples through a 20 µm or 2 µm filtration apparatus. Bacterial response within these treatments was assessed by direct counting of bacteria and by measuring oxygen concentration over time-course incubations in dark bottles. The controls on bacterial activity (oxygen metabolism) varied seasonally, with substrate effects being minimal in the summer, a period of high oyster metabolism, maximal bacterial and phytoplankton abundances, and maximal water column nutrient concentrations. In contrast, in the winter, glycine additions greatly stimulated metabolism over all size-fraction treatments. Ammonium stimulated bacterial metabolism on only one date, and only in the < 2 µm treatment. A strong grazer influence upon metabolism was observed in the summer, when metabolism in the < 20 µm treatments exceeded that from the whole water or < 2 µm treatments. Grazer activity also was important in the winter, when bacterial abundances increased in all < 2 µm treatments compared to whole water. Factors controlling bacterial growth and production changed seasonally; both were primarily grazer-controlled ("top-down") during the summer but, in the winter, growth was grazer-controlled but, bacterial production was substrate-controlled ("bottom-up").

INTRODUCTION

Our understanding of the importance of bacterioplankton in aquatic environments has increased rapidly since the important works of Williams (1981) and Azam et al. (1983). Studies of bacterioplankton production and distribution in estuaries and coastal areas provide evidence that bacteria greatly influence carbon cycling processes by assimilating photosynthetically produced dissolved organic matter (Chrost & Faust 1983, Iturriaga & Zsolnay 1983, Azam et al. 1994), and serving as an important food resource for heterotrophic flagellates and ciliates (Sherr & Sherr 1977, 1994, Fenchel 1982, Wright & Coffin 1983a, b, 1984). Bacteria also can be both major mediators of NH_4 remineralization (Coffin and Sharp 1987; Hopkinson et al. 1989) and responsible for the assimilation of a large proportion of available nutrients into particulate matter (Wheeler and Kirchman 1986; Horrigan et al. 1988, Kirchman 1994). It appears that bacterioplankton can function either as remineralizers or assimilators of nutrients with their exact role dictated by the biochemical characteristics of their substrates. For example, both Goldman et al. (1987) and Hopkinson et al. (1989) showed that gross growth efficiency and the efficiency of bacteria in NH_4 remineralization are highly dependent upon their physiological state and the C:N ratio of the available bacterial substrate.

Ducklow and Peele (1988) further emphasized the importance of bacteria in estuaries, showing that bacterial production and biomass may exceed those of autotrophic assemblages plankton reveal that the majority of oxygen consumption occurs in the bacteria-sized fraction; in fact, Azam & Hodson (1977) suggested that free-living bacteria could be responsible for up to 90% of total heterotrophic activity.

Although it appears that bacteria are of great importance in large estuaries, few studies have been performed to assess the role of bacteria in smaller nutrient-rich ecosystems such as salt marsh tidal creeks. The objective of this study therefore was to examine the seasonal influence of bottom-up controls (substrate limitations) and top-down controls (biomass removal and/or nutrient regeneration by grazers) upon bacterioplankton in a small tidal creek in North Inlet, SC. Work by Lewitus et al. (Limnol. Oceanogr., submitted) indicates that phytoplankton are limited by top-down controls in the summer and bottom-up controls in the winter in a neighboring tidal creek in the North Inlet estuary. Based upon their findings, it is hypothesized that bacteria will be controlled in a similar manner with top-down control during the summer and bottom-up controls in the winter.

METHODS

This study was a component of a NSF project (DEB-9509057) to examine the role of oyster reefs on the structure and function of tidal creeks in North Inlet Estuary, South Carolina. This estuary is shallow, marine-dominated, and pristine. Water samples were collected monthly from the mouth of a small tidal creek off the larger Clambank creek. Monthly samples were obtained from July 1996 to March 1997. Triplicate samples were taken within 30 minutes of low slack tide between 12:00 noon and 3:00 p.m. on each occasion. Upon returning to the lab, water from each carboy was size-fractioned into whole water, < 20 µm and < 2 µm treatments. Each of these size-fraction treatments then either received no added substrate (unamended) or received additions of either NH_4 (2 µM) or glycine (20 µM) producing 9 treatments. All samples were transferred into 300-ml Biological Oxygen Demand (BOD) bottles. Temperature, salinity, dissolved organic carbon (DOC), particulate organic matter (POM), and rainfall data (for the 7-day period prior to sampling) also were obtained for each sampling period.

The BOD bottles were incubated in the dark and time-course sampled for bacterial abundance and respiration (a surrogate for bacterial production). Fixed samples (1% glutaraldehyde) were taken for bacterial abundance from whole water unamended samples at 0, and from all treatments at 72 hours. The samples were refrigerated in the dark at 4°C until slide preparation (typically within 2 weeks). Bacteria were stained with Acridine Orange by the method of Hobbie et al. (1977), and filtered onto black 0.2 µm polycarbonate filters. Bacterioplankton abundance was measured by epifluorescent microscopy on an Olympus BMT microscope, using 100x magnification. Multiple fields were counted until 400 or more bacteria were recorded, and then bacterial abundance was determined using the formula

$$Ab = (b * 26.246) / v \qquad (1)$$

Where Ab is bacterial abundance (cells/ml), b is the mean bacterial abundance per reticule, 26.246 is the ratio of filtered area to reticule area, and v is the filtered sample volume.

Oxygen metabolism (respiration) was measured with a YSI 50B oxygen meter and YSI 5730 self-stirring bottle probe, that was air-calibrated prior to each measurement series. Time-course measurements of dissolved oxygen (DO) were obtained at 0, 3, 5, 7, 24, 48, and 72 hours in all periods, and in the winter and early spring months, additional sampling took place at 96, 120, and up to 144 hours (Dec. & Jan.). After each measurement from the 300-ml BOD bottles, ~2 ml of 0.2 µ particle-filtered water was added to prevent bubble formation after resealing the bottle. Metabolic slopes from each bottle were calculated by linear regression of dissolved oxygen versus time.

RESULTS

Bacterial abundance varied seasonally, with concentrations peaking in July (7.0×10^6 cell/ml), decreasing to a minimum in October (2.5×10^6 cell/ml), and increasing slightly thereafter to 3.8×10^6 cell/ml in March (data not shown). Bacterial abundance varied directly with temperature (Pearson correlation, $R^2 = 0.60$, $p = 1.83 \times 10^{-5}$). The 72-hr change in bacterial abundance varied seasonally, with < 2 µm concentrations lower than other size classes in Sept. and Oct., but higher in the other months (Fig. 1). Glycine addition significantly increased bacterial abundance in Nov. and Feb. only (Fig. 2).

Respiration rates of unamended samples also varied seasonally, decreasing by 5-fold from July to Dec. (Fig. 3). Summer respiration rates were greatest in the < 20 μm fraction, while rates in the < 2 μm were less than those from whole water. In contrast, size-fraction effects on respiration were absent in the winter. Substrate addition had little effect on respiration in the summer (e.g. glycine, Fig. 4). In the late fall and winter, however, substrate effects were observed, with glycine stimulation of all size-fractions occurring throughout this period (Fig. 4), and NH_4 stimulation occurring only in the Feb. < 2 μm fraction (data not shown).

DISCUSSION

Bacterial abundance in marine systems is a balance between grazing on bacteria and substrate supply (Ducklow & Hill 1985, Coffin 1984). In the summer, in North Inlet, substrates did not affect microbial growth or metabolism, but a significant size-fraction effect on bacterial abundance and respiration was found, with the lowest measurements after incubation derived from the < 2 μm fraction. This suggests that either most of the bacteria were attached to particles and/or that grazing was beneficial to bacteria ("positive feedback" by grazer-produced nutrients).

In the winter, we observed a different trend. After incubation bacterial abundance in the < 2 μm fraction was higher than whole water, implying that grazing was limiting bacterial growth ("negative feedback"). Glycine affected bacterial abundance in Nov. 1996 and Feb. 1997, when growth of the < 20 μm fraction, and to a lesser degree, < 2 μm fraction, increased in response to glycine addition. In the winter, there was a significant stimulation of bacterial respiration by glycine, indicating that bacterial production during this season is substrate-limited. This is consistent with the wintertime minima in NH_4 and DOM that characterize this system (Lewitus et al. subm.) The preference for glycine compared to NH_4 could be explained by considering the dual benefit of carbon and nitrogen uptake that occurs when utilizing glycine. Kirchman (1994) has suggested that amino acids may be more important nitrogen sources for bacteria in estuaries whereas NH_4 may be more important in the open ocean environments.

In Summary, seasonal changes in the mechanisms controlling bacterial growth and production were indicated by the contrasting effects of size-fractionation and substrate addition on bacterial abundance and respiration. In the summer, a time of intense microbial activity, bacterial numbers are high, their food sources (substrates) are plentiful, but their predators are also abundant. We found that, in the summer, bacterial growth and respiration were controlled by grazing (top-down) positive feedback. In the winter, a time of low substrate availability, bacterial growth was controlled by grazing (negative feedback), but bacterial respiration was controlled by substrate supply (bottom-up).

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REFERENCES

Azam, F., Fenchel, T., Field, J. G., Gray, J. S., Meyer-Reil, L. A., Thingstad, F. (1983). The ecological role of water column microbes in the sea. Mar. Ecol. Prog. Ser. 10: 257-263.

Azam, F, Smith, D. C., Steward, G. F., Hagstrom, Å. (1994). Bacteria-organic matter coupling and its significance for oceanic carbon cycling. Microb. Ecol. 28: 167-179.

Chrost, R. H., Faust, M. A. (1983). Organic carbon release by phytoplankton: its composition and utilization by bacterioplankton. J. Plankton Res. 5: 477-493.

Coffin, R. B., Sharp, J. H. (1987). Microbial trophodynamics in the Delaware estuary. Mar. Ecol. Prog. Ser. 41: 253-266.

Ducklow, H., Peele, E. (1987). Bacterial carbon pools and fluxes in Chesapeake Bay plankton. In: Makiernan, G. (ed.) Dissolved oxygen in the Chesapeake Bay: processes and effects. Maryland Sea Grant, College Park, Maryland, p. 81-85.

Fenchel, T. (1982). Ecology of heterotrophic microflagellates. IV. Quantitative occurrence and importance as bacterial consumers. Mar. Ecol. Prog. Ser. 9: 35-42.

Goldman, J. C., D. A. Caron, and M. R. Dennett. 1987. Regulation of gross growth efficiency and ammonium regeneration in bacteria by substrate C:N ratio. Limnol. Oceanogr. 32: 1239-1252.

Hopkinson, C. S., Sherr, B., Wiebe, W. J. (1989). Size fractionated metabolism of coastal microbial plankton. Mar. Ecol. Prog. Ser. 51: 155-166.

Horrigan, S. G., A. Hagstrom, I. Kolke, and F. Azam. 1988. Inorganic nitrogen utilization by assemblages of marine bacteria in seawater culture. Mar. Ecol. Prog. Ser. 50: 147-150.

Iturriaga, R., Zsolnay, A. (1983). Heterotrophic uptake and transformation of phytoplankton extracellular products. Bot. Mar. 26: 375-381.

Kirchman, D. L. (1994). The uptake of nutrients by heterotrophic bacteria. Microb. Ecol. 28: 255-271.

Sherr, E. B., Sherr, B. F. (1977). High rates of consumption of bacteria by pelagic ciliates. Nature 325: 710-711.

Sherr, E. B., Sherr, B. F. (1994). Bactivory and herbivory: Key roles of phagotrophic protists in pelagic food webs. Microb. Ecol. 28: 223-235.

Wheeler, P. A., and D. L. Kirchman. 1986. Utilization of inorganic nitrogen by bacteria in marine systems. Limnol. Oceanogr. 31: 998-1009.

Williams, P. J. leB. (1981). Bacterial production in the marinr food chain: The emperor's new suit of clothes? In: M. J. R. (ed.) Flows of energy and material in marine ecosystems. Plenum Press, New York, p.271-300.

Wright, R. T., Coffin, R. B. (1983a). Planktonic bacteria in estuaries and coastal waters of northern Massachusetts: spatial and temporal distribution. Mar. Ecol. Prog. Ser. 11: 205-216.

Wright, R. T., Coffin, R. B. (1983b). Factors affecting bacterioplankton density and productivity in salt marsh estuaries. In: Reddy, C. A., Klug, M. J. (eds.) Current perspectives in microbial ecology, Am. Soc. Microbiol., Washington, D.C. p. 485-494.

Wright, R. T., Coffin, R. B. (1984). Measuring microzooplankton grazing on planktonic marine bacteria by its impact on bacterial production. Microb. Ecol. 10: 137-149.

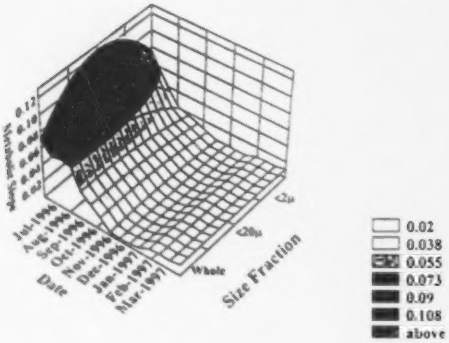

Figure 1. Least squares fit surface plot of oxygen metabolism by date and size-fraction. Note the significant seasonal trend and the size-fraction effect in the Summer.

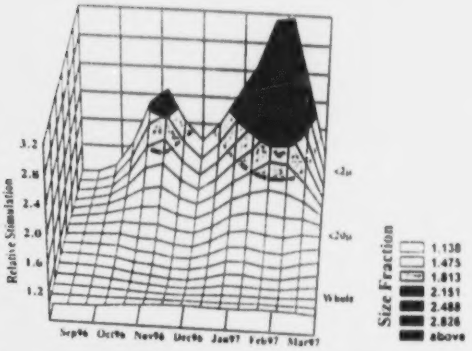

Figure 2. Least squares fit surface plot of the size-fraction effect upon bacterial abundance at 72 hr by date. Note the enhanced abundances in the <2μm fraction from November through the remaining Winter.

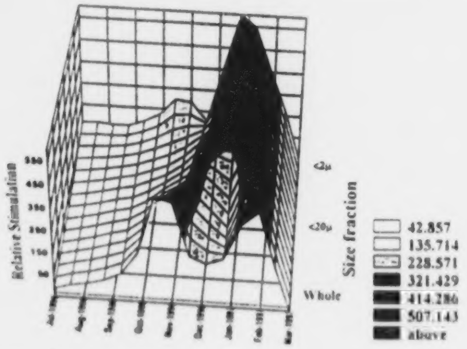

Figure 3. Least squares fit surface plot of glycine effect on oxygen metabolism by date and size-fraction. Note the strong stimulatory effect that begins in November and continues through the Winter.

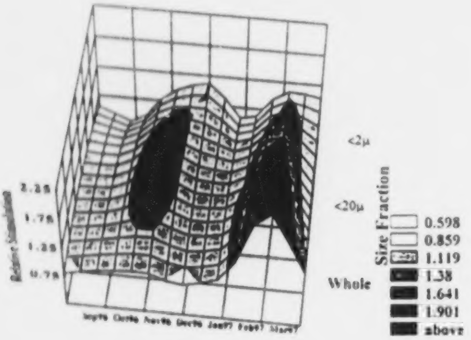

Figure 4. Least squares fit surface plot of glycine effect on bacterial abundance at 72 hr by date and size-fraction.

Efficiency of Latex Gloves as Barriers to Bacterial and Viral Pathogens

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Latex is commonly used in medicine to control the spread of microorganisms The purpose of this experiment was to illustrate the ability of latex to act as a barrier to both bacterial and viral transmission A sterile latex glove was placed in flasks containing either *Escherichia coli* or K1F bacteriophage Bacterial transmission from the interior to the exterior of the glove was indicated by an increased media cloudiness Viral transmission from the interior to the exterior of the glove was indicated by a decreased media cloudiness After a 24 hour incubation at 37 degrees Celsius, spectrophotometer readings indicated that neither *E. coli* nor K1F phage escaped experimental latex gloves After analysis of the experimental results, it can be concluded that latex is an adequate material for use in preventing the transmission of infectious diseases, if the latex is without punctures This experiment would be a good exercise to demonstrate to first year medical students the importance of using latex gloves in order to prevent disease transmission

INTRODUCTION

In the recent medical world, infection control has become extremely important in preventing the transmission of pathogens The Centers for Disease Control and Prevention (CDC) has formulated guidelines, known as universal precautions, for health care workers to follow to prevent the transmission of pathogens to other health workers, patients, or to one's self (Sulzbach 1996) Also, the Occupational Safety and Health Administration (OSHA) has formulated additional standards for the safety of health care workers and patients that are subject to periodical inspection (Sadovsky 1993) The World Health Organization (WHO) has responded to the risk of disease transmission worldwide (Fidler 1996) To implement the use of universal precautions, health care workers must use latex gloves, masks, surgical gowns, and hand-washing procedures on and between all patient visits

The discovery of the first infection control technique, hand-washing, was discovered in 1847 in Vienna by Dr Ignaz Semmelweis (Jarvis 1994) He observed that there was a decrease in the occurrence of disease among patients when they were treated with washed hands, opposed to hands that had not been previously washed

One of the most important materials in the practice of infection control has become latex Several medical and household products are made of latex, including gloves, adhesive bandages, catheters, dental dams, tourniquets, diaphragms, and condoms (Gold 1994)

In recent years, the general public has become more cautious about the quality of infection control practices of health care workers due to the publicity of several dentists and surgeons who transmitted Human Immunodeficiency Virus (HIV), Hepatitis B, and Hepatitis C to several of their patients Traditionally, politically unpopular groups, like homosexuals and intravenous drug users, have been associated with diseases, like AIDS and hepatitis It has been proven that HIV is a threat not only to these risky groups, but also to transfusion patients and children who are born to HIV infected mothers In addition, HIV has become an increasing concern to heterosexuals who have multiple partners or whose partner has multiple partners The evidence of the transmission of these diseases in a medical setting have lead to a public hysteria, causing the fear of even routine medical and dental procedures to be performed in some cases The first case to be publicized was Dr David Acer, a dentist who practiced in Florida who was accused of transmitting HIV to six of his patients (Breo 1993)

The hands, because of the frequency and variability of the people and objects that they contact, are of extreme importance in infection control Both OSHA and CDC mandate the use of hand-washing and latex gloves as a method to prevent the spread of infectious disease In this study, the ability of latex gloves in preventing the transmission of virus and bacteria was determined

METHOD

Luria-Bertani Broth (Difco, Detroit, MI) was prepared and placed in twelve 1000mL Erlenmeyer flasks to replicate the experiment and several test tubes One latex glove was then placed in each flask The test tubes and flasks containing the gloves were autoclaved for thirty minutes at 121 degrees Celsius at 15 psi All of the test tubes but one, which was set aside in the cold storage and used for the blank in the spectrophotometer, were then inoculated with *Escherichia coli* EV36 Of these test tubes, a few were inoculated with 1 mL of K1F bacteriophage solution The inoculated test tubes were allowed to incubate overnight at 37 degrees Celsius

The negative bacterial control was conducted by placing a sterile glove in sterile medium and incubating the flask to ensure the glove and media was properly sterilized (free of bacteria) The positive bacterial control was conducted by placing a punctured glove within the sterilized flask and medium to investigate whether bacteria could be transmitted through needlestick punctures in the latex gloves The viral negative control was conducted by placing sterile gloves in flasks which contained bacterial media to examine whether the gloves were sterile (free of viruses) The viral positive control was conducted by placing sterilized punctured gloves in flasks which contained bacterial media to examine whether viruses could be transmitted through needlestick punctures in latex gloves

The cultures used in the experiment were *Escherichia coli* EV36 and its bacteriophage, K1F These cultures were the generous gift of Dr Eric Vimmer, Department of Microbiology, University of Illinois at Urbana-Champagne

The flasks were then treated as follows Flask A (glove only- negative control), Flask B (bacteria in punctured glove- positive control), Flask C (bacteria in glove- test), Flask D (glove only with bacteria within the flask media- negative control), Flask E (bacteria and phage in punctured glove with bacteria inside the flask media- positive control), Flask F (bacteria and phage in glove with bacteria inside flask media- test) These flasks were incubated at 37 degrees Celsius overnight

Spectrophotometer readings were taken at 600 nm of the media within each of the flasks to compare their Optical Density(OD) readings to the blank Bacterial transmission through the latex gloves was indicated by an increased turbidity of the media in the flasks compared to the blank Viral transmission through the latex gloves was indicated by a decreased turbidity of the *E. coli* culture in the flasks compared to the negative viral control

RESULTS AND DISCUSSION

Optical densities of the cultures in the various flasks are presented in Figure 1

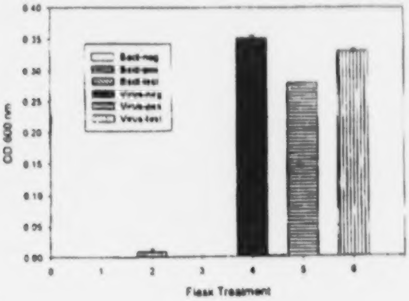

Figure 1 Optical Density of the media in the treated flasks

This experiment shows the importance of using latex in order to prevent disease transmission. Because this simple exercise demonstrates the importance of infection control so well, first year medical students would greatly benefit from performing this lab exercise as an introduction to the caution that must be taken to practice adequate infection control precautions while performing medical procedures

The negative control of the bacterial portion of the experiment shows that the media, flasks, and gloves were successfully sterilized, with no viable bacteria present in the flasks. The positive control of the bacterial portion of the experiment showed that, when the fingers of the gloves were punctured, bacteria were able to infect the media. This indicates that the occurrence of a needlestick during an invasive procedure allows for bacteria that happen to be present to pass inside and outside the glove, possibly infecting either the caregiver or patient. When a sterile, non-punctured glove is used, no bacterial transmission was observed. Both the caregiver and patient can be secure that infectious diseases will not be transmitted.

Some bacterial diseases that can potentially be transmitted through punctured or defective latex materials include tetanus, *Staphlococcus*, and Tuberculosis. Tetanus is a disease characterized by muscle stiffness and lock jaw. Tuberculosis is a respiratory disease caused by *Mycobacterium tuberculosis* in man (Miller and Farmer 1982). *Staphlococcus aureus* is a bacteria transmitted by touching meats that have been left out at room temperature for over five hours (Miller and Farmer 1982).

In the viral portion of the experiment, the negative control flasks show that the flasks and gloves had been properly sterilized: no viable viruses were present. The positive control flasks show the transmission of bacteriophage through the punctured glove. The phage infected the bacterial medium inside the flask causing the medium to clear. A decreased optical density was observed in this situation when compared to the negative control and test flask optical densities. This result clearly shows that when needlesticks occur, viruses can be transmitted either inside or outside the latex barrier, potentially causing either the caregiver or patient to be infected with the viruses present. To the contrary, when a non-punctured, sterile glove is used, little to no risk of viral transmission occurs. Latex reduces the risk of viral transmission.

Some viruses that can potentially be transmitted through defective latex gloves are Human Immuno-deficiency Virus (HIV), Hepatitis A, Hepatitis B, and Hepatitis C. HIV is the virus that causes AIDS (Acquired Immuno-Deficiency Syndrome), a disease which compromises the affected individual's immune system. AIDS leaves the individual with the inability to fight off common infections, such as the flu or pneumonia. Hepatitis causes inflammation of the liver and an increased risk of liver cancer. Huber (1993) claims that Hepatitis B is even more contagious than HIV in a hospital setting. Globally, 300 million people are infected with Hepatitis B (Lou and Wright 1993). 150,000 new cases of Hepatitis C occur in the United States only, omitting other countries (Brown et al. 1994). While Hepatitis B and C is transmitted through contact with blood and blood products, Hepatitis A is transmitted orally, by person to person contact (Miller and Farmer 1982).

Health care workers must be consistent in their practice of adequate infection control, as recommended by CDC and OSHA. Gould et al. (1996) stated that health care workers do not always wear gloves and handle sharp instruments safely. The reasons that have been stated by health care workers that do not always comply with the standards of universal precautions are forgetfulness, the belief that wearing gloves hampers their ability to perform procedures efficiently, and mere habit (Sulzbach 1996). Caregivers, who practice infection control as a method of self-protection instead of also practicing the protection of the patient, often work on multiple patients without changing gloves in between patient visits (Goldmann et al. 1996). These workers carry microorganisms from patient to patient, thus introducing infections to these patients by cross-contamination during procedures and to their surroundings. It is important to change gloves as often as possible, even when working on the same patient for a prolonged period of time, because gloves can be defective or become damaged by needlesticks or degraded by chemicals that are used for sterilization (Olsen et al. 1993).

To prevent the transmission of disease in the hospital setting, the public must become educated about infection control, universal precautions, and how diseases are transmitted. Patients should become aware of their surroundings in the health care setting and analyze whether adequate infection control is being practiced. Turk (1994) stated that patients should look for the following signs when performing an analysis on the infection control practices of health care workers that indicate adequate infection control is being practiced: a clean office, staff members who wear clean, freshly changed gloves, gowns, and masks, and the proper disposal of needles and other sharp instruments in labeled sharps containers.

The general public has become aware of infection control since 1990, when a dentist who practiced in Florida, Dr. David Acer, was accused of infecting several of his patients with

HIV. The media questioned whether Dr. Acer infected his patients with his own AIDS-infected blood accidentally or intentionally (Breo 1993). Furthermore, studies have shown that HIV can be acquired from a dried, contaminated surface for up to three days under certain laboratory conditions (Yim 1993). The Acer incident, along with public outcry, forced Congress to consider mandatory HIV-testing of all health care workers (Breo 1993). Despite the publicity, to date, no legislation has been enacted to enforce this mandatory testing. Since 1990, there have been several incidents where surgeons and dentists have been accused of transmitting diseases, like HIV and Hepatitis, to patients.

The possible transmission of bacteria and viral diseases, especially the deadly AIDS virus, through latex gloves has serious impacts on how society views the medical profession and the legal system. In the recent past, these diseases have affected numerous people, who have been denied items such as jobs, health and life insurance, and medical treatment (Jarvis et al. 1991). To avoid encroaching upon the ability of the many conscientious medical and dental professionals to perform their duties in the process of saving the public from the few professionals who do not follow the guidelines that CDC and OSHA has recommended, the general public must educate themselves on the principles of universal precautions.

REFERENCES

Baldwin, Maitland, et al. *Infection Control in the Hospital.* Chicago, IL: American Hospital Association, 1970.

Bartlett, Raymond C., et al. *Hospital Associated Infections.* Chicago, IL: American Society of Clinical Pathologists, 1971.

Breo, Dennis L. "The Dental AIDS Cases- Murder or Unsolvable Mystery?" *Journal of the American Medical Association*, 8 Dec. 1993: 2732-2733.

Brown, Edwin A., et al. "Hepatitis C and E: How Much of a Threat?" *Patient Care*, 15 May 1994: 105-108.

Favero, Martin S. and Richard Sadovsky. "Office Infection Control, OSHA, and You." *Patient Care*, 30 March 1993: 117-128.

Fidler, David P. "Globalization, International Law, and Emerging Infectious Diseases." *Emerging Infectious Disaeses*, Apr.- June 1996: 77-84.

Gold, Janet. "Ask About Latex." *RN*, June 1994: 32-34.

Goldmann, Donald A., et al. "Strategies to Prevent and Control the Emergence and Spread of Antimicrobial-Resistant Microorganisms in Hospitals." *Journal of the American Medical Association*, 17 Jan. 1996: 234-240.

Gould, D., et al. "Nurses' infection control practice: hand decontamination, the use of gloves and sharp instruments." *International Journal of Nursing Studies*, April 1996: 143-160.

Huber, Joseph. "Hepatitis B virus: a major health concern- guidelines for prevention." *Palaestra*, Wntr 1993: 58-61.

Jarvis, Robert M., et al. *AIDS Law.* St. Paul, MN: West Publishing CO., 1991.

Jarvis, William R. "Handwashing- the Semmelweis Lesson Forgotten?" *The Lancet*, 12 Nov. 1994: 1311-1312.

Johnson, Y. N. and Wright, Teresa L. "Molecular virology and pathogenesis of hepatitis B." *The Lancet*, 27 Nov. 1993: 1335-1336.

Miller, D.L. and Farmer, R.D.T. *Epidemiology of Diseases.* Blackwell Scientific Publications. 1982.

Olsen, Robin J., et al. "Examination Gloves as Barriers to Hand Contamination in Clinical Practice." *Journal of the American Medical Association*, 21 July 1993: 350-353.

Sulzbach, Hoke. "Risk taking by health care workers." *Clinical Nurse Specialist*, Jan. 1996: 30-37.

Turk, Michele. "AIDS At the Dentist's?" *American Health*, Nov. 1994: 65-71.

Yim, Natasha. "How Safe Is Your Dentist?" *Vibrant Life*, Nov.- Dec. 1993: 12- 14.

Oyster Reef Impact On Microbial Food Web Dynamics In Tidal Pools In North Inlet Estuary

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Oysters can influence microbial food web dynamics in tidal creeks through negative (grazing) and positive (nutrient regeneration) feedbacks. Their effects should be a function of water residence time, and therefore oyster reef influence should be more strongly manifested in tidal pools than at the creek mouth. Nutrient concentrations, bacterial abundance, and phytoplankton biomass were compared at three sites within two North Inlet tidal creeks along the ebb tidal cycle. The creeks differed in morphology and hydrological properties. Creek A was larger and characterized by a greater neap tidal prism, greater total oyster biomass, but lower oyster density than Creek B. At low tide, spatial differences in NH_4^+, bacterioplankton, and chlorophyll *a* were found in creek B, with tidal pool chlorophyll exceeding levels at the mouth by >2-fold. In contrast, slight or no differences in these variables were found between sites in Creek A. Temporal variability in the above properties also differed between creeks, e.g. chlorophyll in the tidal pool increased ~6-fold from mid-ebb to low tide in Creek B, while in Creek A, no change was measured during the same period. That the enhancement of chlorophyll production in the Creek B, but not Creek A, tidal pool was due to the net effect of oyster reef activity (nutrient regeneration vs. grazing) is consistent with the greater oyster density and lower tidal volume exchange in the former creek. The results suggest that tidal pools can be sites of enhanced oyster reef impact on microbial food webs, but that the extent of oyster reef influence depends critically on tidal creek physical properties.

INTRODUCTION

Estuarine areas in the world are prime habitat for many species of bivalve mollusks, including the quahog clam (*Mercenaria mercenaria*), the American oyster (*Crassostrea virginica*), the ribbed mussel (*Geukensia demissa*), and the blue mussel (*Mytilus edulis*). The climate of the area decides the dominant species, e.g. oysters in warmer climates and mussels in cooler climates. In the southeastern United States the American oyster (*C. virginica*) is found in great abundance in the intertidal region of tidal creeks. These organisms affect both the physical and biological aspects of the creeks (Dame & Libes, 1993). As the oysters grow and reproduce, their dense aggregations form reefs and dams. These structures function as sediment baffles, and form tidal pools which increase the residence time of water parcels within the creek. Oyster reefs and dams provide shelter, protection, and food for a wide variety of organisms, including many species of polychaete and other worms, arthropods, fish, other mollusks, and crustaceans. In addition, the influence of oyster activities is felt by the microbial community. Oysters are filter feeders, grazing upon zooplankton, phytoplankton, and bacterioplankton (although with low efficiency) within the water column (Langdon & Newell, 1990).

Grazing, however, is not the only manner by which oysters and other bivalves affect the microbial community (Dame & Libes, 1993; Prins et al., 1995). As they feed and metabolize captured food, oysters release large amounts of remineralized, or regenerated, nutrients back into the water column. These regenerated nutrients, such as ammonium (NH_4^+) and orthophosphate (PO_4^{-}), are needed by phytoplankton and bacteria for primary production and growth. In addition, oysters release large amounts of dissolved organic matter (DOM),

1533

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including dissolved organic nitrogen (DON). These substances help to support the bacterial population in the water column. Thus oyster activity can have a net positive effect on phytoplankton and bacterial growth within a tidal creek.

The goal of this study was to examine oyster reef impact on microbial food web dynamics in tidal pools versus other locations within tidal creeks. It was hypothesized that the effect of oyster reef activity on the microbial food web would be a function of the water's residence time within the creek, and therefore the magnitude of this impact would be greater in the tidal pools.

MATERIALS AND METHODS

Sample Sites

This project was a component of the NSF-funded study "The Role of Oyster Reefs in the Structure and Function of Tidal Creeks." Two tidal creeks in North Inlet Estuary (near Georgetown, South Carolina), differing in morphology and hydrological properties, were chosen for the study ("Creek A" and "Creek B"). Within each creek, three sites were sampled: the creek mouth, ~5 m inside the mouth, and the first tidal pool in the creek. A control site, Clambank Creek, midway between the creeks, was also sampled.

Creek A was the larger creek, with a bank full volume (BFV) of 2.8×10^{3} m^{3}, and a low tide volume (LTV) of 1.1×10^{2} m^{3} of water. The neap tidal prism, or average total volume exchange across the tidal cycle, was 2.7×10^{3} m^{3} (Corbett et al., unpublished). The oyster biomass in the creek was 7.6×10^{3} g/m^{2} (Anderson, unpublished data). The ratio of oyster biomass to bank full volume (OB/BFV) was ~3, and the OB/LTV was ~69.

Creek B was smaller, with a BFV of 4.0×10^{2} m^{3}, and a LTV of 16 m^{3} of water, a neap tidal prism of 3.9×10^{2} m^{3}, and an oyster biomass of 1.8×10^{3} g/m^{2} (Corbett et al., unpublished; Anderson, unpublished data). The OB/BFV ratio was ~5, and the OB/LTV ratio was ~115. Thus oyster population density in Creek B was relatively greater than that in Creek A.

Experimental Design

Samples were taken over the ebb tidal cycle on 30 July, 1996. Triplicate 120-ml samples for chlorophyll *a* and bacteria measurements were taken at each site at three tidal stages: high slack, mid-ebb, and low slack. Additional triplicate 120-ml samples were taken at each site for nutrient analyses. All samples were stored in the dark on ice until processed.

Nutrient levels (nitrate/nitrite, NO_2^-/NO_3^-, orthophosphate, PO_4^{-}, and ammonium, NH_4^+) were determined on filtered water (Whatman GF/F filter) using a Technicon AutoAnalyzer II (Glibert & Loder, 1977).

Ten ml of water from each sample was placed into a 15-ml centrifuge tube and fixed with glutaraldehyde for making bacteria and phytoplankton slides for direct counting by epifluorescence microscopy. For bacteria slides, 0.25 ml of sample was diluted into 4.5 ml of sterile-filtered seawater and 0.50 ml of Acridine Orange stain was added (Hobbie et al., 1977). The mixture was allowed to incubate for 1 min, after which it was filtered under low vacuum onto a 0.2 µm black polycarbonate membrane filter. The slides were then frozen until counting. For phytoplankton slides, 5 ml of undiluted sample was stained with 0.5 ml of DAPI, allowed to incubate for 5 min (Porter & Feig, 1980), and then filtered under low vacuum onto 0.2 µm polycarbonate membrane filters and frozen until counting.

For size-fractionated chlorophyll *a* (chl *a*) analysis, 60 ml of sample was used. Chl *a* concentrations were determined on whole water, and <20 µm and <2 µm filtrates, using a 20 µm sieve or a 2 µm polycarbonate membrane syringe filter. These values were then used to calculate the chl *a* concentrations for the following size ranges of plankton: >20 µm, 2-20 µm, and <2 µm. A freeze-thaw acetone extraction method was used to determine the chl *a* concentration (Glover & Morris, 1979), using a Sequoia-Turner Model 450 fluorometer.

Means were compared with a *t*-test with a significance level of 0.05.

RESULTS

Nutrient Levels

From mid to low tide a significant increase was measured in all nutrients in Creeks A and B, with NH_4^+ levels increasing greatly in both creeks (Table 1). In contrast, nutrients decreased during this same period at the control site, Clambank Creek. The lowest nutrient levels in Creeks A and B at low tide were in the tidal pools. NH_4^+ showed the most variation within the creeks, tending to decrease with distance into the creeks.

Table 1. Mean nutrient levels ± standard deviation (μM) at high, mid-ebb, and low tide stages broken down by creek and by sample site within the creek

Creek A, high tide				Creek B, high tide			
Site	NH_4	PO_4	NO_2/NO_3	Site	NH_4	PO_4	NO_2/NO_3
Mouth	15 ± 4.3	6.7 ± 2.0	2.8 ± 1.0	Mouth	13 ± 2.1	7.2 ± 0.3	3.4 ± 0.1
Inside Mouth	11 ± 2.9	12 ± 8.5	2.0 ± 0.6	Inside Mouth	13 ± 0.8	9.0 ± 0.4	3.3 ± 0.7
Tidal Pool	9.4 ± 1.5	7.4 ± 3.3	3.2 ± 1.0	Tidal Pool	20 ± 4.8	7.8 ± 0.3	3.5 ± 0.2
Creek A, mid-ebb:				Creek B, mid-ebb			
Site	NH_4	PO_4	NO_2/NO_3	Site	NH_4	PO_4	NO_2/NO_3
Mouth	30 ± 1.1	11 ± 0.3	5.4 ± 0.1	Mouth	58 ± 6.1	17 ± 0.3	4.8 ± 0.1
Inside Mouth	30 ± 1.2	10 ± 0.5	4.4 ± 0.3	Inside Mouth	59 ± 2.9	17 ± 1.0	4.6 ± 0.2
Tidal Pool	22 ± 2.8	10 ± 0.2	4.5 ± 0.3	Tidal Pool	60 ± 3.9	17 ± 1.0	4.8 ± 0.6
Creek A, low tide				Creek B, low tide			
Site	NH_4	PO_4	NO_2/NO_3	Site	NH_4	PO_4	NO_2/NO_3
Mouth	300 ± 6.6	38 ± 1.1	13 ± 0.1	Mouth	652 ± 15	117 ± 6.1	13 ± 0.1
Inside Mouth	297 ± 4.0	33 ± 1.0	13 ± 0.2	Inside Mouth	451 ± 19	114 ± 3.5	17 ± 0.4
Tidal Pool	280 ± 2.9	32 ± 0.5	13 ± 0.1	Tidal Pool	302 ± 29	106 ± 2.3	16 ± 0.3
Clambank Creek:							
Tidal Stage	NH_4	PO_4	NO_2/NO_3				
High	28 ± 4.0	9.5 ± 1.0	4.2 ± 0.6				
Mid-ebb	34 ± 6.1	11 ± 0.02	6.0 ± 0.1				
Low	10 ± 0.4	6.6 ± 0.2	5.2 ± 0.2				

Bacterial Abundance

Bacterial abundance in Creek A varied temporally, but not spatially (Fig. 1a). The pattern of bacterial abundance in Creek A over the tidal cycle resembled that of Clambank Creek, which ranged from ~8.0×10^6 cells/ml at high tide to ~1.2×10^7 cells/ml at low tide.

Creek B bacterial abundance increased from high to mid tide at all sites, but least significantly in the tidal pool (Fig. 1b). Values were equal to control (Clambank) values at high tide, as is expected due to the homogeneity of the water column at high tide, but thereafter remained lower. The bacterial abundance in the tidal pool remained lower than other sites within the creek. This corresponded to a significant increase in nanoflagellate plankton at the site (see below).

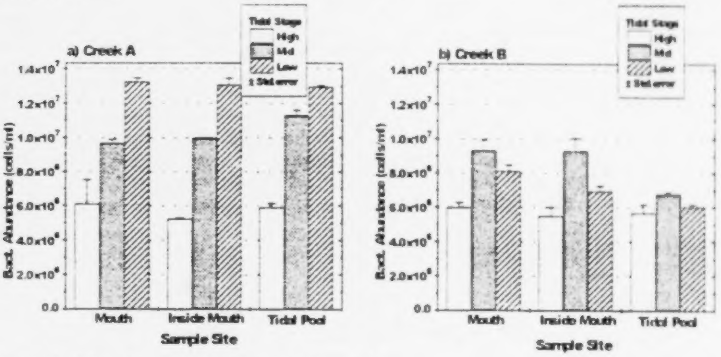

Figure 1: Mean bacterial abundance in the creeks

Chlorophyll Concentrations

Chl *a* concentrations at Clambank Creek increased steadily over the tidal cycle, ranging from ~10 $\mu g/m^3$ at high tide to ~35 $\mu g/m^3$ at low tide (Fig. 3a). Whole water chl *a* concentrations in Creek A showed little spatial or temporal variation (Fig. 1a). In Creek B, whole water chl *a* concentrations decreased from high to mid tides at all sites, but exhibited rapid increases at all sites from mid to low tides (Fig. 1b). The magnitude of this increase was greatest in the tidal pool, where nearly a 6-fold increase in chl levels was measured. At high tide, the largest fraction of whole water chl at all sites was in the > 20 μm range (Fig. 3). Along the tidal cycle, the 2-20 μm size fraction increased substantially, and by low tide comprised the largest proportion of the chl content in the creek. A dramatic (~ 16-fold) increase in this size fraction occurred from mid to low tide in the Creek B tidal pool (Fig. 3e), which corresponded

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to a significant increase in phototrophic nanoflagellate abundance from 5.3×10^3 cells/ml to 9.0×10^4 cells/ml (determined by direct count). It is likely that this population increase was accompanied by an increase in heterotrophic bacterivores, which may explain the observed decrease in bacteria (see above).

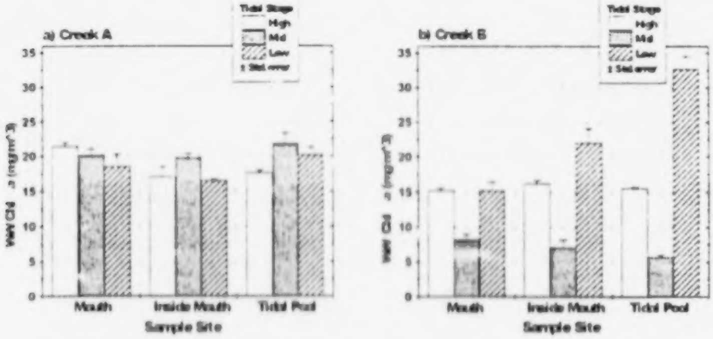

Figure 2: Mean whole water chl *a* concentrations in the creeks

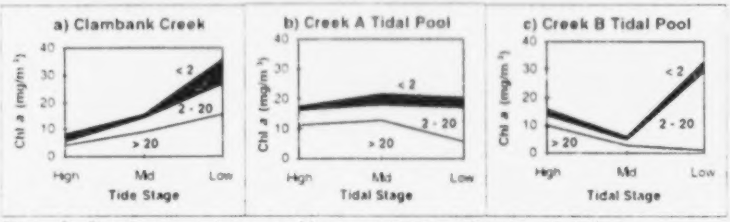

Figure 3: Size-fractionated (in µm) chl *a* concentrations relative to whole water.

DISCUSSION

Clambank Creek vs. Tidal Creeks

Nutrient levels in Clambank Creek decreased over the tidal cycle, in contrast to the tidal creeks, where nutrients were highest at low tide. These differences likely resulted from some combination of the following factors: 1) the greater resupply of nutrients by sediment resuspension in the tidal creeks, and 2) a greater influence of oyster reef nutrient regeneration in the tidal creeks. The decrease in nutrients from high to low tide in Clambank Creek coincided with increases in bacterial abundance and chl *a* concentrations, suggesting that nutrient uptake by these groups could explain ambient nutrient decline. Besides active growth at Clambank Creek, the increases in bacteria and chl *a* also probably resulted from the flushing of plankton-rich water from the tidal creeks.

Creek A vs. Creek B

Nutrient levels in the two creeks were similar at high tide due to the relative homogeneity of the water column in the estuary at that time. The increase in NH_4^+ levels in both creeks at mid-tide may have resulted from increased feeding by the oysters lining the banks as the plankton-rich water flowed out of the creeks on the ebbing tide. NH_4^+ is a major excretory product of oysters, therefore the higher nutrient levels in Creek B (especially NH_4^+), relative to Creek A, at nearly all tidal stages may be attributed to the higher oyster density in the former creek. The lower NH_4^+ level in the Creek B tidal pool, relative to the rest of Creek B, is consistent with phytoplankton uptake, as evidenced by the increased chl *a* levels at that site. According to Bishop et. al. (1984), NH_4^+ is readily utilized by nearly all species of phytoplankton and is the preferred form of nitrogen available for assimilation by phytoplankton.

Bacterial abundance in the two creeks at high tide did not vary significantly. In Creek A, bacterial abundance increased along the tidal cycle. In Creek B, bacterial abundance peaked at mid tide, and declined at low tide. No spatial variation was found in Creek A, while Creek B bacterial abundance decreased with distance into the creek, with the tidal pool having the lowest abundance at all tidal stages. The peak in bacteria at mid-tide in Creek B could be due to oyster phytoplankton and is the preferred form of nitrogen available for assimilation by phytoplankton.

Bacterial abundance in the two creeks at high tide did not vary significantly. In Creek A, bacterial abundance increased along the tidal cycle. In Creek B, bacterial abundance peaked at mid tide, and declined at low tide. No spatial variation was found in Creek A, while Creek B bacterial abundance decreased with distance into the creek, with the tidal pool having the lowest abundance at all tidal stages. The peak in bacteria at mid-tide in Creek B could be due to oyster removal of bacterivores. Oysters graze most effectively on particles between 3 and 10 µm (Newell & Langdon, 1996), which includes most bactivorous flagellates. The influence of oysters in reducing bacterivores in this size range is consistent with the reduction in the 2 - 20 µm fraction of chl *a* from high to mid tide.

Chl *a* concentrations in Creek A exhibited very little variation either spatially or temporally. In Creek B, the significant decrease in levels from high to mid tides could result from increased grazing pressure from oysters. The dramatic increase in levels from mid to low tide could have been a response to the high nutrient levels, presumably caused by oyster regeneration. The drop in the level of NH_4^+ in the Creek B tidal pool coincided with an increased level of chl *a* at that location, indicating an increased level of production.

CONCLUSIONS

The net result of nutrient and microbial dynamics was an increase in chlorophyll in the creek with relatively high oyster density (Creek B). The greatest stimulation was found in the tidal pool of that creek. These results suggest that tidal pools in estuarine tidal creeks can be sites of enhanced oyster reef impact on microbial communities in creeks of high oyster density.

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REFERENCES

Bishop, S. S., K. A. Emmanuele, and J. A. Yoder, 1984. Nutrient Limitation of Phytoplankton Growth in Georgia Nearshore Waters. *Estuaries*, Vol. 7, pp. 506-512.

Dame, R. and S. Libes, 1993. Oyster Reefs and Nutrient Retention in Tidal Creeks. *J. Exp. Mar. Biol. Ecol.*, Vol. 171, pp. 251-258.

Glibert, P., and T. Loder, 1977. Automated Analysis of Nutrients in Sea Water. Woods Hole Oceanographic Institute. Tech. Rep. WHOI-77-47, 47 pp.

Glover, H. E. and I. Morris, 1979. Photosynthetic Carboxylating Enzymes in Marine Phytoplankton. *Limnol. Oceanogr.*, Vol. 23, pp. 510-519.

Hobbie, J. E., R. J. Daley, and S. Jasper, 1977. Use of Nuclepore Filters for Counting Bacteria by Fluorescence Microscopy. Applied and Environmental Microbiology, Vol. 33, pp. 1225-1228.

Langdon, C. J. and R. I. E. Newell, 1990. Utilization of Detritus and Bacteria as Food Sources By Two Bivalve Suspension-feeders, the Oyster *Crassostrea virginica* and the Mussel *Geukensia demissa*. *Mar. Ecol. Prog. Ser.*, Vol. 58, pp. 299-310.

Newell, R. I. E., and C. J. Langdon, 1996. Mechanisms and Physiology of Larval and Adult Feeding, pp. 185-229. In: The American Oyster *Crassostrea virginica*, V. S. Kennedy, R. I. E. Newell, and A. F. Eble, editors, Maryland Sea Grant College, College Park, MD.

Porter, K. G. and Y. S. Feig, 1980. The Use of DAPI for Identifying and Counting Aquatic Microflora. *Limnol. Oceanogr.*, Vol. 25, pp. 943-948.

Prins, T. C., V. Escaravage, A. C. Smaal, and J. C. H. Peeters, 1995. Nutrient Cycling and Phytoplankton Dynamics in Relation to Mussel Grazing in a Mesocosm Experiment. *Ophelia*, Vol. 41, pp. 289-315.

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The Molecular Evolution of HLA-H

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Random genetic drift may play an important role in evolution, however there have been few studies of neutrally evolving regions in the human genome. Pseudogenes are assumed not to be under selective constraints. Thus, they are useful for studying the role of neutral evolution as well as for testing for selectionacting upon similar functional genes. Using 17 unrelated African-American individuals and three greater ape species: gorilla (*Gorilla gorilla*), chimpanzee (*Pan troglodytes*) and bonobo (*Pan paniscus*), variability was studied in the pseudogene HLA-H, located in the human major histocompatibility complex. SSCP (Single-strand conformation polymorphism) analysis was used to identify sequence variants. A portion of the HLA-H region of one or two individuals representing each variant SSCP pattern was sequenced and the data analyzed using two statistical tests: the McDonald-Kreitman test, and a test of substitution rates by codon position. The pattern of variability in HLA-H was not found to be significantly different from the expectations for neutral evolution.

INTRODUCTION

Darwin's theory of natural selection provided a mechanism for evolution: the maintenance of alleles in a population that increase an organism's fitness and the removal of those which decrease fitness. In the years since Darwin proposed the theory of natural selection, evolutionary biologists have proposed other mechanisms of evolution including neutral evolution. Unlike other processes, neutral evolution assigns chance an evolutionary role. The neutral theory of evolution holds that most mutations are selectively neutral, occur continuously and that by chance, some of these mutations will become fixed in the genome at a steady rate. Kimura (1968) argued that this type of evolution, the random fixation of selectively equivalent (or nearly equivalent) genes, accounted for the majority of changes at the molecular level. Neutral evolution may play an important role in the patterning of human genes. Pseudogenes can be used to study the molecular pattern of variability resulting from neutral evolution. Pseudogenes are once functional portions of the genome that mutations have rendered nonfunctional, and it is hypothesized that the genetic variability in pseudogenes should be patterned by neutral evolution (Li and Graur 1991). This hypothesis is based on the idea that the nucleotide substitutions present in pseudogenes reflect the pattern of spontaneous point mutations and cannot alter fitness because pseudogenes are not associated with an expressed gene product on which selection may act. Studies using pseudogenes are a powerful way to examine neutral selection alone as well as in comparison with other types of selection acting upon structurally similar functional genes to determine the type of selection acting upon these genes.

Such studies could be performed using the human major histocompatibility complex (MHC), also called the human leukocyte antigen (HLA) region. The HLA region of the short arm of chromosome 6 comprises 30 to 40 genes (Williams 1985) which code for proteins involved in various aspects of the immune response (Srivastava et al. 1985). Within the HLA region, the loci are grouped into three classes (Fig. 1). Class I genes, which include HLA-A, -B, -C, -E, -F, -G, -H, and -J (Messer et al. 1992) are located closer to the telomere than other classes of HLA genes and encode antigens which are expressed the cell surfaces of most nucleated cells (Williams 1982). The most extensively studied HLA genes are the highly polymorphic class Ia loci (HLA-A, -B, and -C) which are also called the classical loci, and are expressed on all nucleated cells (Klein 1986). Their gene products present foreign peptides to CD8$^+$ T cells for destruction (Quigstad et al. 1986). The less polymorphic class Ib (Klein 1986) genes in general have a more restricted tissue distribution (Hughes and Nei 1989). These nonclassical genes include HLA-E, -F and -G. Although some researchers believe those to be nonfunctional genes (Parham 1995), according to Grimsley (1997), HLA-E and -F show patterns of variation indicating the action of a selective force on a functional gene, and tests for selection acting upon HLA-G were unable to reject the null hypothesis of neutral selection. HLA-J is believed to be a gene fragment (Messer et al. 1992).

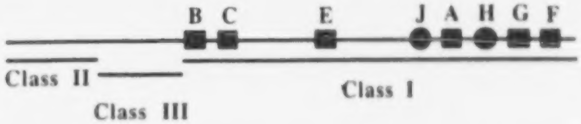

Fig. 1 HLA Complex Genes. This figure is not to scale. Squares represent functional genes, while circles represent pseudogenes or gene fragments. (Modified from Grimsley and Ober 1997)

Class II genes are highly polymorphic (Hughes and Nei 1989), have a much more limited distribution and are expressed in antigen presenting cells such as B cells, macrophages and dendrite cells (Williams 1982). These genes code for proteins which present foreign antigens to $CD4^+$ T cells (Quigstad et al. 1986). Class III genes code for complement proteins and other non-HLA peptides (Carroll et al. 1987).

The HLA region is among the most highly polymorphic in the human genome, with heterozygosity in some cases as high as 80 - 90% (Chomey 1990; Hughes and Nei 1988, 1989). The research of Hughes and Nei (1988, 1989) has supported the hypothesis of overdominant selection (heterozygote advantage) to explain the high level of polymorphism at some sites. They suggest that individuals heterozygous at these sites have a selective advantage over homozygous individuals because they produce more varieties of antigen-binding molecules, thus increasing their ability to respond to foreign antigens. In contrast to these highly polymorphic areas, other areas of the HLA region show higher levels of conservation (Srivastava et al 1985). Clearly, different selective pressures are acting within a small area on various HLA regions, allowing powerful comparisons between different selective mechanisms and neutral selection.

The pseudogene HLA-H is located between HLA-A and HLA-G (Fig. 1) in the class I region. It has the same eight exon structure which, in functional class I HLA genes, codes for a heavy chain with an extracellular portion, a transmembrane domain and a cytoplasmic tail (Williams 1985). Several authors have suggested on the basis of sequence homologies, that HLA-A, -H, -G and -J were all generated in several gene duplication events and that HLA-H was inactivated sometime after these events (Bjorkman et al. 1987, Chomey et al. 1990, Messer et al. 1992, Zemmour et al. 1990). Chomey et al. (1990) and Zemmour et al. (1990) have reported a frameshift mutation in human HLA-H which is created by a basepair deletion in the region corresponding to exon 4 in functional class I HLA genes. Upstream of this deletion, the amino acid sequence is different from that in functional class I HLA genes, and a premature stop codon is present near the end of the region, leading to the hypothesis that HLA-H is not functional (Chomey et al. 1990; Zemmour et al. 1990).

In addition, Venditti and Chomey (1992) reported that HLA-H was entirely deleted in some individuals with HLA-A23 or HLA-A24 alleles at the nearby HLA-A locus, supporting the hypothesis that HLA-H is nonfunctional. Chomey et al. (1990) obtained small amounts of HLA-H transcript, demonstrating that it retains a functional promoter. They suggested that if translated, an HLA-H protein would not interact with the phospholipid bilayer (as do other class I proteins) but would be secreted instead and could be linked to the cell surface by a phosphatidylinositol linkage. However, this translated protein would also lack a cysteine necessary for an intrachain disulfide bond present in all other class I peptides (Malissen et al. 1982). For these reasons, Chomey and et al. (1990) hypothesized that while the gene may still be functional in other primates it has been inactivated in the human lineage but that this inactivation occurred recently on an evolutionary time scale. Also supporting the hypothesis of recent inactivation is the one human HLA-H allele (HLA-12.4) without the frameshift deletion (Zemmour et al. 1990) which implies that the deletion occurred after the human lineage split from other primates. Hughes (1995) constructed phylogenetic trees of class Ia and Ib genes and several class Ia pseudogenes to study pseudogene evolution and presented further evidence that HLA-H is currently evolving neutrally but was acted upon by diversifying selection in the past and evolved from the duplication of a class Ia gene.

In this study, the hypothesis that HLA-H shows the pattern of variability characteristic of a neutrally evolving region was tested. Two current statistical tests were used which predict the patterns of variability present in a region under neutral selection: the McDonald-Kreitman test (McDonald and Kreitman 1991), which compares intraspecies polymorphisms to interspecies divergence and a test of substitution rate by codon position (Sawyer et al. 1987).

METHODS

Samples

Standard chloroform/phenol extractions (Bell et al. 1981) were used to purify DNA samples from 17 unrelated African American individuals who participated as controls in other studies (van der Ven and Ober 1994; Ober et al. 1989). Dr. Peter Parham, Stanford University, provided us with DNA samples from four chimpanzees and one bonobo. According to the "out of Africa" hypothesis of human evolution (Cann et al. 1987), Africans show the greatest amount of polymorphisms because they are the oldest human population, i.e., other races descended from an ancestral African subpopulation and emigrated from Africa.

SSCP (Single-strand conformation polymorphism) analysis

The amount of variation present in the region of HLA-H which corresponds to exon 2 in functional class I genes was determined using SSCP analysis (which is sensitive to single base pair differences) to identify sequence variants. In functional class I genes, exon 2 codes for the α_1 domain which forms part of the pocket that binds peptides and presents them to the T cell receptors (Williams 1985). Because pseudogenes do not code for a specific gene product, it is not correct to refer to exons and introns within HLA-H. For clarity, the region of HLA-H which corresponds to exon 2 in functional class I genes will be referred to as "exon 2".

SSCP analysis is based on the varying migration patterns in a non-denaturing polyacrylamide gel of short DNA fragments which differ by single point mutations (Orita et al. 1989). DNA samples were amplified by PCR (polymerase chain reaction) using primers designed for the intronic regions 3' and 5' of "exon 2" of HLA-H . Primer sequences were: H25, 5'-gacccagggagccgcgca-3', and H23, 5'-cggccctccgtgggggat -3'. About 0.5 µg template DNA was used for 10 µl total volume amplification reactions containing 2 pmol of each primer, 10 mM tris hydrochloride (pH 8.3), 50 mM potassium chloride, 1.5 mM magnesium chloride, 0.4 mM each dATP, dCTP, dTTP and dGTP, 0.5 units Taq DNA polymerase and 1 µCi ^{32}P-dCTP incorporated into the PCR product. After a PCR program of a 5 minute denaturation at 94°C, 30 cycles of denaturation (1 min at 94°C), annealing (1 min 15 sec at 70°C) and extension (2 min 5 sec at 72°C) followed by a 10 minute incubation at 72°C, 1 µl of the reaction was heated with 9 µl denaturing stop solution for 5 minutes at 94°C to denature the PCR product to single strands and then the product was chilled on ice. The strands were separated by electrophoresis on an MDE Hydrolink gel (FMC BioProducts, Rockland, Maine) at 8 watts for 17 hours and bands were visualized using autoradiography.

DNA Sequencing

For each human variant SSCP pattern, one or two samples (whenever possible) were to determine the nucleotide sequences. Initial forward sequencing of samples was performed manually using ^{32}P-labeled 5' sequencing primer. Perkin Elmer's (Banchbug, NJ) Amplicycle sequencing kit was used for the dideoxy method of cycle sequencing with Taq DNA polymerase following the manufacturer's instructions. Bands were visualized using autoradiography. Reverse sequencing of samples was performed using Pharmacia's ALF automated sequencer. The same amplification reaction conditions scaled up to a volume of 100 µl were used with the following exceptions: the H25 primer was biotinylated for solid-phase sequencing, the reactions contained 3.75 units of Taq DNA polymerase and between 0.5 and 1.0 µg DNA for each PCR reaction. All sequencing reactions were performed using Autoload, a solid-sequencing kit (Pharmacia, Piscataway, NJ), following the manufacturer's instructions. The concentration of the binding/washing solution was increased to 4M NaCl, 20 mM Tris-HCl, 2 mM EDTA, the first binding step was increased to one hour, annealing was at 71 °C and extension at 43 °C. The "exon" 2 region in the pongid ape samples was sequenced using the same techniques with the following exceptions: 1 min 30 sec annealing at 68°C, and 2 min 30 sec extension.

Data Analysis

The first test performed was an analysis of substitution rates at the three codon positions which can be used to determine whether or not a gene is functional (Sawyer et al. 1987). This test compares the numbers of substitutions at different codon positions. In functional genes that are under the influence of purifying selection, the substitution rate by position is expected to be:

$$S_3 > S_1 > S_2 \qquad (1)$$

Where S_1 represents the number of substitutions at the first codon position, S_2 the number of substitutions at the second codon position, and S_3 the number of substitutions at the third codon position. Because of degeneracy of the genetic code, substitutions at position 3 alter the amino acid less often than those at position 1, while substitutions at position 2 alters the amino acid most often (Sawyer et al. 1987). The neutral expectation is:

$$S_3 = S_1 = S_2 \qquad (2)$$

Data from the 17 individuals was used and a Chi-squared analysis of variance performed to determine significant differences.

The McDonald-Kreitman test (McDonald and Kreitman 1991) compares interspecies divergence to intraspecies polymorphisms to detect adaptive evolution. The ratio of replacement substitutions (M_r) to silent substitutions (M_s) is calculated within a species. This ratio represents intraspecies polymorphism. The M_r to M_s ratio between two species represents interspecies divergence. The McDonald-Kreitman analysis tests whether the relationship between M_r and M_s is the same within the species of interest as between two species. This test allows predictions of neutral, balancing or purifying selection occurring at a specific locus by comparing interspecies M_r:M_s and intraspecies M_r:M_s. When balancing selection is acting upon the locus, the intraspecies polymorphisms will be maintained in the population (the intraspecies replacement to silent substitution ratio will be higher than the interspecies ratio). A higher interspecies replacement to silent substitutions ratio (more divergence than intraspecies polymorphism) indicates that purifying selection is occurring at the locus. The prediction for neutrally evolving regions is equal interspecies divergence and intraspecies polymorphism. This test assumes equal likelihood of all nucleotide substitutions and no recombination, but is robust to deviations from these assumptions.

To perform the McDonald-Kreitman test, the human sequences were compared to three greater ape species: gorilla (*Gorilla gorilla*), chimpanzee (*Pan troglodytes*) and bonobo (*Pan paniscus*). The chimpanzee and bonobo genes used in the comparison were sequenced. The published Gogo-Oko allele, which Lawlor et al. (1991) suggest may be the gorilla homologue to HLA-H, was used for the analysis between humans and gorillas. Fischer's Exact test (performed using JMP version 3.0.2) was used to determine significant differences ($\alpha \le .05$).

RESULTS

SSCP analysis of the 17 samples indicated 15 different patterns in "exon 2". Sequence analysis revealed 10 different sequences.

Substitution by codon position

In "exon 2" there were two substitutions at position 1, seven substitutions at position 2, and six substitutions at position 3. One of these second position substitutions resulted in a termination codon in one individual. This pattern does not differ significantly from the null hypothesis of equal numbers of substitutions at each codon position ($\chi^2 = 2.8$, d.f. = 2, $p > 0.2$).

McDonald-Kreitman test

Using the McDonald-Kreitman test, the comparison between gorillas and humans, between bonobos and humans and between chimpanzees and humans all failed to reject the null hypothesis of neutral evolution (Table I). For humans, the numbers shown in the table represent intraspecies polymorphisms, and the numbers shown in the table for apes represent interspecies divergence. Interspecies divergence was calculated by comparing one ape sequence to all human sequences and considered as fixed differences only those basepair replacements that differed between the ape sequence and all human sequences. *P*-values were calculated using Fischer's Exact test.

Table I Data for McDonald-Kreitman test

	Replacement	Silent	p-value
Humans	9	6	
Gorilla	11	2	.2213
Bonobo	2	1	1.000
Chimpanzee	2	2	1.000

DISCUSSION

Evidence for the status of HLA-H as a pseudogene includes the deletion of the HLA-H locus in individuals with certain HLA-A alleles (Venditti and Chorney 1992), and a frameshift deletion in "exon 4" which results in a garbled sequence from this point and a stop codon near the end of this "exon". The inactivation of HLA-H, however, is believed to have been a recent event, which occurred during human evolution (Chorney et al. 1990; Zemmour et al. 1990). Our data are consistent with the hypothesis that HLA-H is a pseudogene in the human lineage.

Based on the results of the codon position test and the McDonald-Kreitman comparisons between humans and three primate species (gorillas, chimpanzees and bonobos), the null hypothesis that HLA-H is evolving neutrally cannot be rejected. In addition, the premature stop codon in the middle of one allele of "exon 2" is consistent with HLA-H being a neutral gene. For this reason, HLA-H may be used to represent neutral selection acting at a specific locus in comparison with nearby functional genes.

Interestingly, the p-value for the McDonald-Kreitman comparison for gorillas versus humans was much lower (0.2213) than the p-values (both 1.000) for bonobos versus humans and for chimpanzees versus humans. Lawlor et al. (1991) present three possibilities for the Gogo-Oko allele: that it is a homologue to HLA-H, that it is a homologue to HLA-A or that it is another HLA-A related locus which is not present or has not been discovered in humans. The low p-value suggests that one of the last two hypotheses is more likely.

It would be interesting to sequence "exon 3" and "exon 4" of HLA-H as well to determine if they also show a pattern of variation characteristic of a neutrally evolving region. In functional class I genes, these exons encode the α_2 and α_3 domains. The α_3 domain interacts with β_2 microglobulin (Williams 1985) and is more conserved than the α_1 and α_2 domains. As well as the tests presented here, a comparison of variability patterns between "exons" would help clarify the type of selection acting on HLA-H. Studies of variability in other populations would describe whether HLA-H is evolving similarly in other human populations. Further sequencing of HLA-H homologues among a larger pool of non-human primates would reveal more about the pseudogene's evolutionary history.

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REFERENCES

Bell, G. I.; Karam, J. H.; Rutter, W. J., Proc. Natl. Acad. Sci., Polymorphic DNA region adjacent to the 5' end of the human insulin gene. Vol 78, 1981. pg. 5759-5763.

Bjorkman, P. J.; Saper, M. A.; Samraoui, B.; Bennett, W. S.; Strominger, J. L.; Wiley, D. C., Nature, Structure of the human class I histocompatibility antigen, HLA-A2. Vol 329, 1987. pg. 506-512

Cann, R. L.; Stoneking, M.; Wilson A. C., Nature, Mitochondrial DNA and human evolution. Vol 325, 1987. pg. 31-36

Carroll, M. C.; Katzman, P.; Alicot, E. M.; Koller, B. H.; Geraghty, D. E.; Orr, H. T.; Strominger, J. L.; Spies, T., Proc. Natl. Acad. Sci., Linkage map of the human major histocompatibility complex including the tumor necrosis factor genes. Vol 84, 1987. pg. 8535-8539

Chorney, M. J.; Sawada, I.; Gillespie, G. A.; Srivastava, R.; Pan, J.; Weissman, S. M., Molec. Cell. Biol., Transcription analysis, physical mapping, and molecular characterization of a nonclassical human leukocyte antigen class I gene. Vol 10, 1990. pg. 243-253

Grimsley, C. The nature of selection acting on the class Ib HLA genes: HLA-E, HLA-F, and HLA-G. The University of Chicago, Chicago, Illinois, 1997.

Grimsley, C.; Ober, C., Human Immunol., Population Genetic Studies of HLA-E: Evidence for selection. Vol 52, 1997. pg. 33-40

Hughes, A. L., Mol. Biol. Evol., Origin and evolution of HLA class I pseudogenes. Vol 12, 1995. pg. 247-258

Hughes, A. L.; Nei, M., Proc. Natl. Acad. Sci., Nucleotide substitution at the major histocompatibility complex class II loci: evidence for overdominant selection. Vol 86, 1989. pg. 958-962

Hughes, A. L.; Nei, M., Nature, Pattern of nucleotide substitution at major histocompatibility complex class I loci reveals overdominant selection. Vol 335, 1988. pg. 167-170

Kimura, M., Nature, Evolutionary rate at the molecular level. Vol 217, 1968. pg. 624-626

Klein, J., Natural history of the major histocompatibility complex. New York: John Wiley & Sons. 1986.

Lawlor D. A.; Warren, E.; Taylor, P.; Parham, P., J. of Exp. Med., Gorilla class I major histocompatibility complex alleles: comparison to human and chimpanzee class I. Vol 174, 1991. pg. 1491-1509

Li, W.; Graur, D., Fundamentals of molecular evolution. Sunderland: Sinauer Associates Inc. 1991.

Malissen, M.; Malissen, B.; Jordan, B. R., Proc. Natl. Acad. Sci., Exon/Intron organization and complete nucleotide sequence of an *HLA* gene. Vol 79, 1982. pg. 893-897

McDonald, J. H.; Kreitman, M., Nature, Adaptive protein evolution at the Adh locus in Drosophila. Vol 351, 1991. pg. 652-654

Messer, G.; Zemmour, J.; Orr, H. T.; Parham, P.; Weiss, E. H.; Girdlestone, J., J. Immunol., *HLA-J*, a second inactivated class I HLA gene related to *HLA-G* and *HLA-A*. Vol 148, 1992. pg. 4043-4053

Ober, C.; Xiang, K. S.; Thistad, R. A.; Indovina, K. A.; Wason, C. J.; Dooley, S., Genet. Epidemiol. Increased risk for gestational diabetes mellitus associated with insulin receptor and insulin-like growth factor II restriction length polymorphisms. Vol 6, 1989. pg. 559-569

Orita, M.; Iwahana, H.; Kanazawa, H.; Sekiya, T. 1989. Detection of polymophisms of human DNA by gel electrophoresis as single-strand conformation polymophisms. Proc. Natl. Acad. Sci. 86:2766-2770.

Parham, P., Am. J. Reprod. Immunol., Antigen presentation by class I major histocompatibility complex molecules: a context for thinking about HLA-G. Vol 34, 1995. pg. 10-19

Quigstad, E.; Bruserud, Ø.; Thorsby, E., The role of human class II molecules in Activation of T4 lymphocytes. in Solheim, B. G.; Moller, E.; Ferrone, S., editors. HLA class II antigens: A comprehensive review of structure and function. Berlin: Springer-Verlag. 1986.

Sawyer, S. A.; Dykhuizen, D. E.; Hartl, D. L., Proc. Natl. Acad. Sci., Confidence interval for the number of selectively neutral amino acid polymorphisms. Vol 84, 1987. pg. 6225-6228

Srivastava, R.; Duceman, B. W.; Biro, P. A.; Sood, A. K.; Weissman, S. M., Immunol. Rev., Molecular organization of the class I genes of human major histocompatibility complex. Vol 84, 1985. pg. 93-121

van der Ven, K.; Ober, C., J. Immunol., HLA-G polymorphisms in African Americans. Vol 153, 1994. pg. 5628-5633

Venditti, C. P.; Chorney, M. J. Genomics, Class I gene contraction within HLA-A subregion of the human MHC. Vol 14, 1992. pg. 1003-1009

Williams, R. C., Yrbk. Phys. Anthropol., HLA. Vol 25, 1982. pg. 91-112

Williams, R. C., Yrbk. Phys. Anthropol., HLA II: The emergence of the molecular model for the human major histocompatibility complex. Vol 28, 1985. pg. 79-95

Zemmour, J; Koller, B. H.; Ennis, P. E.; Geraghty, D. E.; Lawlor, D. A.; Orr, H. T.; Parham, P. J. Immunol., HLA-AR, an inactivated antigen-presenting locus related to HLA-A. Vol 144, 1990. pg. 3619-3629

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Restriction Endonuclease Analysis
# of Plasmid DNA from
Methicillin Resistant *Staphylococcus aureus*

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Methicillin resistant *Staphylococcus aureus*, commonly referred to as MRSA, is one of the leading causes of nosocomial infections. A large number of techniques are used to distinguish among MRSA strains in hospital outbreaks. Restriction endonuclease analysis of plasmid DNA, (REAP), is one of the techniques that has been used extensively in MRSA outbreaks and is the focus of this research. Thirty six-strains of MRSA were isolated from infected patients from three different local hospitals in Western North Carolina and subjected to REAP analysis in addition to antibiotic susceptibility tests.

INTRODUCTION

MRSA bacteria are gram positive cocci that are responsible for a wide percentage of nosocomial outbreaks. Several studies have reported that as many as 30%-50% of physicians and nurses have colonization within their anterior nares with *Staphylococcus aureus* and 2% are colonized with MRSA (Zafar et al, 1995). Certain patients are predisposed to staphylococcal infections: among these are newborns, nursing mothers, burn patients, transplant patients, AIDS patients, leukemia patients, and surgical patients. Patient-to-patient transmission via the hands of personnel is the most common and important means of spread.

MRSA is one of the leading causes of nosocomial infections and the increased length of stay in isolation units greatly increases the cost for both the patient and the hospital. In one study, 84% of the excess cost attributed to MRSA infections was due to the prolonged stay in the hospital as a result of the infection process (Pfaller et al, 1991). MRSA began to emerge as a nosocomial pathogen in the USA in the late 1970s and it was noted early on that an outbreak in any given hospital was probably caused by one or two strains that spread throughout the infected institutions (Boyce, 1992). REAP analysis can also be a very effective tool in examining the quality of infection control measures within hospital facilities before a MRSA outbreak occurs. It has been estimated that intensive surveillance and infection control measures, which include focused microbiologic support, can reduce the rate of nosocomial infection by 32% (Pfaller et al, 1991).

MRSA epidemics are a sign of an infection control breakdown and REAP analyses, along with other techniques, are used to trace the carrier of the MRSA outbreak. REAP subtyping has been shown to be a useful aid in defining the epidemiology of nosocomial infections (Branchini et al, 1993). However, MRSA plasmid analysis has been widely criticized due to the plasmid content instability and the possibility for gaining or losing plasmids during an outbreak of a single strain. There are several other techniques that are commonly used to categorize MRSA, such as bacteriophage typing, antibiotype, and genomic DNA analysis (Sabria-Leal et al, 1994). Antibiograms and phage typing are commonly used for characterization of MRSA during epidemiological outbreaks, but antibiograms are frequently inadequate to accomplish the differentiation and phage typing requires an inventory of bacteriophages that is unavailable at most hospitals. Phage typing is also often uninformative and too slow for epidemiological work (Zuccarelli et al, 1990). This project explored REAP analysis in order to categorize the collected MRSA strains.

METHODOLOGY

MRSA Strains. Thirty-six strains of MRSA were obtained from infected patients from three local hospitals in Western North Carolina. Twenty-two strains came from the Mission-St.

Joseph Hospital complex in Asheville, NC, a 758 bed facility, the bacteria were labeled A1-A22 for easy identification. Nine strains were obtained from McDowell Hospital located in Marion, NC, a 65 bed hospital, the bacteria were labeled B1-B9. Five strains were obtained from VA Hospital of Asheville which is a 330 bed facility, the bacteria were labeled C1-C5.

The thirty-six bacteria strains were transferred to slants and incubated at 37°C for 24 hours. Samples of the bacteria were then frozen in 50% TSY and 50% Fetal Calf Serum at -70°C. Each bacteria strain was then tested for methicillin, oxacillin, and augmentin susceptibilities before their use in the study. The bacteria were incubated at 30°C for 48 hours and the antibiotic susceptibilities were determined by the Kirby-Bauer disk diffusion method (Bauer *et al.* 1966).

Plasmid isolation. Two different plasmid isolation methods were used to isolate the plasmid DNA. The first was a modified Holmes and Quigley method (Holmes *et al.* 1981) and the second was a modification of the alkaline lysis method (Zuccarelli *et al.* 1990). In the Holmes and Quigley procedure, the bacteria were grown in 5ml of TSB in 15ml centrifuge tubes and incubated overnight in a 37°C water bath. The bacteria were then pelleted by centrifugation at 5,000 rpm for 10 minutes and the pellets were suspended in 5 ml TE buffer (10 mM Tris 1 mM EDTA pH 7.5). The cells were again pelleted by centrifugation and resuspended with 350µl STET buffer and transferred to microfuge tubes. Then 10µl of lysostaphin (1mg/ml stock) was added to the bacteria, and they were incubated for 30 minutes in a 37°C water bath. The tubes were then placed in a boiling water bath for 1 minute and centrifuged for 10 minutes. A sterile toothpick was used to remove the coagulated mass of chromosomal DNA from the solutions. After the chromosomal DNA was removed, 2µl of ribonuclease A (10 mg/ml) was added to the microfuge tubes, and samples were vortexed and incubated for 1 hour in a 37°C water bath. The solution was then extracted with an equal volume of phenol and again with an equal volume of chloroform. The aqueous layer was saved each time and 35µl of 3M sodium acetate was added along with 1 ml of 95% ethanol, then the samples were held on ice for 10 minutes. The pellets were then obtained by centrifuging the samples for 5 minutes. The supernatant was discarded and the pellets were allowed to dry. The pellets were then resuspended with 50µl of sterile distilled water.

Another sample of plasmid DNA was then isolated by a modification of the alkaline lysis method. The bacteria were grown in 30ml of TSB overnight in a 37°C incubated shaker. Each bacterial sample was then carefully poured into a 50ml centrifuge tube and centrifuged for 5 minutes at 5,000rpm. The supernatant was then discarded and the pellet was resuspended in 1ml TE pH 7.5. The suspended pellet was then transferred to microfuge tubes and spun for 5 minutes. The pellet was resuspended in 0.2 ml TE pH 7.5 and then 10µl of lysostaphin was added and the bacteria were incubated in a water bath for 1 hour at 37°C. Then 0.4ml of 0.2 M NaOH, 1% SDS was added and the samples were held on ice for 10 minutes. After 10 minutes, 0.3 ml of a potassium acetate solution was added and the samples were held on ice for another 10 minutes and then spun in a cold centrifuge for 10 minutes. The supernatants were transferred to fresh microfuge tubes and extracted once with an equal volume of phenol and then extracted twice with equal volumes of chloroform. After the extractions, 2µl of ribonuclease A (10mg/ml) was added and the samples were incubated in a 37°C water bath for 15 minutes. The samples were then extracted with 1ml of 1:1 solution of phenol-chloroform. Then 0.1ml of sodium acetate (3M, pH 7.0) was added to each sample. The DNAs were then precipitated with 3 volumes of ethanol and stored overnight at -20°C. The precipitates were then collected by centrifugation and washed with 70% ethanol. The pellets were allowed to dry for 30 minutes and then dissolved in 25µl of TE pH 7.5.

Restriction enzyme digestion. Twenty-five microliters of each sample was then digested with 2µl of EcoRI enzyme (24 units) and 3µl of EcoRI 10X reaction mix and allowed to incubate for 1 hour in a 37°C water bath. The digested DNAs were then applied to adjacent wells on 0.75% agarose gels in 1X TBE buffer. DNA markers, 1-kilobase DNA ladders (Gibco BRL), were applied to the end wells in each gel and the gels were run at 80V for 60-90 minutes. Gels were stained for 10-20 minutes with 0.5µg/ml ethidium bromide in 1X TBE buffer. The gels were photographed on an ultraviolet transilluminater using Polaroid 667 film.

RESULTS

Of the thirty-six bacteria strains obtained, B7 was lost during the time span of the research. All of the remaining thirty-five bacteria samples were resistant to methicillin, augmentin, and oxacillin. The sizes of measured zones of inhibition are shown in Table 1. Some results from agarose gel electrophoresis are shown in Figure 1. No plasmid bands are dectectable in the lanes loaded with DNA samples from B3, B8, and B9. Fifteen other samples were similar and produced no detectable bands. In lane 5, which contained DNA from sample A11, 4 distinct bands of size 9, 7, 5, and 4.5 KB are visible. Two additional samples from the Mission-St. Joseph Hospital complex produced the same pattern with 4 bands of size 9, 7, 5, and 4.5 KB. One sample produced a pattern of 3 bands: 9, 5, and 2.5 KB. Lane 6, sample A13, contains a smear of DNA. Five additional samples yielded similar smears. While lane 7, sample A14, shows a smear, some distinct bands are detectable. In addition, five samples (not shown) produced a single band >12.2 KB. In our laboratory, restriction endonuclease analysis of plasmid DNA from local MRSA isolates was not very informative. While a few samples yielded distinct profiles, most samples did not.

TABLE 1. Properties of MRSA strains from local hospitals in Western North Carolina. Sizes in mm of measured zones of inhibition are shown for oxacillin, methicillin, and augmentin.

Strain	Oxacillin	Methicillin	Augmentin	Fragment Sizes
A1	4.0- R	2.0- R	5.2- R	
A2	4.2- R	none- R	3.5- R	
A3	none- R	none- R	1.4- R	>12.2 KB
A4	none- R	none- R	2.8- R	
A5	none- R	5.1- R	3.2- R	
A6	4.1- R	2.8- R	4.1- R	
A7	4.4- R	none- R	4.4- R	>12.2 KB
A8	none- R	none- R	2.8- R	>12.2 KB
A9	none- R	4.9- R	2.7- R	
A10	none- R	none- R	2.6- R	
A11	2.8- R	none- R	2.3- R	9, 7, 5, & 4.5 KB
A12	3.0- R	none- R	4.2- R	9, 5, & 2.5 KB
A13	4.6- R	1.9- R	4.7- R	
A14	4.2- R	2.0- R	4.5- R	9, 7, 4.9, & 4.5 KB
A15	none- R	none- R	1.0- R	
A16	none- R	none- R	1.2- R	
A17	none- R	5.1- R	3.0- R	
A18	none- R	none- R	3.8- R	
A19	5.4- R	3.6- R	6.0- R	
A20	2.1- R	2.2- R	9.8- R	
A21	2.7- R	none- R	4.2- R	9, 7, 5, & 4.5 KB
A22	none- R	none- R	4.3- R	
B1	none- R	none- R	2.2- R	
B2	none- R	none- R	2.7- R	
B3	4.1- R	none- R	1.9- R	
B4	3.6- R	1.6- R	5.0- R	
B5	4.6- R	2.7- R	4.9- R	
B6	none- R	none- R	1.3- R	
B7				
B8	2.3- R	none- R	2.2- R	
B9	none- R	none- R	1.9- R	
C1	4.3- R	6.1- R	7.2- R	
C2	none- R	none- R	1.0- R	>12.2 KB
C3	none- R	4.4- R	2.9- R	>12.2 KB
C4	4.4- R	2.2- R	6.9- R	
C5	none- R	4.1- R	2.4- R	
MRSA	2.4- R	none- R	4.1- R	

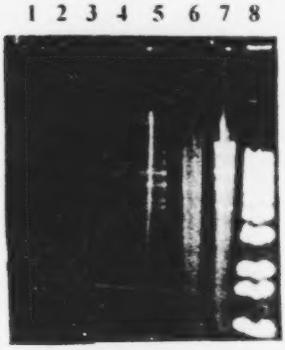

Figure 1. Agarose gel of restriction enzyme fragments of plasmid DNAs. DNA samples were loaded in lanes 1, 2, 3, 5, 6, and 7, which contain samples B3, B8, B9, A11, A13, and A14, respectively. A DNA size standard (1KB ladder, Gibco BRL) was loaded in lane 8.

DISCUSSION

Attempts to isolate plasmid DNAs and produce restriction enzyme fragment patterns met with little success. With the initial Holmes and Quigley plasmid isolation from 5 ml cultures, very few of the bacteria exhibited DNA fragments following agarose gel electrophoresis. Because of the low percentage of DNA bands obtained, the modified alkaline lysis method was employed. This method used a 30ml TSB sample to produce more plasmid DNA. The initial experimental procedure with this method called for incubation for 30 minutes with lysostaphin. The first gels obtained with this procedure did not produce bands and a major concern was that the cells were not being lysed during this short incubation time. The incubation time was then doubled to 1 hour to increase cell lysis. The final resuspension was also altered from 50μl of TE pH 7.5 to 25μl in hopes of obtaining a more concentrated sample for gel analysis. These alterations were marginally effective.

There are certain requirements that must be met for REAP analysis to be effective. The bacterial strains under investigation must contain a plasmid and the plasmids must be sufficiently diverse so that independent isolates are likely to carry distinctly different plasmid DNA. For this to be an effective tool within clinical settings, plasmid profiling must be rapid, reproducible, inexpensive, and accessible to clinical laboratories.

The rich diversity of plasmids among MRSA suggests that there are mechanisms at work, perhaps involving conjugation, phage mediated contact, transduction, transposition, and site-specific or homologous recombination that are continuously generating new plasmid forms (Zuccarelli et al. 1990). For REAP analysis to be useful in epidemiological outbreaks, the rate at which these DNA reorganizations occur is important. Also, the specific plasmid profile of MRSA needs to remain consistent, at least during the infection and hopefully for the duration of a MRSA outbreak. This is very probable based on observations of specific digestion profiles that remained consistent in hospitals over a period of more than two years (Archer et al. 1983).

While attempts to use restriction enzyme analysis of plasmid DNA as a molecular tool to identify similar MRSA isolates were not very successful, better profiles might be obtained by more experienced personnel. Even though more specialized instrumentation is necessary, other molecular tools which analyze genomic DNA from MRSA samples might be more reproducible (Sabria-Leal et al. 1994).

REFERENCES

Archer GL, Mayhill CG (1983) Comparison of epidemiological markers used in the investigation of an outbreak of methicillin-resistant *Staphylococcus aureus* infections. J Clin Microbiol 18:395-399.

Back NA, Linnemann CC, Pfaller MA, Staneck, JL, Morthland V (1993) Recurrent epidemics caused by a single strain of erothromycin-resistant *Staphylococcus aureus*. JAMA 270:1329-1333.

Bauer AW, Kirby WMM, Sherris JC, Turck M (1966). Antibiotic susceptibility testing by a standardized single disk method. American Journal of Clinical Pathology 45:493-496.

Boyce JM (1992). Methicillin-resistant *Staphylococcus aureus* in hospitals and long-term care facilities: microbiology, epidemiology, and preventive measures. Infect Control Hosp Epidemiolgy 13:725-737.

Branchini ML, Morthland VH, Tresoldi AT, Nowakonsky AV, Souza Dias MB, Pfaller MA (1993). Application of genomic subtyping by pulse field gel electrophoresis and restriction enzyme analysis of plasmid DNA to characterize methicillin-resistant Staphylococcus aureus from two nosocomial outbreaks. Diagn Microbiol Infect Dis 17:275-281.

Hartstein AI, Morthland VH, Eng S, Archer GL, Schoenknecht, Rashad AL (1989). Restriction enzyme analysis of plasmid DNA and bacteriophage typing of paired *Staphylococcus aureus* blood culture isolates. J Clin Microbiol 27:1874-1879.

Holmes DS, Quigley M. (1981) A Rapid Boiling Method for the Preparation of Bacterial Plasmids. Anal Biochem 114:193.

Pfaller MA, Wakefield DS, Hollis R, Fredrickson M, Evans E, Massanari RM (1991). The clinical microbiology laboratory as an aid in infection control: the application of molecular techniques in epidemiological studies of methicillin-resisatnt *Staphylococcus aureus*. Diagnostic Microbiology of Infectious Diseases 14:209-217.

Sabria-Leal M, Morthland VH, Pedro-Boter ML, Sopena N, Gimmez-Perez, Branchini ML, Pfaller MA (1994). Molecular epidemiology for local outbreaks of methicillin resistant *Staphylococcus aureus* (MRSA). European Journal of Epidemiology 10:325-330.

Zafer AB, Butler RC, Reese DJ, Gaydos LA, Mennonna PA (1995). Use of 0.3% triclosan (Bacti-Stat) to eradicate an outbreak of methicillin-resistant *Staphylococcus aureus* in a neonatal nursery. American Journal of Infection Control 23:200-207.

Zuccarelli AJ, Roy I, Harding GP, Couperous JJ (1990). Diversity and stability of restriction enzyme profiles of plasmid DNA from methicillin-resistant *Staphylococcus aureus*. Journal of Clinical Microbiology 28:97-102.

Macrorestriction Patterns and Genome Sizes of Two Strains of Bdellovibrio

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Little is known about the genetics of the bdellovibrios. Therefore, the development of a map of the Bdellovibrio genome would serve as a stimulus for additional genetic studies and provide a framework onto which genetic data could be coordinated. Conditions were established for the extraction of high quality, unsheared genomic DNA from two prey-independent strains of Bdellovibrio and for embedding that DNA in agarose plugs. Genomic DNA in the agarose plugs was subjected to restriction digestion by rare-cutting restriction endonucleases. Macrorestriction patterns were determined using Pulsed Field Gel Electrophoresis (both FIGE and CHEF) using various voltage settings and switch times. Maximum genome sizes have been determined for the two strains to be approximately 2.07Mb. Digestion with Not I, Pme I, Asc I, and Pac I resulted in 21, 18, 16, and 13 fragments respectively. Ordering of these fragments was begun using Southern Blot analysis. Probes were constructed from fragments generated by cutting the Bdellovibrio genome with different restriction endonucleases.

INTRODUCTION

Bdellovibrio bacteriovorus is a ubiquitous, gram-negative bacterium that exists by preying on other gram negative bacteria. It attacks the cell wall of its prey, entering the periplasmic space where it grows, feeding on the biochemical products of the cell. Reproduction takes place within the periplasm and progeny are released upon lysis.

The development of Bdellovibrio bacteriovorus is complex and has been studied ever since the bacterium was discovered in the early 60's. The bacterium especially serves as a good test organism fort he study of gene expression during development (1). If the gene organization of the bacterium can be mapped, it would help to elucidate the role of specific genes during its development and possibly the development of other predacious bacteria. Physical genome analysis is one of the most productive steps in creating a genetic map since it provides initial information on the organization of the genetic information (3).

Macrorestriction mapping using restriction endonucleases has been used successfully in conjunction with Pulsed Field Gel Electrophoresis (PFGE) to construct physical maps for the chromosomes of E. coli, P. aureus, H. parainfluenzae, and B. cereus (4). The genomes of the bacteria are cut using rare-cutting restriction endonucleases to attain large pieces of DNA. The DNA is then separated using PFGE. With the use of PFGE, DNA molecules in the size range of 1Kb to 6Mb have been made possible to separate (4).

Four rare-cutting restriction endonucleases, Not I, Pme I, Asc I, and PacI have been successful in cutting the Bdellovibrio genome into relatively few fragments for analysis. Analysis of the macrorestriction patterns of these four enzymes has yielded an estimated genome size of 2.7Mb for the prey independent strains Sa109 and 109JA. Southern Blot analysis has been used to assemble preliminary data for the physical map. Further analysis is necessary.

MATERIALS AND METHODS

Cell Propagation

Axenic strains Sa109 and 109JA of the bacterium Bdellovibrio bacteriovorus were cultured overnight by shaking at 240 r.p.m at a temperature of 30°C. These strains were obtained from fresh stock cultures and transferred daily by inoculating 9ml of peptone and yeast extract, pH 7.2 (PYE) with 1ml of bacteria. Cultures were checked daily before transferring for contamination.

Preparation of Agarose Embedded Bacterial DNA

The 10ml cultures were then spun down at 8,000 r.p.m for 10 minutes at 4°C. The DNA was embedded in agarose by following the procedure of Kreuger, Marks, and Ihler (2) except that the DNA was embedded in rods not slabs. The spun down culture was washed 3X with 5ml of PBS. Each wash was centrifuged at 8,000 r.p.m for 10 minutes. Following the washes, the pellet was resuspended in 1ml of PBS and mixed with 1ml of 2% low melting point agarose. The mixture was then pulled up into syringes and cooled to form the rods.

The rods were then removed from the syringes and soaked overnight in 5ml of proteinase K solution (1% SDS, 1mg/ml proteinase K, 1X TBE) to lyse the cells. While being soaked in proteinase K solution, the rods were shaken at a temperature of 50°C in a shaker water bath. The proteinase K solution was removed and the rods washed 10X with 5ml of 1X TBE (54g Tris base, 27.4g boric acid, 20ml .5M EDTA) while being shaken for 10 minutes. The rods were then washed 2X with 3ml of acetone while being shaken for another 10 minutes. Finally, the rods were washed 5X with 5ml of 1X TBE and simultaneously shaken for 10 minutes. The rods were then stored in 1X TBE until used for digestion.

Digestion of Agarose Embedded DNA

For digestion with restriction endonucleases, plugs ranging in volume from 10ul to 30ul were cut from the rods and placed in microfuge tubes. Three washes with 100ul of the appropriate buffer were performed before the enzyme was added. Depending on the digestion, the incubation time and the amount of enzyme varied. Conditions for digestion were based upon information presented by New England Bio Labs. Plugs were digested in 100ul of the appropriate buffer. Digestion times were minimal, ranging from 2 to 4 hours. After digestion, the enzyme was stopped by the addition of 1ml of 10mM EDTA.

Gel Electrophoresis and Analysis

Digested plugs were run on 2 electrophoresis apparatae, the LKB Pulsaphor 2015 CHEF and the PPI-200 MJ FIGE. The gels were made to a final concentration of 1% agarose using Fast Lane agarose in .5X TBE buffer. Cold circulating buffer was run through the chambers. The buffer was kept at a temperature of 4°C. The conditions for each gel run varied to obtain the best results. Optimal running conditions for the FIGE were 150 volts for 24hrs on PGM 4. For the Chef, the best patterns were achieved using pulse times varying from 10 to 60 seconds and voltages between 120 and 200 volts. After completion of electrophoresis, the gels were stained in ethidium bromide and analyzed using the Stratagene Eagle Eye II.

Probe Preparation

DNA fragments from different restriction digests were isolated from gels and labeled for use in Southern Blot analysis with digoxigenin by using the DIG High Prime Labeling kit from Boehringer and Mannheim.

Southern Blot Analysis and Hybridization

Gels were blotted onto positively charged nylon membranes by capillary treatment in 20X SSC (175.32g NaCl, 88.2g Na-Citrate, pH 7.0) and then were used in hybridizations. Hybridizations were performed according to the procedures of Boehringer and Mannheim. Membranes were subsequently stripped by boiling for 10 minutes in .1% SDS.

RESULTS AND DISCUSSION

Analysis of digestions from four different rare-cutting enzymes estimated the genome size to be about 2.7Mb for strains

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Sa109 and 109JA. Digestion of the DNA with Not I produced 21 fragments that ranged in size from 5.80kb to 265.54kb (Table 1). The intensities of bands A, B, C, D, J, K, and L indicated the possibility that these bands were doublets (Figure 1). Digestions with Pme I yielded 18 bands that ranged in size from 18.13kb to 472.49kb (Table 1). Bands D, E, and J were also calculated as doublets due to their increased intensity compared to other fragments in the digest (Figure 1).

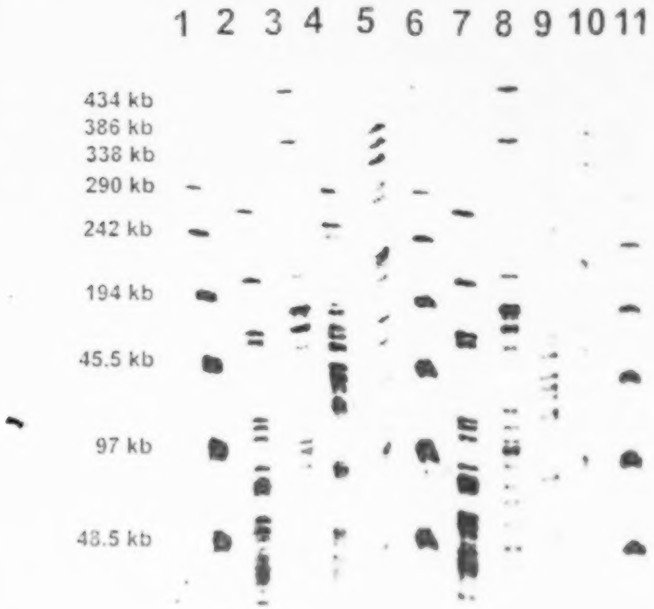

Figure 1: Not I, Pme I, Asc I and Pac I digests of Bdellovibrio DNA from strains Sa109 and 109JA separated by PFGE (CHEF). Lanes 1,6, and 11 Lambda Ladder; Lanes 2-5 Sa109; Lanes 7-10 109JA; Lanes 2,7 Not I Digests; Lanes 3,8 Pme I digests; Lanes 4,9 Asc I Digests; Lanes 5,10 Pac I Digests.

Maximum genome sizes estimated from the macrorestriction patterns generated by each of the enzyme are relatively consistent. Genome size calculated from Not I and Asc I digestions are about 200kb-300kb smaller than the genome sizes estimated by digestions with Pme I and Pac I. The presence of doublets in the patterns of Not I and Asc I digests other then those already indicated might reconcile the difference in size. Further PFGE analysis needs to be performed in order to determine the presence of doublets.

The macrorestriction patterns obtained for axenic strains Sa109 and 109JA with the rare-cutting restriction endonucleases, Not I, Pme I, Asc I and Pac I are very similar to each other. A similar banding pattern is produced by each enzyme in both strains of Bdellovibrio. This similarity in banding patterns suggests that Sa109 and 109JA are phylogenitically related to one another. The macrorestriction patterns generated by digestion with these enzymes can help to characterize these and other strains of Bdellovibrio and facilitate the creation of a phylogenetic tree.

Southern hybridizations at this point have revealed very preliminary results in construction of the physical map of the

Bdellovibrio genome. Trouble with high background on Southern blots that have gone through hybridizations and detections has prevented analysis. Work on reducing background and optimizing signal is in progress. With these conditions under control, the ordering of fragments can proceed by probing digests with fragments from other digests.

Table 1: Average band sizes for restriction fragments produced through digestion with *Not* I and *Pme* I.

Band	Average Band Sizes for *Not I* Digests (kb)	Band	Average Band Sizes for *Pme I* Digests (kb)
A	259.56	A	298.19 kb
B	214.80	B	286.60 kb
C	211.70	C	223.61 kb
D	171.02	D	200.50 kb
E	163.35	E	185.64 kb
F	115.08	F	170.05 kb
G	110.55	G	129.75 kb
H	105.13	H	120.98 kb
I	92.47	I	110.90 kb
J	86.07	J	95.06 kb
K	81.08	K	79.72 kb
L	71.1	L	64.44 kb
M	67.77	M	36.59 kb
N	57.33	N	29.67 kb
O	53.37		
P	50.27		
Q	43.04		
R	34.29		
S	26.68		
T	22.04		
U	18.64		
V	16.15		
Average Genome Size	2,071.49 kb		2,031.70 kb

ACKNOWLEDGMENTS

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REFERENCES

1. Diedrich, D.L. 1988. Bdellovibrio: recycling, remodeling, and relocalizing components from their prey. Microbiological Sciences. 5: 100-103.
2. Kreuger, Charles M., K.L. Marks, and G.M. Ihler. 1995. Improved 2D-PFGE technique generally applicable to bacterial genome mapping. Texas A&M University, TX.
3. Romling, U., D. Grothues, T. Heuer, and B. Tumler. 1992. Physical genome analysis of bacteria. Electrophoresis. 13: 626-631.
4. Whatling, C.A., and C.M. Thomas. 1993. Preelectrophoresis of agarose plugs containing bacterial chromosomal DNA prepared for analysis by pulsed field gel electrophoresis can improve the clarity of restriction patterns. Analytical Biochemistry. 210: 98-101.

Effects of Specific and Non-Specific Transport ATPase Inhibitors on Gill and Rectal Gland Tissues of the Little Skate, *Raja erinacea*

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ABSTRACT

Gill and rectal gland tissue homogenates of the little skate *Raja erinacea* were examined to determine the types and amounts of transport ATPases present in the membranes. Tissue homogenates were treated with varying concentrations of different transport ATPase inhibitors and observed for changes in enzyme activity. Under conditions in which Ca^{2+}-ATPase and mitochondrial ATPase activity were inhibited, ouabain, an inhibitor of Na^{+}/K^{+}-ATPases, inhibited 93% of all remaining rectal gland activity whereas only 29.6% of all gill activity was inhibited. In contrast, *N*-ethylmaleimide, which inhibits proton ATPases, inhibited a greater percent of total activity in the gill tissues than in those of the rectal gland.

INTRODUCTION

Gill epithelial cells and a special regulatory organ known as the rectal gland are responsible for active uptake and secretion of Na^{+}, Cl^{-} and other ions in teleosts. Mitochondria-rich (MR) cells are present in gill epithelium and are the site for active NaCl secretion, a process catalyzed by Na^{+}/K^{+}-ATPase (Kultz and Somero, 1995).

Active transport can be selectively inhibited by certain blocking agents. The cardiac glycoside ouabain is a drug that selectively inhibits Na^{+}/K^{+}-ATPases while *N*-ethylmaleimide (NEM) inhibits H^{+}-ATPases. NEM-sensitive ATPase activity is also inhibited by other H^{+}-ATPase blockers such as DCCD and PCMBS, and also the plasma membrane ATPase inhibitor vanadate (Lin and Randall, 1993).

ATPase activity was measured in crude homogenates of skate gill and rectal gland tissue using a coupled-enzyme ATPase assay in the presence of EGTA, ouabain and azide (modified from Kultz and Somero, 1995, and Lin and Randall, 1993). Isolates of skate gill and rectal gland were examined to determine amounts of transport enzymes present. Experiments were performed at the Mount Desert Island Biological Laboratory in Salisbury Cove, Maine, during the summer of 1996.

MATERIALS AND METHODS

Prior to use, skates were removed from common pool holding tanks of sea water and a small incision was made between the eyes with a scalpel. The skates were pithed by the insertion of a wire through the incision into the brain and then down the entire length of the spinal column. The wire was then manipulated to effect destruction of the nervous tissue. The skates were taken to a running sea water holding tank where sea water was directed over the body and the gills were perfused to prevent drying and to keep the fish cool.

An incision was made on the ventral surface of the skate's body to expose the heart. The lower portion of the ventral aorta was then cut and a small plastic tube was inserted and tied into place with surgical thread. The fish was then perfused with heparinized, calcium free, Elasmobranch Ringer's Solution (ERS) consisting of 250 mmol l^{-1} NaCl, 6 mmol l^{-1} KCl, 3 mmol l^{-1} MgCl$_2$, 350 mmol l^{-1} Urea, 72 mmol l^{-1} Trimethylamine oxide (TMAO), and 8 mmol l^{-1} NaHCO$_3$ for 15 minutes to clear gills of blood (modified from Kultz and Somero, 1995). During perfusion the rectal gland was removed and placed into ERS on ice. The tissue was then scraped away from the gill arches using a scalpel, blotted dry and weighed. The rectal gland was also blotted dry and weighed and the data was recorded.

Gill and rectal gland tissues were each placed into 5 ml of homogenization medium which contained 300 mmol l^{-1} Sucrose, 2 mmol l^{-1} EGTA, 1 mmol l^{-1} Dithiothreitol, 100 mmol l^{-1} Tris-HCl, and 0.1% Deoxycholate (modified from Lin and Randall, 1993). The tissue was homogenized for one minute and then transferred to micro centrifuge tubes. The homogenate was centrifuged for one minute, the supernatant was removed, the pellet discarded, and the supernatant was either assayed immediately or frozen in a -80° C freezer until the day of the assay.

On assay day 0.9 ml ATPase reaction mix consisting of 30 mmol l^{-1} Imidazole, 125 mmol l^{-1} NaCl, 20 mmol l^{-1} KCl, 4 mmol l^{-1} MgCl$_2$, 5 mmol l^{-1} Na$_2$EDTA, and 0.4 mmol l^{-1} NaN$_3$ was added to a cuvette. The ATPase reaction mix contained azide, EDTA and was Ca^{2+} free in order to ensure complete inhibition of F-type (mitochondrial) and Ca^{2+} ATPase. Also added were 2 mmol l^{-1} phosphoenol pyruvate, 10 microliters LDH/PK enzyme mix (SIGMA), 1

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mmol l^{-1} Na_2ATP, .5 mmol l^{-1} NADH, and either 25 or 50 microliters of rectal or gill tissue extract, respectively (modified from Kultz and Somero, 1995). Inhibitors used were ouabain, NEM, vanadate, PCMBS, and DCCD added in concentrations to yield 1 to 0.001 mmol l^{-1}. The tests were read for 5 minutes in a spectrophotometer at a wavelength of 340nm. There was an initial time delay of one minute to allow the solution to acclimate to 15^{o}C. Results are expressed as means ± standard error of means (S.E.M.).

RESULTS

Tests were run on 6 samples of skate gill and rectal gland tissue homogenates and enzyme activity on each control sample was measured before inhibition. A mean gill enzyme activity of 1.83 ± 0.285 umol mg^{-1} protein h^{-1} and a mean rectal gland enzyme activity of 12.1 ± 1.57 umol mg^{-1} protein h^{-1} were observed.

Ouabain (1 mmol l^{-1}) inhibited an average of 29.6% of all gill activity whereas 1 mmol l^{-1} NEM inhibited 23.7%. Vanadate was added in a concentration of 0.1 mmol l^{-1} and it inhibited 42.8% of all activity while 0.01 mmol l^{-1} PCMBS inhibited 24.4% of all gill activity (Table 1).

In the skate rectal gland it was observed that 1 mmol l^{-1} ouabain inhibited 93% of all activity and 1 mmol l^{-1} NEM inhibited only 19%. PCMBS, in a concentration of 0.01 mmol l^{-1}, inhibited 67.4% and 0.1 mmol l^{-1} vanadate inhibited 93.9% of all activity in the skate rectal gland (Table 2).

Table 1. Average activity (in percent) remaining after inhibition of crude homogenates of skate gill tissue

Inhibitor	Concentration (mmol l^{-1})	Remaining activity (%)	N
None		100	
Ouabain	1	70.4 ± 7.33	6
NEM	1	76.3 ± 5.07	6
Vanadate	0.1	57.2 ± 5.19	6
PCMBS	0.01	75.6 ± 6.22	6
DCCD + Ouabain	1 + 1	57.0 ± 5.78	6

NEM, *N*-ethylmaleimide; DCCD, dicyclo hexylcarbodiimide;
PCMBS, *p*-chloromercuribenzensulfonate
Values are mean ± SEM

Table 2. Average activity (in percent) remaining after inhibition of crude homogenates of skate rectal gland tissue.

Inhibitor	Concentration (mmol l^{-1})	Remaining activity (%)	N
None		100	
Ouabain	1	7.0 ± 0.648	6
NEM	1	81.0 ± 9.25	6
Vanadate	0.1	6.1 ± 0.393	5
PCMBS	0.01	32.6 ± 3.62	6
DCCD + Ouabain	1 + 1	67.3 ± 4.03	6

NEM, *N*-ethylmaleimide; DCCD, dicyclo hexylcarbodiimide;
PCMBS, *p*-chloromercuribenzensulfonate
Values are mean ± SEM

DISCUSSION

Our results support the conclusion that the bulk of the activity in the skate rectal gland was mediated by Na^+/K^+ ATPase as shown by the amount of ouabain needed to cause inhibition. In contrast, a substantial amount of the ATPase activity in the skate gill tissue was NEM-sensitive. The experiments were performed in the presence of EGTA, azide and ouabain to abolish any Ca^{2+}, mitochondrial or Na^+/K^+-ATPases in order to minimize the contribution of any unrelated ATPase activity. Therefore, the ATPase activity in the gill tissue that was NEM-sensitive was probably of the plasma membrane type. This is the first research of its kind to show the presence of any NEM-sensitive ATPase in the skate gill tissue. H^+-ATPase has been reported to be either bound to membranes or packaged in cytoplasmic vesicles. NEM is an alkylating agent that is relatively selective for sulphydryl groups (SH-) and inhibits vacuolar H^+-ATPase. The gill ATPase that was NEM-sensitive was also sensitive to vanadate. However, in the mammalian kidney, vanadate fails to inhibit NEM-sensitive activity which is believed to be mediated by vacuolar H^+-ATPase (Lin and Randall, 1993). Supported by NSF IBN-9507456 to GAK; NSF REU BIR 9322221 to MDIBL.

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REFERENCES

Kultz, D. and Somero, G.N. (1995). Osmotic and thermal effects on *in situ* ATPase activity in permeabilized gill epithelial cells of the fish *Gillichthys mirabilis*. *J. exp. Biol.* 198, 1883-1894.

Lin, H and Randall, D.J. (1993). H^+-ATPase activity in crude homogenates of fish gill tissue: Inhibitor sensitivity and environmental and hormonal regulation. *J. exp. Biol.* 180, 163-174.

Effects of Wood Frog (Rana sylvatica) Predation on Spotted Salamander (Ambystoma maculatum) Oviposition Site Selection

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Wood frog (Rana sylvatica) tadpoles have been presumed to be herbivorous filter-feeders. They have recently been shown to possess the ability to shift to being upper-level carnivores, preying upon eggs and hatchlings of amphibians coexisting within the same pond community. Wood frog tadpoles have been documented to feed on spotted salamander (Ambystoma maculatum) eggs. Two experiments were conducted to determine the effect of wood frog tadpole predation in structuring communities as well as influencing the oviposition site of spotted salamanders. The number of egg masses deposited by spotted salamanders in experimental ponds with or without a standard density of Rana egg masses (0.6/m^2) was monitored. Later, spotted salamander hatchlings were added to these same ponds and tracked their survival.

Spotted salamanders did not exhibit avoidance behavior towards wood frogs when selecting breeding sites. Salamander larvae survival was not significantly affected by tadpoles, but several Rana-free ponds contained Bufo and Hyla tadpoles. The results of this and other studies indicate that R sylvatica tadpoles have both direct and indirect effects in structuring southern Appalachian amphibian communities.

INTRODUCTION

The structure of biological communities is determined by a system of complex interrelationships involving both biotic and abiotic factors (Wilbur 1972, Cortwright and Nelson 1990). Community structure changes in response to many different stimuli in very complex ways, often affecting, through an intricate chain of events, far more than is at first apparent. For example, the harshness of winter conditions may affect predator survival, which in turn may determine the population density of prey species the following spring (Cortwright and Nelson 1990). Body size and growth rate of amphibian larvae generally decrease in response to an increase in density (Cortwright and Nelson 1990). In response to reduced growth, the larval period is increased, and larvae are more susceptible to threats from predation, parasitism or pond drying (Wilbur 1972). Also, because salamanders tend to reproduce upon reaching a certain body size rather than a certain age, large body size and fast growth rate increase the likelihood of survival to sexual maturity (Wilbur 1972).

Competitive interaction among species in a community is not simply dependent on the total number of larvae present, but depends also on the identity and abundance of each species present (Wilbur 1972). The experimental addition of a foreign species to a temporary amphibian community by Wilbur (1972) did not simply eliminate one species and allow a free niche for the newcomer, but modified the growth curves of many of the native species. Thus, the entire structure of the community was affected. This and other studies showed that the impact of one species on a second competing species is dependent upon the density of both heterospecific competitors and conspecifics (Wilbur 1972).

The study of community structure has often emphasized the effect of competition and predation, taking into account the direct (lethal) effects of predators that reduce or eliminate a population, but ignoring a predator's potential indirect (nonlethal) effects. Recent research indicates that predators can have important indirect effects. Figiel and Semlitsch (1990) found that the introduction of predatory fish into a small pond caused salamanders to modify their behavior, reducing activity in open water areas and moving into protective leaf litter at the pond's edges. The leaf litter was presumably a more resource-poor environment. Because of this change in food supply and competition for food from the fish, the larvae declined in conjunction with a change in larval feeding activity. Grey treefrogs

(Hyla chrysoscelis) have developed an extended breeding season that, by spanning a range of seasonal conditions, may allow better survivorship at some point in the season when ambystomatid predators are absent or less prevalent (Resetarits and Wilbur 1989). Another way in which species composition of a community is influenced is evident when two species of prey coexist. The less preferable species enjoys a much higher survival rate in the presence of the preferred prey as the predator seeks out the latter first (Cortwright and Nelson 1990).

The selective pressures to develop effective anti-predator defenses are obviously great, as complete mortality can otherwise result (Petranka et al. 1994, Semlitsch 1988, Wilbur 1972). Some amphibian larvae have developed noxious secretions to protect themselves (Kats et al. 1988) and others have evolved mechanical defenses, such as the thickly coated egg masses of Ambystoma maculatum (Semlitsch 1988). A more recently discovered method is spatial segregation through adult choice. There is an increasing volume of data which suggest the importance of adult choice as an evolved predator defense mechanism. In certain species, adults detect the presence of predators prior to laying eggs and avoid these sites in favor of predator-free environments. Certain insects can detect fish using chemical cues (Petranka and Fakhoury 1991), and Hyla chrysoscelis individuals are able to detect different competitors and predators and discriminate according to the risk to their offspring (Resetarits and Wilbur 1989). Several amphibian species that live in habitats with fish are able to detect the presence of a fish predator by chemical means and modify activity to minimize contact (Kats et al. 1988, Petranka 1994). In an experiment by Kats and Sih (1992), streamside salamanders avoided ovipositing in stream pools with fish. Kats (1988) has suggested that predator avoidance by chemical means evolved in response to fish predation on amphibians, and a recent study by Petranka et al. (1994) showed that this response extends to non-fish predators as well.

Because choice of oviposition site plays such a primary role in the success of a species in the temporary pond amphibian community, it is logical that selection should favor females who are able to evaluate a site based on its suitability for successful hatching and growth of their offspring. Minimal contact with a predator, most effectively achieved through the evolution of avoidance behavior, should be selected for.

In western North Carolina two species, the wood frog (Rana sylvatica) and the spotted salamander (Ambystoma maculatum) exist sympatrically, and often coexist within a single pond community. Though wood frog tadpoles were presumed to be herbivorous filter-feeders, recent observations and research have shown that they possess the ability to temporarily shift, under certain conditions, to being very effective upper level carnivores (Petranka et al. 1994). Recent studies indicated that wood frog tadpoles will eat the eggs and hatchlings of American toads and will cannibalize their own eggs and hatchlings (Petranka et al. 1994). Unpublished studies (J. W. Petranka pers. comm.) also indicate that wood frog tadpoles feed on spotted salamander eggs. Rana sylvatica and A. maculatum also appear to compete for invertebrate food resources (Wilbur 1972).

Sexton (1994) reported that naive A. maculatum adults do not avoid fish based on olfactory cues when selecting sites for ovipositing, even though strong selection pressure exists. Sexton's experiment was conducted with individuals having no prior experience with fish, and it is possible that adults with larval experience with fish would exhibit an avoidance response. Two experiments were designed to examine the effects of R. sylvatica in structuring an Appalachian bog community, and the ability of A. maculatum to detect and avoid predators when selecting breeding sites.

BACKGROUND AND METHODS

Rana sylvatica prefers shallow ponds and pools and is an "explosive" early- season breeder. A single female may remain at a breeding site for only a few days, though the entire breeding season lasts through much of February in western North Carolina. Ambystoma maculatum favors temporary or semi-permanent ponds where fish are absent. They often share ponds with other ambystomatids and generally begin ovipositing in early March in western North Carolina. Females lay both clear and white egg masses. Clear masses are more vulnerable to predation from tadpoles than are white eggs (J. W. Petranka pers. comm.).

Research was conducted at Tulula Bog, a mountain bog located in Graham County in western North Carolina. In the late 1980's, development was underway to turn the site into a golf course. Before the project was halted, and then abandoned, much of the site was drained, leveled and cleared of timber. The area currently contains several fish ponds and vernal ponds, as well as many small depressions which house temporary pond communities.

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Ambystoma avoidance - Experiment 1 was designed to determine the response of breeding A. maculatum adults to predatory R. sylvatica tadpoles. Ten pairs of fish-free vernal ponds were selected. The ponds in each pair were of similar size and depth, and within 20-30 m of one another. Pond dimensions were recorded and surface area calculated for each pond. In each pair, one pond was randomly selected and the average egg mass density observed for Tulula bog during 1995 (0.6 Rana egg masses/m^2) was established. Wood frog eggs were collected from various natural and man-made sites throughout the bog. Prior to the addition of wood frog eggs on 3 March, spotted salamander eggs were removed from all ponds. Ponds were inspected for salamander eggs during major breeding bouts throughout the month of March and the total number of masses deposited was recorded.

Effect of Rana sylvatica on community structure -The second experiment was designed to focus on the effect of R. sylvatica tadpoles on the structure of pond communities and also the survival of A. maculatum hatchlings when with R. sylvatica. The same pairs of ponds were used; therefore, R. sylvatica tadpoles were already present in all experimental ponds. All A. maculatum egg masses were removed from the ponds after breeding had ceased. In late March, A. maculatum eggs were collected from various sites in the bog and placed in several plastic wading pools to hatch. After hatching in mid-April, salamander larvae were added to all ponds at a density of 10 larvae/m^2. After 7 weeks, the survival of A. maculatum larvae was determined by sampling larval density with an open-bottomed can sampler. Ten samples were taken per pond. For each sample, an open-bottomed trash can was forced into the mud and larvae dip-netted until 5 consecutive sweeps yielded no A. maculatum larvae. The size of the salamander population for each pond was calculated. These netted salamanders were measured from snout to the back of the rear legs to determine the mean size of the animals in each population. In addition to A. maculatum, the presence of Bufo, and Hyla tadpoles was also recorded. Data were analyzed using

RESULTS

Experiment 1 - Data collected from nine A. maculatum breeding sites between 3 March and 29 March 1996 provide no evidence of discrimination in oviposition site choice, in regard to R. sylvatica presence (Figure 1). The total number of egg masses laid in control versus experimental ponds did not differ significantly (P=0.53). The number of egg masses laid per pond ranged from 0 to 6 in control ponds and 0 to 21 in experimental ponds, with a median in both pond types of 1 mass per pond. There was also no significant difference in the number of clear or white A. maculatum egg masses laid in control versus experimental ponds.

Experiment 2 - Data collected between 12 April and 10 June 1996 indicate that R. sylvatica predation has no significant effect on A. maculatum larval survival (Figure 2). Mean numbers of A. maculatum hatchlings caught per pond were 14.0 for control ponds and 12.5 for experimental ponds. Mean size of hatchlings was 19.1 mm for control ponds and 21.6 mm for Rana-free ponds. Survival and growth rates in experimental and control ponds did not differ significantly (P=0.77). Rana sylvatica predation of A. maculatum appears to be limited to the egg stage, as hatchlings coexisted successfully with tadpoles.

Field observation of spatial segregation - Several other species which are preyed upon by R. sylvatica showed complete spatial segregation. Bufo americanus or Hyla chrysoscelis tadpoles were never observed in a pond containing R. sylvatica. Hyla and Bufo eggs were present in all experimental ponds and ranged from 6 to 207 tadpoles per pond, averaging 131 tadpoles per pond.

DISCUSSION

Even though predation by R. sylvatica tadpoles on A. maculatum eggs might favor the development of an active avoidance behavior, such as adult choice of oviposition site, no such behavior is apparent. The surprising lack of avoidance behavior may result from constraints associated with oviposition sites available to A. maculatum. Large permanent ponds usually contain fish, which are very efficient predators of A. maculatum embryos and larvae. Fish have been known to cause 100% mortality in A. maculatum larvae (Ireland 1989). Fish-free options for oviposition available to A. maculatum are limited. Rana sylvatica tadpoles are also efficient predators of A. maculatum with greater than 90% mortality of embryos observed (J. W. Petranka unpub. data). Rana sylvatica is a prevalent species at Tulula Bog and lays its eggs in most suitable temporary ponds. This leaves very few ponds which are free of both fish and R. sylvatica tadpoles. Ponds which are free of both are often unsuitable because they do not retain water through A. maculatum's 4 to 6 month larval period. If A. maculatum avoided sites containing fish and R. sylvatica tadpoles when ovipositing they would be unlikely to find adequate breeding sites.

Ireland (1989) observed that the A. maculatum do not select breeding sites based on the probability that larvae will survive and Sexton (1994) found no evidence that of A. maculatum actively avoids breeding sites with fish. Petranka (pers. comm.) however, has observed that ponds containing fish rarely contain A. maculatum egg masses. Ambystoma maculatum may rely on other methods other than adult choice to avoid predators, such as returning to natal ponds. Strong philopatric tendencies have been observed in A. maculatum (Phillips and Sexton 1989, Shoop 1968). Consequently, the number of eggs laid in a pond should be proportional to the rate of premetamorphic survival in preceding years. In this scheme, A. maculatum would be ovipositing in the best possible sites, however, the pattern would be by a passive trial-and-error method, rather than active avoidance. Regardless of the mechanism, both produce spatial segregation from egg or larval predators such as fish.

Ambystoma maculatum may be buffered from local extinction by R. sylvatica because of recruitment from other populations and high adult survivorship. Females typically lay 150-200 eggs per season and live 10-15 years, with high adult survivorship (Woodward 1982, Whitford and Vinegar 1966). Ambystoma populations tend to follow a boom/bust pattern with survival from year to year and pond to pond varying greatly (Stenhouse 1987). Selection for a long life-span allows A. maculatum to occasionally have years with high juvenile recruitment (e.g. in years when Rana populations are small to offset years in which hatchling mortality is high).

Ambystoma also have egg masses which are resistant to predation, an adaptation Bufo and Hyla do not exhibit, perhaps because of the lack of suitable fish-free breeding sites. The white egg masses of A. maculatum are significantly less vulnerable to predation than the clear morph. There appears to be a positive correlation between R. sylvatica density and the percent of total egg masses laid which are white (Petranka unpub. data). Thus evolution of resistant egg masses, rather than adult avoidance behavior, appears to be another strategy used by this species to minimize predation risk to offspring.

Rana sylvatica predation affects amphibian communities in both direct and indirect ways. Ambystoma, Bufo, and Hyla all suffer the direct effects of predation when ovipositing in ponds containing R. sylvatica. Spatial segregation is among the many indirect effects of R. sylvatica predation. In response to egg predation, Hyla and Bufo have responded by developing the ability to detect and avoid R. sylvatica and other predators when selecting breeding sites (Petranka et al. 1994, Resetarits and Wilbur 1989).

In conclusion, R. sylvatica indirectly excludes Hyla and Bufo from ponds. It appears that the effects on A. maculatum are somewhat different. By way of direct predation, R. sylvatica may also indirectly exclude A. maculatum from ponds with low reproductive success. Ponds with low survival rates should lead to smaller numbers of returning adults to that pond the following year.

Direct effects of R. sylvatica predation on eggs is only one way in which the community is effected by R. sylvatica predation. These experiments add to the growing body of knowledge on the interaction and role of R. sylvatica in structuring mountain bog amphibian communities. They also confirm that tadpole's ability to shift to function as upper-level predators has much greater ecological consequences than was previously thought. Understanding the complex biological interactions occurring in this type of community will facilitate the restoration of this and other communities which have been damaged by human activity.

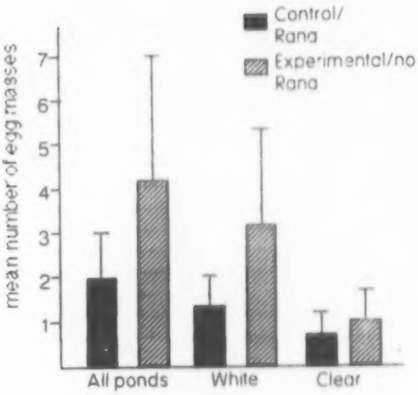

Figure 1 - Mean number (± 1 SE) of Ambystoma egg masses laid in ponds

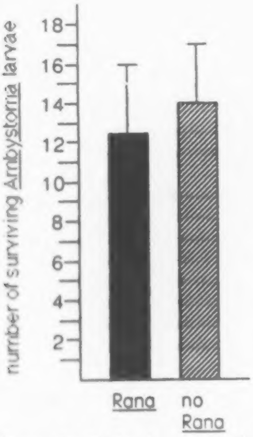

Figure 2 - Ambystoma larval survival (± 1 SE) in ponds containing Rana vs. no Rana

REFERENCES

Cortwright, S. A., and C. E. Nelson. 1990. An examination of multiple factors affecting community structure in an aquatic amphibian community. Oecologia 83:123-131.

Figiel, C. R., Jr., and R. D. Semlitsch. 1990. Population variation in survival and metamorphosis of larval salamanders (Ambystoma maculatum) in the presence and absence of fish predation. Copeia 1990:818-826.

Ireland, P. H. 1989. Larval survivorship in two populations of Ambystoma maculatum. Journal of Herpetology 23(3):209-215.

Kats, L. B., and A. Sih. 1992. Oviposition site selection and avoidance of fish by streamside salamanders (Ambystoma barbouri). Copeia 1992:468-473.

----, J. W. Petranka, and A. Sih. 1988. Antipredator defenses and the persistence of amphibian larvae with fishes. Ecology 69:1865-1870.

Petranka, J. W., and D. A. G. Thomas. 1995. Explosive breeding reduces egg and tadpole cannibalism in the wood frog, Rana sylvatica. Animal Behaviour 50:731-739.

---- 1994. Restriction of wood frogs to fish-free habitats: how important is adult choice? Copeia 1994:1023-1025.

----, and K. Fakhoury. 1991. Evidence of chemically-mediated avoidance response of ovipositing insects to blue-gills and green frog tadpoles. Copeia 1991:234-239.

----, M. E. Hopey, B. T. Jennings, S. D. Baird, and S. J. Boone. 1994. Breeding habitat segregation of wood frogs and American toads: the role of interspecific tadpole predation and adult choice. Copeia 1994:691-697.

Resetarits, W. J., Jr., and H. M. Wilbur. 1989. Choice of oviposition site by Hyla chrysoscelis: role of predators and competitors. Ecology 70:220-228.

Semlitsch, R. D. 1988. Allotopic distribution of two salamanders: effects of fish predation and competitive interactions. Copeia 1988:290-298.

Sexton, O. J., C. A. Phillips, and E. Routman. 1994. The response of naive breeding adults of the spotted salamander to fish. Behaviour 130: 113-121.

Shoop, C. R. 1968. Migratory orientation of Ambystoma maculatum: Movements near breeding ponds and displacements of migrating individuals. Biological Bulletin 135:230-238

Stenhouse, S. L. 1987. Embryo mortality and recruitment of juveniles of Ambystoma maculatum and Ambystoma opacum in North Carolina. Herpetologica 43:496-501.

Whitford, W.G. and A. Vinegar. 1966. Homing, survivorship, and overwintering larvae in spotted salamanders, Ambystoma maculatum. Copeia 1966:515-519.

Wilbur, H. M. 1972. Competition, predation, and the structure of the Ambystoma-Rana sylvatica community. Ecology 53:3-21.

Woodward, B. D. 1982. Local interspecific variation in clutch parameters in the spotted salamander (Ambystoma maculatum). Copeia 1982:157-160.

Consequences of Opportunistic Predation by a Primary Consumer (Rana) on a Predator (Ambystoma)

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Wood frog *(Rana sylvatica)* tadpoles are microphagous filter-feeders. Nonetheless, tadpoles may prey upon the eggs and hatchlings of amphibians. Opportunistic predation by *R. sylvatica* tadpoles on spotted salamander *(Ambystoma maculatum)* eggs was examined. The jelly coat that surrounds the eggs of *A. maculatum* varies in color from milky white to clear. Populations in western North Carolina are polymorphic for egg mass color and the white morph occurs more frequently than clear or intermediate forms. In a wading pool experiment, food level, egg mass color, and tadpole presence was varied. Tadpoles significantly reduced embryonic survival of *A. maculatum*. When supplemental food level was low, egg predation rates were relatively high and clear egg masses suffered greater mortality than white egg masses. The data suggest that opportunistic predation by a primary consumer can result in high premetamorphic mortality. Tadpole predation appears to be one of several selection pressures maintaining egg color polymorphism in *A. maculatum*.

INTRODUCTION

Most tadpoles are considered to be microphagous suspension feeders that eat algae, fungi, detritus, and associated microorganisms. They have morphological adaptations such as well developed filter-feeding apparati and elongated guts for processing bulk quantities of low-quality food. Nonetheless, certain species that are morphologically adapted for filter-feeding prey opportunistically on the eggs of other anurans (Crump 1983, Petranka et al. 1994). In the present study, the significance of egg predation by wood frog (*Rana sylvatica*) tadpoles on the spotted salamander (*Ambystoma maculatum*) was examined.

In the southern Appalachians *R. sylvatica* breeds in late January through mid-March in temporary ponds. Breeding activity peaks in February and tadpole densities may exceed 2,000 tadpoles/m^2 when other amphibians arrive to breed later in the season (Biesterfeldt et al. 1993). Spotted salamanders often share breeding ponds with wood frogs. Females attach eggs to fallen tree branches or other supports in firm masses that are 5-15 cm wide and 5-25 cm long. Individual egg masses may have > 180 eggs and range in color from milky white to clear. In western North Carolina the white morph occurs more frequently than clear or intermediate forms.

Experiments were designed to address the following questions: (1) To what extent does *A. maculatum* suffer egg predation from tadpoles? (2) Does supplemental food level or intensity of intraspecific competition for food influence rates of egg predation? (3) Do white and clear egg masses differ in susceptibility to tadpole predation? (4) Do tadpoles play a role in maintaining egg color polymorphism? (5) Do tadpoles that feed on eggs benefit through increased growth or survival?

METHODS

Test for effects of food level and egg color on predation rates in wading pools.

A 2 x 2 x 2 factorial experiment was conducted using 0.9 m-diameter plastic wading pools to examine whether survival of *A. maculatum* embryos is affected by tadpole presence, food level, and *A. maculatum* egg mass color. The factors used were food level (low; high), egg mass color (clear; white), and *R. sylvatica* tadpoles (present; absent). The following levels for each treatment were established: (1) adding 3 g versus 9 g of powdered rabbit chow to each pool each week, (2) adding one clear or one white egg mass to each pool, (3) adding or not adding 800 *R. sylvatica* tadpoles to each pool. To determine if tadpoles that feed on eggs benefit through increased growth and survival, two additional treatments were included (800 *R. sylvatica* tadpoles and no *A. maculatum* egg masses at low and high food levels specified above).

Wading pools (N=50) were arranged in a spatial array consisting of five replicates of the 10 experimental conditions. Pools were set outdoors in an area that received direct sunlight. *Rana sylvatica* tadpoles were added on 28 March and *A. maculatum* egg masses on 30 March when tadpoles had developed to the feeding stages. The experiment was terminated 17 d after adding *A. maculatum* masses to the pools.

Eggs in clear masses could be accurately counted but those in white masses could not. Subsequently the relationship between the wet mass of egg masses and the number of embryos per egg mass was examined. Covariance analysis indicated that egg number determined from egg mass dissection was positively correlated with the wet mass of egg masses ($p = 0.006$), that the number of eggs per egg mass did not differ significantly between white and clear egg masses of similar wet mass ($p = 0.45$), and that the slopes for the regressions were homogeneous ($p = 0.27$). Based on these results, clear and white egg masses were matched in each replicate as closely as possible by wet mass, and changes in wet mass were used to estimate egg predation rates.

Egg masses and tadpoles (N = 10 tadpoles/pool) were weighed prior to adding egg masses to the pool, and after 7 and 14 d. The experiment was terminated 17 d after adding *A. maculatum* masses to the pools. After 14 d, most egg masses in one treatment (clear; low food) were completely consumed.

To determine if tadpole feeding activity varied among treatments, the number of tadpoles feeding on each egg mass was scored in late afternoon (4, 6, 7, 11, and 12 d after the start of the experiment).

Vulnerability of released embryos to tadpole predation

In this experiment, it was determined whether *A. maculatum* embryos that are released from masses prior to reaching the hatching stages are vulnerable to tadpole predation. *Rana sylvatica* tadpoles (N = 800) were placed in a wading pool and supplied with powdered rabbit chow until tadpoles reached Gosner stage 26. On test day, one *A. maculatum* egg mass was dissected. Then one embryo [Harrison stages 38 - 39 (Duellman and Trueb 1986)] was placed in the vicinity of feeding tadpoles. This simulated conditions that occur when late-term embryos escape from egg capsules that have been opened by foraging tadpoles. Embryos at these stages are capable of uncoordinated swimming for several decimeters.

RESULTS

Relationships between food level, egg color, and predation rates in wading pools.

Tadpoles began feeding on *Ambystoma* egg masses within a few hours after masses were added to wading pools. Mean wet mass of egg masses in treatments with tadpoles declined through the second week of the experiment. In contrast, mean wet mass in treatments without tadpoles increased over this period due to absorbance of water. In general, clear egg masses were more vulnerable than white egg masses to tadpole predation, and egg predation was greater when food level was low (Fig. 1).

The mean number of tadpoles observed foraging on eggs was significantly greater in the low food treatments ($p = 0.0002$) but did not differ significantly for either egg mass color ($p = 0.33$). Tadpoles grew significantly faster in high food treatments ($p < 0.0001$). However, feeding on egg masses did not increase tadpole growth rate (Fig. 2).

Predation on late-term embryos by tadpoles

Within 5 min after being introduced into the pool, 14 of 20 embryos were killed and consumed by foraging tadpoles. Tadpoles frequently attacked the abdominal region of embryos where yolk reserves are concentrated, and the release of body fluids triggered nearby tadpoles to feed frenetically on the injured embryos. Six embryos swam away after being attacked and survived > 5 min.

DISCUSSION

In the southern Appalachians, *R. sylvatica* appears to function as a keystone species structuring amphibian communities. Here, an adaptive value to white spotted salamander egg masses was identified. This study suggests that tadpole egg predation is an important factor maintaining the high frequency of white egg masses in vernal ponds in western North Carolina.

The number of tadpoles feeding on clear versus white eggs did not differ significantly, which suggests that protein crystals do not make white masses distasteful. However, white masses tend to be firmer in consistency than clear masses, particularly as the masses age and absorb water. This may present a physical barrier to the mechanics of grazing by tadpoles. Because most populations in the southern Appalachians are polymorphic for egg color, the selective advantage of white eggs may be context-dependent suggesting that clear eggs are favored under certain conditions (e.g., years when tadpoles occur at low densities).

The results indicate that egg predation rates can be mediated by food level and intraspecific competition. Differences in tadpole growth rates between low and high food treatments presumably reflect intraspecific competition for limited food resources (Wilbur 1976). Although the low food treatment stunted tadpole growth, small (hungrier) tadpoles caused greater egg mortality than larger tadpoles. This, along with data on the number of foraging tadpoles observed on egg masses, suggests that tadpoles switch to *A. maculatum* egg masses only when high quality food resources are scarce. The outer jelly coat has a high water content and is presumably a low-quality food source. However, symbiotic algae (Gilbert 1942) along with mucopolysaccharides and mucoproteins that occur in the jelly (Duellman and Trueb 1986) provide some nutritional benefit.

Although *A. maculatum* embryos are a high-quality food resource containing yolk reserves with high lipid and protein content, there is some question as to whether tadpoles that are not specialized for carnivory can effectively digest animal matter because they lack a well-developed, acid-secreting stomach. Tadpoles in treatments with eggs did not grow any faster than tadpoles without eggs. This may reflect the fact that only a single egg mass was used per pool. In a similar experiment in which four egg masses were added per pool, tadpoles that fed on eggs grew significantly faster than those that did not (A. Rushlow, unpublished manuscript). Thus, there may be evidence that tadpoles benefit through increased growth when per capita consumption of eggs is high.

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LITERATURE CITED

Biesterfeldt, J. M., J. W. Petranka, and S. Sherbondy. 1993. Prevalence of chemical interference competition in natural populations of wood frogs, *Rana sylvatica*. Copeia 1993:688-695

Crump, M. L. 1983. Opportunistic cannibalism by amphibian larvae in temporary aquatic environments. the American Naturalist 121:281-287

Duellman, W. E. and L. Trueb. 1986. Biology of Amphibians. McGraw-Hill Book Company, New York.

Gilbert, P. W. 1942. Observations on the eggs of *Ambystoma maculatum* with especial reference to the green algae found within the egg envelopes. Ecology 23:215-227.

Petranka, J. W., M. E. Hopey, B. T. Jennings, S. D. Baird, and S. J. Boone. 1994. Breeding habitat segregation of wood frogs and American toads: the role of interspecific tadpole predation and adult choice. Copeia 1994:691-697.

Wilbur, H. M. 1976. Density-dependent aspects of metamorphosis in *Ambystoma* and *Rana sylvatica*. Ecology 57:1289-1296.

Fig. 1 Changes in wet mass (± 1 SE) of egg masses as an estimate of embryonic survival in different experimental treatments. W = white masses; C = clear masses; dashed lines = 800 tadpoles/pool; solid lines = no tadpoles.

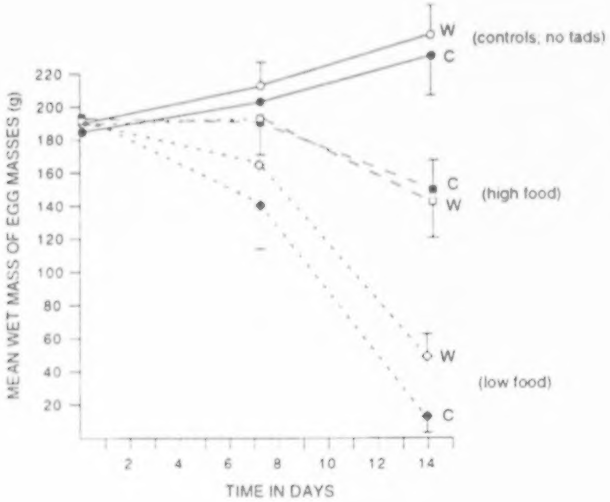
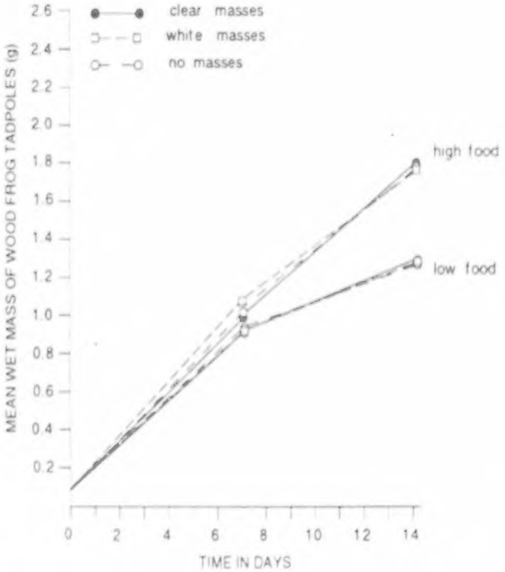


Fig. 2 Mean grow rates of wood frog tadpoles exposed to spotted salamander egg masses and two food levels. Standard error bars are not shown to prevent clutter.



Proceedings — NCUR XI (1997)

THE ROLE OF VISUAL CUES IN DETERMINING RECOGNITION BEHAVIORS IN *POECILIA LATIPINNA* AND *POECILIA VELIFERA x POECILIA LATIPINNA*

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Fish species rely on the ability to recognize fish of similar appearance in an anti-predator behavior known as the confusion-effect. Either white mollies (*Poecilia latipinna*) or black mollies (*Poecilia latipinna* x *Poecilia velifera*), placed in the central chamber of a three chambered tank spent significantly more time in the compartment of the central chamber closest to fish of similar appearance as opposed to an empty chamber. However, when given a choice between a group of black mollies in one side chamber and white mollies in the other side chamber, the white test fish spent significantly more time in the compartment closest to the side containing the white mollies. When given the same choice, the black test fish spent significantly more time in the compartment closest to the side containing the black mollies. Therefore, both the white and black mollies demonstrated the ability to choose fish of similar appearance based on visual cues.

INTRODUCTION

For many animals, living in groups is a way of life that confers important fitness advantages. Group living may increase the probability of securing a mate, finding food, or evading predators. In an interesting phenomenon known as the confusion effect, animals in groups (ie fish schools or flocks of birds), have a reduced risk of predation when compared to solitary animals. The confusion effect theory holds that predators have a more difficult time isolating and targeting specific individuals within a group. Neil and Cullen (1974) showed that increasing fish shoal size decreased successful predatory attacks, and that this effect held for both ambush predators such as squid, cuttlefish, and pike, and chasing predators such as perch. For the three ambush predators, increasing shoal size appeared to produce hesitation behaviors, which may have been responsible for the lowered rate of successful attack. The chase predator appeared to switch prey targets more frequently with increasing shoal size, thus reducing the probability of making a kill.

One of the restrictions on the success of the confusion effect involves the morphological similarity of the individuals within the shoal. It has been shown that the presence of odd , or morphologically distinctive individuals within a shoal tends to decrease the success of the confusion effect (Landeau and Terborgh, 1986). Animals that stand out within the group are easily isolated and attacked by the predator. This suggests that the ability to recognize and school with fish of similar appearance would provide a selective advantage.

Accordingly, this experiment was undertaken to determine whether fish choose to associate with fish of similar morphological characteristics. Two distinct varieties of molly, white (*Poecilia latipinna*), and black (*Poecilia latipinna* x *Poecilia velifera*), were given opportunities to associate with fish of similar or dissimilar coloration based only on visual cues.

MATERIALS AND METHODS

Test Organisms

Groups of 50 black (*Poecilia velifera* x *latipinna*) and 50 white mollies (*Poecilia latipinna*) were housed separately in two 30 gallon aquaria(36" x 18" x 12"). Both varieties were obtained from local pet shops. Both test tanks and housing tanks were maintained at 20 C.

Test Tanks

Five standard 20 gallon all-glass aquaria (30" x 12" x 12") were converted into test tanks by adding glass partitions using silicon. Each test tank was divided into three chambers; left, right , and center. The left and right end chambers were completely sectioned off from the center chamber by siliconing glass partitions, each one 7.5 in. from opposite ends of the tank. The center chamber was partitioned into left and right compartments by siliconing opaque plastic partitions (7" x 10") 6 in. from each end of the chamber wall. These partitions allowed the fish to move freely through the center chamber, but did not allow the fish to view both left and right end chambers at the same time. The tanks were covered with opaque foam on the outside of the back, right and left sides of the tank.

Behavioral Assays

Tests were performed on a weekly basis, Monday through Friday. On Friday, all experimental fish were returned to the holding tank. Fish for the upcoming week were then chosen at random from the holding tanks and placed into the test tanks. Following a three day acclimation period, tests resumed on Monday. Tests were run once in the morning and once in the afternoon. During the 10-minute testing period, the time spent by a test fish in either the left or right section of the center chamber was recorded. Two eight week experiments ran in succession, one using black mollies as test fish and the other using white mollies as test fish. Assay 1: one test molly was placed in the center chamber with nothing in either the left or right chambers. Assay 2: one test molly was placed in the center chamber and four mollies of opposing color were placed in either the right (week 3) or left (week 4) chambers. Assay 3: one test molly was placed in the center chamber and four mollies of similar color were placed in either the right (week 5) or left (week 6) chambers. Weeks Assay 4: one test molly was placed in the center chamber, four white mollies were placed in one side chamber(week 7- right, week 8- left), and four black mollies were placed in the other side chamber. For trials in which mollies were held in end chambers an equal number of tests were run with mollies in the left and right chambers to correct for possible "tank effects."

RESULTS

There was no significant difference in the time spent by test fish on either side of the central chamber when both the left and right chambers were empty. When 4 fish of opposing color were added to either the left or the right chamber, their was no significant difference in the time spent by the white test fish on either side of the central chamber (Table 1). However, the black test fish spent significantly more time on the side of the central chamber closest the fish of opposing color when given the same scenario (Table 2). When 4 mollies of similar color were added to either the left or the right chamber, the test fish spent significantly more time on the side of the central chamber closest to the 4 mollies of similar color. When given a choice between a group of 4 white mollies in one side chamber and 4 black mollies in the other, the test fish spent significantly more time on the side of the central chamber closest to the 4 mollies of similar color. (Results for white mollies summarized in Table 1. Results for black mollies summarized in Table 2.).

Table 1. Time spent on each side of central chamber by white molly test fish.

Assay	Side	Mean Time (sec.)	Standard Deviation
1	side 1- nothing	2777.3	708.781
	side 2- nothing	3222.7	708.781
			(p = .177; p > .05)
2	side 1- nothing	2933.6	625.164
	side 2- 4 black mollies	3066.4	625.164
			(p = .641; p >.05)
3	side 1- nothing	1397.3	840.200
	side 2- 4 white mollies	4602.7	840.200
			(p = .000; p < .05)
4	side 1- 4 white mollies	5031.7	838.003
	side 2- 4 black mollies	978.3	838.003
			(p = .000 ; p < .05)

N = 10 for each assay

Table 2. Time spent on each side of the central chamber by black mollie test fish.

Assay	Side	Mean Time (sec.)	Standard Deviation
1	side 1- nothing	2715.7	1321.816
	side 2- nothing	3284.3	1321.816
			(p = .349; p > .05)
2	side 1- nothing	1769.9	1062.355
	side 2- 4 white mollies	4230.1	1062.355
			(p = .000; p < .05)
3	side 1- nothing	1381.0	788.121
	side 2- 4 black mollies	4619.0	788.121
			(p = .000; p < .05)
4	side 1- 4 white mollies	4450.0	483.666
	side 2- 4 black mollies	1550.0	483.666

N = 10 for each assay

DISCUSSION

Results from Assay 1 (for both white and black mollies) ruled out the presence of "tank variables" that could have affected other assays. Results from the second Assay were mixed. While there was no significant difference in the time spent by the white test fish on either side of the central chamber, the black test fish spent significantly more time on the side of the central chamber closest the 4 fish of opposing color.

In Assay 3, both white and black test fish demonstrated a pronounced tendency to recognize and group in close proximity to fish of the same color. In Assay 3, both white and black test fish spent significantly more time on the side of the central chamber closest the 4 fish of similar appearance. When given the choice between a group of white test fish and a group of black test fish, results from Assay 4 suggest that the test fish was able to choose members of similar appearance based on visual cues alone. The ability of fish to recognize fish that share the same color variety is presumably a very important aspect of anti predator defense amongst wild populations. The confusion effect principle behind schooling states that many predators seek individuals from amongst a population that have a conspicuous appearance and can easily be singled out from amongst the larger group (Theodorakis, 1989).

It is known that species from aquatic habitats use a variety of sensory means to recognize predators. Aquatic prey species often learn to recognize predators through chemosensory recognition (Chivers and Smith, 1994; Chivers, Wisenden and Smith, 1996). Paradise fish appear to recognize predators visually based on their antipredatory reaction to eyespots (Altbacker and Csanyi, 1990).

It appears that the association choices of fish in this experiment were made solely on the basis of visual cues. Phermonal cues, if they exist, were unlikely to have traveled through the siliconed glass partitions separating the chambers of the test tanks. Auditory cues, if they exist, were also unlikely to have affected these results. While we have no evidence of the production of auditory cues by mollies, the possibility exists that these fish make sounds. However, even so, it is unlikely that these sounds could have penetrated the glass barriers without being occluded by the sound of air bubblers in the tanks. Furthermore, if sound was responsible for the results obtained in this study, we must assume that white and black mollies produced different sounds. Again, there is no evidence for this from our experiment or from the literature.

The most reasonable interpretation of these results is that the mollies utilized visual cues to make association choices. These results are consistent with a study in which black and white convict cichlids (*Cichlasoma nigrofasciatum*) chose to associate with members of their own type in similar experimental tanks (S.P. McRobert, personal communication).

While this study shows a case of recognition and preference based on visual cues alone, there are many questions regarding the specific parameters of this behavior. First, this phenomenon needs to be demonstrated in wild-caught fish species. Mollies were used in this experiment due to their easily distinguishable color morphs, which are rarely found in the wild. It will be important to determine whether fish from natural communities have the ability to recognize and distinguish between different fish based on the subtle cues found in nature. Another future experiment may focus on the origins of recognition behavior. It is still not known whether fish learn to recognize similar individuals or whether the phenomenon is innate.

Other experiments may focus on the degree to which fish can visually distinguish fish of similar appearance. Recent studies on visual systems in fish may provide clues to this problem. It has been shown that fish have the ability to see certain wavelengths of ultraviolet light utilizing patterns undetectable by humans. (Hawryshyn, 1992) This is similar to the visual system of honeybees, who use UV patterns to distinguish flowers(Wehner and Bernard, 1992). Experiments using UV sensitive film may uncover patterns in fish that would remain unseen by the human eye. The ability to recognize and choose fish of similar physical characteristics may rely on these patterns.

The formation and coordination of animal groups results from natural selection acting upon the individuals within the group. In this study, evidence is presented that individual fish choose to associate with similar-looking fish, which may lead to benefits from the confusion effect. In this way, the activity of individuals results in school formation which, in turn, increases the fitness of the animals within the school.

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LITERATURE CITED

Altbacker, V., and Csanyi, V. (1990). The role of eyespots in predator recognition and antipredator behaviour of the paradise fish *Macropodus opercularis* L. *Ethology*. 85: 51 - 57.

Chivers, D. P., and Smith, J.F. (1994). Fathead minnows, *Pimephales promelas*, acquire predator recognition when alarm substance is associated with the sight of unfamiliar fish. *Animal Behaviour*. 48: 597 - 605.

Chivers, D.P., Wisenden, B. D., and Smith, J. F. (1996). Damselfly larvae learn to recognize predators from chemical cues in the predator's diet. *Animal Behaviour*. 52: 315 - 320.

Hawryshyn, C. W. (1992). Polarization vision in fish. *American Scientist*. 80: 164-173.

Landeau, L., and Terborgh, J. (1986). Oddity and the "confusion effect" in predation. *Animal Behaviour*. 34: 1372 -1380.

Neill, S. R., and J. M. Cullen. (1974). Experiments on whether schooling by their prey affects the hunting behaviour of cephalopods and fish predators. *J. Zool., Lond*. 172: 549-569.

Theodorakis, C. W. (1989). Size segregation and the effects of oddity on predation risks in minnow schools. *Animal Behaviour*. 38: 496-502.

Wehner, R., and G. D. Bernard. (1993). Photoreceptor twist: A solution to the false-color problem. *Proc. Natl. Acad. Sci*. 90: 4132-4135.

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The Effect of the Lipid Content of the Diet of Blue Crabs, *Callinectes sapidus*, on Osmoregulation

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ABSTRACT

Blue Crabs, *Callinectes sapidus*, increase phospholipid production in their gills to waterproof the cuticle and to better deal with drastic salinity changes. A high lipid diet for blue crabs may increase their tolerance to salinity changes. The crabs were acclimated to 30 ppt. Crabs were fed a high fat or a low fat diet. Crabs from each diet were placed in a lower salinity or remained at 30 ppt. Osmoregulation was examined by testing the osmolarity of the crab's blood with a freezing point osmometer. The lipid content of the diet had no statistically significant effect on waterproofing.

INTRODUCTION

Crabs can prevent an excessive absorption of water in a hypotonic environment by incorporating lipids into their exoskeleton. Kata and Kamemoto (1968) documented the importance of lipids in the cuticle, showing that incorporation of extra lipids was under hormonal control. Whitney (1974) demonstrated that when a crab is transferred to water with half the original salinity, there is an increase in phospholipid production in the gills.

Lipids are incorporated into the epicutical layer of the cuticle, which is responsible for permeability (Lockwood, 1967), and is formed in the later stages of the moulting process. Moulting takes place in five stages. Stage A is the post-moult period where the crab does not feed, but takes in excess water . During Stage B, the exoskeleton begins calcification. The crab still does not feed. Stage C is a period of tissue growth and the restoration of normal feeding. Stage D is the pre-moult stage where the pigment and epidermis are secreted. The crab no longer feeds in this stage. The last stage, Stage E, is ecdysis where the exoskeleton is shed (Lockwood, 1967). For this experiment, Stage D is the greatest concern because this is when the epidermis, the site of the incorporation of lipids, is formed. However, the crabs must be at Stage C at the beginning of the experiment so that they will eat the artificial food source.

If an increased production of lipids is beneficial to hyporegulation, then an increased diet of lipids should also be beneficial. If the hypothesis is correct, crabs in the treatments with constant salinity should maintain a constant blood osmolarity. Crabs in treatments with a drop in salinity are predicted to show a decline in osmolarity, but the osmolarity of those in the high fat diet treatment should decline less.

MATERIALS AND METHODS

Two types of artificial food were prepared for the crabs. The artificial food consisted of non-nutrient agar and commercially canned tuna fish packed in water, with blended chicken fat and skin added to produce the high fat diet. For every 25 grams of agar powder, 1 L of de-ionized water was added. For every 250 mL of agar solution, 42 grams of tuna fish was added for the low fat diet, or 21 grams of tuna fish and 21 grams of chicken fat was added for the high fat diet. The food was heated and blended until it formed a homogeneous mixture. The food was then be allowed to solidify in ice cube trays. Solidified blocks were stored in sea water to allow the food cubes to absorb water before they were weighed so that the weight of the food consumed could accurately be calculated. The lipid content was measured on triplicate of each diet using gravimetric estimation after extraction with 2:1 chloroform in methanol (Barnes and Blackstock, 1973).

Twenty four crabs, all male, were acquired from a local distributor (Atlantic Coast Sea Food). Twenty four aerated tanks were set up containing sea water at 25 ppt. Blue crabs are often cannibalistic (Warner, 1977); therefore, each crab was placed in a separate tank. The crabs were allowed to acclimate for one week, or until they progressed on to Stage D of the moulting process. This stage is evident by a sudden decline in eating, or by the appearance of a clear ring around the last segment of the swimmeret caused by an engorgement of blood under the exoskeleton to prepare for separation during ecdysis. Half of the crabs were fed the low fat food source and the other half were fed the high fat food source. The crabs were weighed every other day to determine the trend of their weight change as a way to monitor their health.

Twelve aquariums were changed to 15 ppt. The other twelve tanks remained at 25 ppt. Every other day for one week, salinity was monitored with a refractometer and the crabs were weighed. The amount of food consumed each day was monitored to ensure that both types of food were being consumed. Food consumption was recorded by weighing the food before it was put in the tank and again after 48 hours. This experiment was set up as a randomized block design with four blocks. Each block contained one crab of each salinity/diet combination: low fat/constant salinity, high fat/constant salinity, low fat/changing salinity, and high fat/changing salinity.

During the week, three blood samples were taken from each crab, once before the salinity was reduced, and twice afterward. A syringe was inserted at the base of the swimmeret, and 0.5 cc of lymphatic fluid was removed and frozen. The frozen blood samples were tested in a freezing point osmometer. This device records the osmolarity of the blood by analyzing the freezing point, which is a function of the quantity of water in the blood. For each sample, three readings were taken and averaged. Due to a high mortality rate caused by power outages, this experiment was performed twice: once in the summer and once in the fall. Minimal changes in the experimental design were implemented including having a control salinity at 35 ppt and a low salinity at 25 ppt.

RESULTS AND DISCUSSION

The gravimetric estimation indicated that the lipid content of the high fat food source was substantially higher than the low fat food source. The high fat diet was on average 5.07% lipid (± 1.98, N=3), whereas the low fat diet was on average 0.08% lipid (± 0.11, N=3).

To ensure that the summer and fall experiments were comparable, the conditions and behavior of the crabs in both experiments were compared. In both experiments, crab weight changes fluctuated so greatly that no pattern or relationship could be determined. All of the crabs ate in the summer and fall; however, the amount that was consumed was highly variable. This variation may indicate that the crabs were in different stages of the moulting cycle. The crabs ate generally less in the fall than they ate in the summer. All of the crabs still ate some food, which allows for the further analysis of the effect of the diet. To ensure that food consumption was independent of food type, the food consumption results were combined (Figure 1). This graph demonstrates that one food type did not consistently influence consumption.

To correct for the initial variation in osmolarity, the mean osmolarity results were adjusted to a percentage of the initial value (Figure 2). This reduced the variation in the treatments with constant salinity. Osmolarity dropped for both of the treatments with a drop in salinity regardless of diet. This trend was repeated in the fall (Figure 3). A repeated measures analysis of variance of the % Initial Osmolarity combining summer and fall data (Table 1) indicated that both time period and salinity were statistically significant, but treatment (P>F of 0.2497) was not statistically significant.

Table 1: ANOVA Table of % Initial Osmolarity (Repeated Measures)

Source	Nparm	DF	Σ Squares	F Ratio	Prob>F
animal#(treatment)	2	2	45.5735	0.5862	0.5601
time period	2	2	1312.4578	16.8812	<.0001
treatment	1	1	52.6764	1.3551	0.2497
salinity	1	1	2366.6462	60.8810	<.0001
treatment*salinity	1	1	12.0868	0.3109	0.5795

There are several implications of these results. They could indicate that the hypothesis was incorrect, but there are also other possibilities of why the results were different from the expected results. The lipid content of the crabs natural diet was not known; thus, the low fat diet could have had a significantly higher lipid content than their natural food source, or the high fat diet could have had a lower lipid content than the natural food source. The crabs may not have been in the stage of their moulting cycle where they would absorb and incorporate the lipids into their epicuticle, as indicated by the fluctuation in the amount of food consumed. The content of the diet may have been another problem. Also, the amount of protein in the diet was not considered. The possible decrease in protein in the high fat diet may have affected the blue crab's osmoregulation. Also, the experiment may not have run long enough for the lipids to become incorporated into the epicuticle.

CONCLUSIONS

The results indicate that there is no significant effect of lipids in the diet of blue crabs on osmoregulation. There are several possibilities why the original hypothesis may have been false. First of all, there may actually be no relationship between diet and osmoregulation. On the other hand, the crabs may not have been in the right stage of their moulting cycle to absorb and incorporate the lipids into their epicuticle. Another possibility is that the experiment did not run long enough for the lipids to become incorporated into the epicuticle. These issues can be explored in further studies.

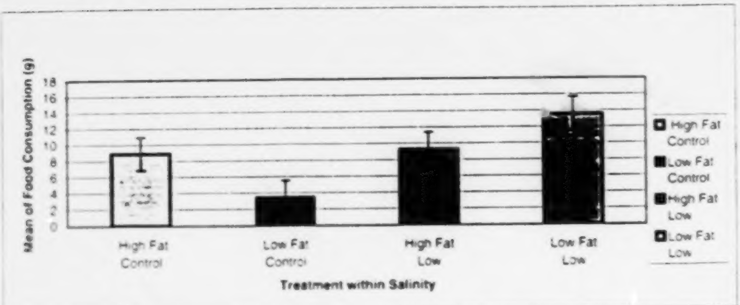

Figure 1. Food Consumption by Blue Crabs. Summer and Fall data are combined. (Error bars = + One Standard Error)

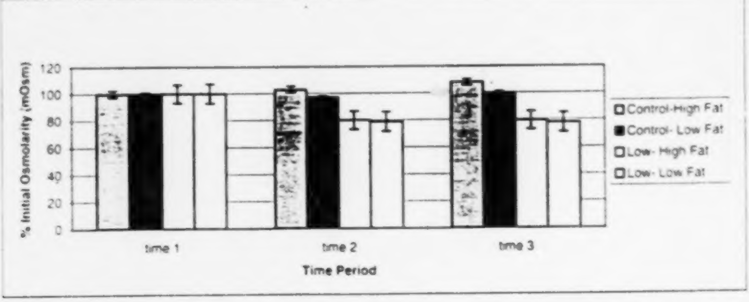

Figure 2 % Initial Osmolarity of Blue Crab blood in Summer (Error bars = ± One Standard Error)

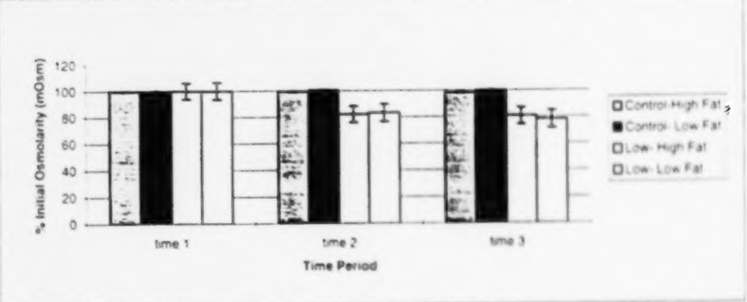

Figure 3 % Initial Osmolarity of Blue Crab blood in Fall (Error bars = ± One Standard Error)

REFERENCES SITED

Barnes, H., and J. Blackstock. Estimation of Lipids in Marine Animals and Tissues: Detailed Investigation of the Sulphophosphovanillin Method for 'Total' Lipids. Journal of Experimental Marine Biology and Ecology. Vol. 12. (1973)

Kato, K.N, and F.I. Kamemoto. Neuroendocrine Involvement in Osmoregulation in the Grapsid Crab *Metopograpsus messo.* Comp. Biochem. Physiol. Vo. 28, pp. 665-674. (1968)

Lockwood, A.P.M. Aspects of the Physiology of Crustacea. San Francisco: W.H. Freeman and Company. (1967)

Prawdzik, Toren Andrew. Total Hemocyanin Content in Response to Varying Oxygen and Salinity in the Blue Crab *Callinectes sapidus*. Jacksonville University Journal of Undergraduate Research. Vol. IX. (1995)

Warner, G.F. The Biology of Crabs. Atlanta: Van Nostrand Reinhold Company. (1977)

Whitney, J.O. The Effects of External Salinity Upon Lipid Synthesis in the Blue Crab *Callinectes sapidus* Rathbun and in the Spider Crab *Libinia emarginata* Leach. Comp. Biochem. Physiol. Vol. 49A, pp. 433-440. (1974)

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Short-Term Effects of UV-B Radiation on Salt Marsh Vegetation

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ABSTRACT

The effect of UV-B radiation, on the morphology and physiology of marsh vegetation was studied *in situ*. Plots of *Spartina* intermixed with *Salicornia* were covered by screens with selective absorption in the UV-B range. Results were compared to control plots (without screens and screens transmitting all UV-B). The screened plots transmitted less ambient light leading to decreased concentration of UV pigments in *Salicornia virginica* and *Spartina alterniflora*. Also, *S. alterniflora* showed morphological change when covered. However, the effects of decreased UV radiation on marsh vegetation is unclear from the data of this study.

INTRODUCTION

Atmospheric studies have shown that a number of man-made gases have the potential to significantly deplete the ozone layer of the stratosphere (Tevini, et al. 1983). Among these, chlorofluorocarbons are the most detrimental. The depletion of the ozone layer leads to an increase of ultraviolet radiation at the earth's surface. As this depletion is an on going trend, biological processes will be increasingly unprotected from UV radiation and, thus, increasingly susceptible to its effects.

In terrestrial plants, UV-B radiation (218-315nm) was observed to affect photosynthesis through disruption of the electron transport system and pigment stability (Bornman, 1989). These effects result in species specific degradation of plant growth (Tevini et al., 1983; Post and Larkum, 1992; Tevini, 1994; Cullen and Neale, 1994; Nikolopoulos et al., 1995). Most work has been done on individuals and/or in controlled environments. Though various effects of UV may be finely quantified in such laboratory environments, *in situ* effects may not be determined; and thus, may not be connected to probable consequences in nature.

Most work on the effect of UV on plants has focused on terrestrial and aquatic vegetation. The effects of UV on plants inhabiting the sea-land interface (i.e. salt marshes and mangroves) have been ignored. These regions are of extreme ecological and economic importance to fisheries and inland properties. Marshes throughout the world are characterized by zones of flora colonization dependent on the degree of inundation. Specifically, genuses *Spartina*, *Salicornia*, and *Juncus* are found in marshes of both North and South America; more specifically, *Juncus roemerianus* and *Spartina alterniflora* are found in higher and lower salt marshes of the Chincoteague Bay, respectively. *Salicornia virginica* is also found throughout the marsh, widely adapting to the marsh environment through numerous micro-species (Noble et al., 1992).

The purpose of this study was to observe the effects of UV-B radiation on the morphology and physiology of marsh vegetation while providing preliminary data for a future global study of the effects of UV-B radiation on salt-marsh vegetation along a latitudinal gradient.

METHODS

This study was conducted *in situ* for six weeks near Greenbackville, MD, on the Chincoteague Bay marshland (38 00'N 75 23'W). Two areas of *Spartina alterniflora* with intermixed *Salicornia virginica* at different degrees of inundation were selected for study.

Natural UV levels were reduced at each site, *in situ*, by placing triplicate 1.5 x 1.5 meter Mylar films over the canopy. Mylar selectively absorbs UV-B but transmits UV-A and visible light; this property was quantified with a Hitachi spectrophotometer.

1931

Natural UV levels were reduced at each site, *in situ*, by placing triplicate 1.5 x 1.5 meter Mylar films over the canopy. Mylar selectively absorbs UV-B but transmits UV-A and visible light; this property was quantified with a Hitachi spectrophotometer.

Two sets of controls were established:

1) near ambient UV-B plots were established by covering similar (but randomly selected) areas with Aclar which transmits 90% of all UV and visible light (this was also quantified with a Hitachi spectrophotometer);

2) ambient UV plots were delineated but not covered.

Three replicates of each treatment (Mylar, Aclar, and No Cover) were placed at each site (high and low inundation) for a total of 18 treatments.

Light intensity was quantified with a Licor portable light meter on a sunny and clear day. Readings were taken at canopy height and averaged for each type of covering or lack thereof.

Nondestructive growth rate determinations and UV protective pigment analyses were made every two weeks in order to quantify morphological and physiological responses over time at different degrees of exposure. *S. alterniflora* were tagged and measured (plant height, leaf number, and leaf width) in order to observe morphological changes. Samples of *S. alterniflora* and *Salicornia virginica* were taken and stored on ice until analyzed at Horn Point Environmental Lab. The plant material was ground with a mortar and pestle, and plant pigments were extracted with 5ml of spectrophotometric grade methanol, followed by centrifugation for 10 minutes to pelletize plant fibers. The pigment extract was scanned for absorption between 190 and 700nm using a Hitachi spectrophotometer in order to quantify physiological changes in pigment concentrations (Post and Larkum, 1993).

Plant growth measurements were compiled, differences between treatments computed and averaged to each group's respective plot type (five or ten plants tagged per plot). Plant pigment analysis was averaged according to plot type and normalized to 1 in the 660nm range. Data was compared by plot type (in respective salt stress environments).

RESULTS

Plastic covering material (Mylar and Aclar) was found to pass expected wavelengths. Mylar absorbed wavelengths from the UV-B and UV-C regions of the electromagnetic spectrum while transmitting all wavelengths from UV-A through the visible regions. Aclar was found to pass all wavelengths of light from PAR through UV-B, absorbing some UV-C. See Figure 1.

Light intensity was reduced under plastic coverings by 10%, as compared to control plots without cover. See Figure 2.

Plant morphology data yielded normal seasonal growth under the no-cover conditions, while the salt-stressed-short-form of *Spartina* at the more inundated site showed enhanced growth in plant height under both Aclar and Mylar coverings. See Figure 3.

Plant pigment analysis of *Salicornia*, two weeks after initiation of treatments, showed chlorophyll levels to be identical in all samples, regardless of filter covering; while there is a difference between no-cover-plot results and covered-plots in the UV pigment region. Covered plots (Aclar and Mylar) demonstrate a reduction in UV pigment concentrations. See Figure 4.

Plant pigment analysis of *Salicornia* six weeks after initiation of treatment showed chlorophyll levels to be slightly separated for Aclar covered samples. This difference became more pronounced in the UV-B region. No-cover-plot-samples contained the highest amounts of UV pigment with Mylar-filter-samples containing the next highest amount of UV pigment and Aclar-cover-samples containing the lowest amounts of UV pigments. See Figure 5.

Plant pigment analysis of salt stressed (short form) *S. alterniflora* two weeks after deployment of filters shows chlorophyll levels to be identical in all samples, regardless of filter covering; while there is a distinct separation of no-cover-plot results from covered plots in the UV pigment region. Covered plots demonstrate a clear reduction in UV pigment amounts. See Figure 6.

Plant pigment analysis of salt stressed (short form) *S. alterniflora* six weeks after deployment of filters shows chlorophyll levels to be nearly identical in all samples, regardless of filter covering; while difference in UV pigment concentrations are observed.

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No-cover-samples show the lowest amounts of UV pigment, followed by Mylar-filter-samples, with Aclar-cover-samples containing the most UV pigment. See Figure 7.

Plant pigment analysis of tall form *S. alterniflora* two weeks after deployment of filters shows chlorophyll levels to be identical in all samples, regardless of filter covering; while there is a distinct separation of no-cover-plot results from covered-plots in the UV pigment region. Covered plots demonstrate a definite reduction in UV pigment concentration. See Figure 8.

Plant pigment analysis of tall form *S. alterniflora* six weeks after deployment of filters shows chlorophyll levels to be identical in all samples, regardless of filter covering. Pigments in the UV region show minimal separation, with no-cover-samples containing the most pigment, followed by Aclar-cover-samples, with Mylar-filter-samples containing the least amount of pigment. See Figure 9.

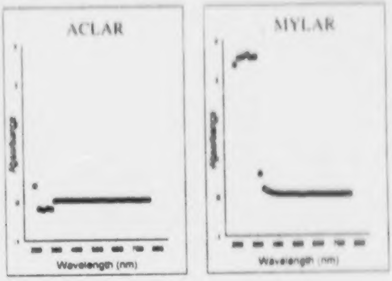
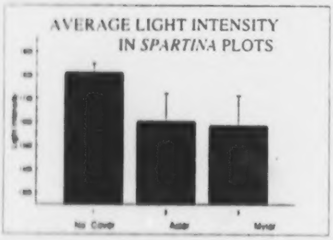


Figure 1



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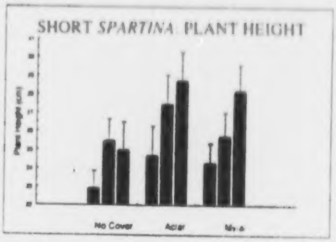

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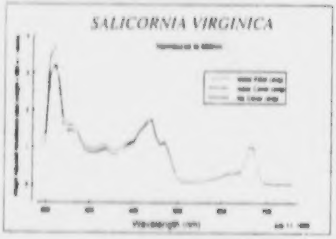

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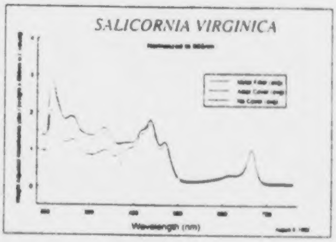

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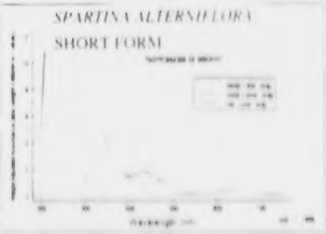

Figure 6

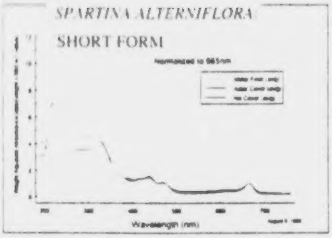

Figure 7

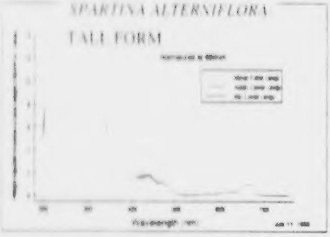

Figure 8

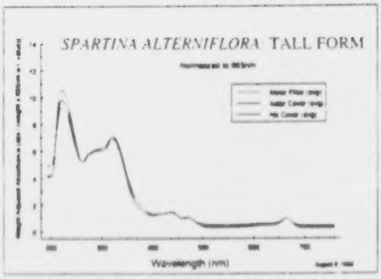

Figure 9

DISCUSSION

The major accomplishment of this project rests with the experience gained with *in situ* testing of marsh vegetation utilizing thin plastic coverings and/or filters. A durable and fairly portable frame was developed to support the plastic films which lended itself to field adjustments for plant growth, plant measurements, and sampling. A long list of "bugs" developed and many were worked out, enabling future *in situ* work to progress in a less hindered fashion. Also, a good deal of experience was gained with valuable laboratory

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techniques and data analysis. However, a longer period of time with which to completely analyze all data and run invaluable statistical studies of the data would have greatly aided in drawing significant conclusions and further inferences.

This study established a viable methodology to manipulate UV levels in salt-marshes. Screened marsh vegetation (with or without UV being filtered out) presented morphological and physiological changes in the vegetation. Morphologically, *S. alterniflora* showed an increase in plant height as compared to uncovered-control-vegetation. Physiologically, *S. alterniflora* and *Salicornia* showed decreases in UV protective pigments as compared to unscreened-control-vegetation. However, the treatment where UV was screened out did not show differences from the plants exposed to UV. Therefore, the effect of UV-B screening is unclear at this point.

The absorption spectrum of pigments of plants exposed to no UV-B radiation was expected to yield clear reductions in the pigment concentrations in the UV range, as demonstrated by Figures 6 & 8. It should be noted that peaks in the 200-250nm range represent amino acids and soluble proteins, while the focus of this study is on the 280-315nm range where the plant contains a UV protective pigment(s) -- possibly flavonoids. An unexpected finding was a reduction of UV pigment in plants under the Aclar-control-covering and the Mylar filters. Clearly, this is a shading artifact of the screens. This also caused morphological changes in the plants, as was seen in Figure 3, where plants clearly etiolated over the course of the study.

Salicornia did not demonstrate a clear change in pigment concentration under screened or exposed conditions while *S. alterniflora* was affected after two weeks but later showed either a drop in pigments under the uncovered conditions or a refreshing (that is: a regeneration) of pigments while covered with Aclar or Mylar. This could be due to complications with the plastics. After approximately three weeks, both Mylar and Aclar plastics deteriorated from sun and wind exposure and were found to be ripped, torn, or otherwise no longer completely covering the plots. Also, it was necessary to remove all frames (supports to which the Mylar/Aclar films were attached) from the marsh to prevent extreme damage and/or total loss of the materials due to Hurricane Bertha. Thus, for 36-48 hours, the experiment was totally interrupted and all plants were subjected to ambient light intensity and UV levels. It may be stated with certainty that the data from the first two weeks of the study was not compromised by an interruption of UV filtering or light intensity screening. Thus, conclusions drawn for the first two weeks (Figures 4, 6, & 8: where *Salicornia* did appear to be slightly affected by screening and *S. alterniflora* showed definite effects from screening) should carry far more weight than conclusions regarding data from the end of the six week *in situ* study. This final data should be viewed with the exposure insight in mind, leading to the issue of further study: in order to draw true conclusions regarding the effects of UV radiation on marsh vegetation, further research is needed.

LITURATURE CITED

Bornman, J.F. 1989. Target sites of UV-B radiation in photosynthesis of higher plants. J.Photochem. Photobiol., B: Biol 4:145:158.

Cullen, John J. and Patrick J. Neale. 1994. Ultraviolet radiation, ozone depletion, and marine photosynthesis. Photosynthesis Research. Vol. 39: 303-320.

Nikolopoulos, D. et al. 1995. Effects of enhanced UV-B radiation on the drought semi-deciduous Mediterranean shrub *Phlomis fruticosa* under filed conditions are season-specific. Aust. J. Plant Physiology. Vol. 22: 737-45.

Noble, S. M. et al. 1992. Ribosomal DNA variation and population differentiation in *Salicornia L.* New Phytologist 122: 553-565.

Post, Adele and A. W. D. Larkum. 1993. UV-absorbing pigments, photosynthesis and UV exposure in Antarctica: comparison of terrestrial and marine algae. Aquatic Botany. Vol.
45: 231-243.

Tevini, Manfred. 1994. UV-B Effects on terrestrial and aquatic organisms. Progress in Botany. Vol. 55: 174-190.

Tevini, Manfred. 1983. UV-B Radiation on plants during mild water stress II. Effects on growth, protein and flavonoid content. Z. Pflanzenphysiol. Bd. 110. S. 459-467.

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The Study of the Oxidation of CZT with H_2O_2 Using XPS

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The oxidation of Cadmium Zinc Telluride (CZT) was studied using the chemical H_2O_2 as an oxidizing agent. Elemental and chemical information on a sample of CZT was obtained using X-ray photoelectron spectroscopy (XPS). The sample was first left untreated with H_2O_2 as a control and then etched with H_2O_2 for one, five and fifteen minute(s), respectively, to compare the oxidation of CZT at the conditions of different etching times. Mg K_α X-ray (E_p = 1253.6 eV) beams were used to bombard the CZT sample. Emitted photoelectrons from the CZT sample surfaces were collected and energy analyzed. Elemental and chemical information on the surfaces of the CZT crystals was obtained from the photoelectron spectra based on the peak positions of individual elements, and the information of surface composition was determined from the data of relative atomic concentrations extracted from the spectra. This experiment reveals that tellurium is very sensitive to the oxidation while cadmium and zinc were relatively inert to the etching agent. Carbon (the major contaminant) residing on sample surfaces can be reduced with increasing the H_2O_2 etching time. The impact of the tellurium oxidation to the performance of a CZT radiation detector will be discussed in the paper.

INTRODUCTION

Cadmium Zinc Telluride (CZT) is one of the advanced ternary semiconductor materials. Research of CZT was brought about to meet the need of room temperature radiation detection of energetic radiation, especially X-rays and gamma-rays. Unlike germanium detectors which require a liquid nitrogen temperature for proper operation, and silicon detectors which are not efficient for measuring energetic radiation, a detector made of CZT could be highly efficient, very compact, and operable at room temperature.[1] The research of CZT has also greatly benefited from the study of Cadmium Telluride (CdTe) semiconductors and the commercial success of CdTe devices. CdTe detectors can be operated at room temperature, have good stopping power for energetic radiation and produce reliable spectra, and be fairly rugged and convenient in field applications. However, the large leakage currents associated with CdTe detectors restrict them from most X-ray detection. The fact that CdTe crystals are difficult to grow, limits the manufacture of large scale detectors required for gamma-ray applications. Compared to CdTe, CZT retains similar stopping power for photons, but the reduced leakage currents make it suitable for X-ray applications. It is also less difficult to produce a large scale CZT detector for gamma-ray measurements. The first CZT based gamma-ray spectrometer was reported in 1992.[2]

The performance of a CZT radiation detector depends not only on the size and quality of the CZT crystal, but also heavily on the surface treatment of the crystal during fabrication of the detector. Tellurium precipitates and oxidation of crystal components, which determine the surface leakage currents and contact property of electrodes, have been found common on the surfaces of both CdTe and CZT crystals. Controlled surface oxidation, at ambient and/or elevated temperature, employing chemical etching and thermal annealing has been studied to reduce surface leakage currents and to create metal-oxide-semiconductor(MOS) structures.[3,4] However, no report has been found on the study of surface oxidation of CZT by employing hydrogen peroxide (H_2O_2), a conveniently available oxidation agent. In this study, a controlled oxidation process using H_2O_2 was developed to investigate surface modification with oxidation. X-ray photoelectron spectroscopy (XPS)[5] was employed to determined the chemical compositions on the CZT surfaces. The XPS results combined with the surface morphology measurements using atomic force microscopy (AFM) and dark current-voltage (I-V) measurements[6] can reveal detailed information about the dependency of device performance on the surface conditions of a crystal.

EXPERIMENTAL

A detector grade cadmium zinc telluride ($Cd_{0.9}Zn_{0.1}Te$ from eV Products) crystal wafer was used in

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the study The wafer was first polished by a mechanical polisher using 0.05 micrometer alumina to smooth the outer surface. It was then washed in a methanol solution and chemically etched with 5% bromine in methanol for two minutes. It was then rinsed in methanol again and dried. Next, the CZT sample was treated in hydrogen peroxide solution (15% H_2O_2 + distilled water) in ambient air three different times. In the first test the sample was left untreated as a control sample, coded as CZT-H_2O_2-00. It was then etched in H_2O_2 for one minute, five minutes, and 15 minutes, and coded as CZT-H_2O_2-01, CZT-H_2O_2 and CZT-H_2O_2-15, respectively. After each treatment, the sample was placed into a UHV chamber for surface analysis using XPS. The XPS technique was used because it is a chemically sensitive and nondestructive method. XPS can determine which elements are within the near surface region of a sample and their chemical states.

The XPS measurements were conducted by employing the XSAM 800 spectrometer from KRATOS ANALYTICAL LTD. The major instruments involved in the experiments include an X-ray gun, an electron energy analyzer, electron detectors, and a sample manipulator. A laser and an electron gun were also used for the alignment of a sample. To prevent over-heating the X-ray gun during operation, a closed circulation cooling system using distilled water as the coolant was employed to cool the interior of the X-ray gun. The CZT sample was bombarded with Mg K_α X-rays emitted from the X-ray gun located at a 50° angle with respect to the electron energy analyzer. Photons from the X-ray gun were guided to hit the sample. Photoelectrons, emitted from the sample surface as a result of photoelectric excitation, carry the elemental and chemical information of the sample surface. The photoelectrons were collected and energy analyzed by the energy analyzer. The angular resolving study was conducted by rotating the sample each at 0°, 30°, and 45° angles with respect to the electron analyzer. Data made by the emitted photoelectrons were taken and stored using a SUN SPARC station. The spectra are plotted as the electron binding energy versus the number of electrons in a fixed, small energy interval. Each element is represented by a group of peaks corresponding to specific binding energies. The strongest peaks used in data analysis are: Carbon 1s at 284 eV, Oxygen 1s at 531 eV, Cadmium 3d at 405 eV, Tellurium 3d at 574 eV, and Zinc 2p at 1022 eV.

RESULTS/DISCUSSION

In analyzing the data, techniques such as smoothing, normalizing, fitting, and quantification, were used to obtain proper results from the spectra about the CZT sample. The different peaks in one spectrum of an element are due to electrons residing in different orbitals (levels), which have not lost energy while emerging from the sample. The raised background at binding energies higher than the peaks is formed by electrons that have lost energy. The deficiency of electrons caused the sample to be charged and the peaks shifted to the left. Figure 1 shows the spectra of the carbon for all four etching times. The peak with higher binding energy was from the carbon within the sample and the other peak is from the sample holder.

Figure 2 shows the spectra of oxygen from the CZT samples. The spectra identifies three peaks in the control sample and four peaks in the etched samples. The fourth peak with the smallest binding energy is the so-called satellite peak. The highest peak in the control sample corresponds to the smaller peak to the far left in the etched samples, which continually decreased as etching time increased. The intensity of the middle peak is increased significantly with the etching length, which is attributed to the formation of Te oxide on the sample surfaces. The third peak is mainly the species from the sample holder.

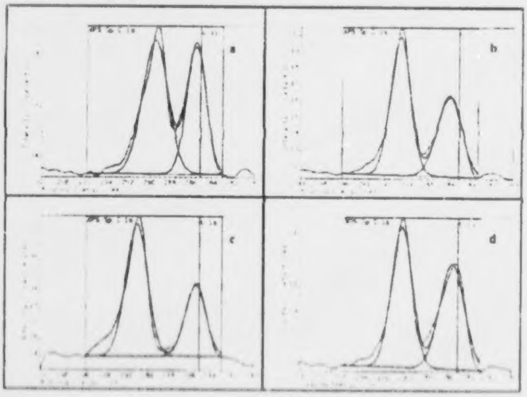

Figure 1. XPS Spectra of Carbon from CZT samples: a) without H_2O_2, b) one minute H_2O_2 etching, c) five minute H_2O_2 etching, and d) fifteen minute H_2O_2 etching.

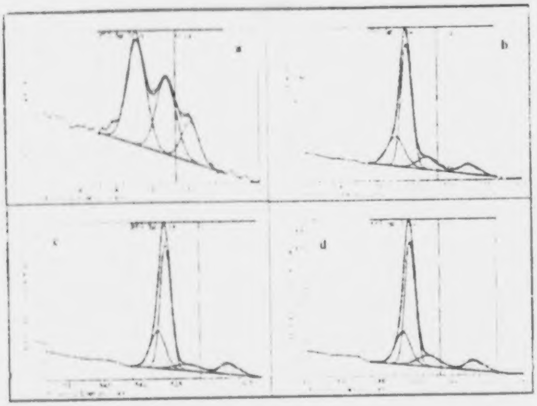

Figure 2. XPS Spectra of Oxygen from the CZT samples: a) without H_2O_2, b) one minute H_2O_2 etching, c) five minute H_2O_2 etching, and d) fifteen minute H_2O_2 etching.

Figure 3 shows the spectra of cadmium after normalization. Three peaks, assigned to the $3d_{5/2}$, $3d_{3/2}$ and the satellite peaks of cadmium, respectively, are present in the CZT sample. The spectra show that cadmium reacted very little to the oxidation because the cadmium peaks only slightly changed in height and width.

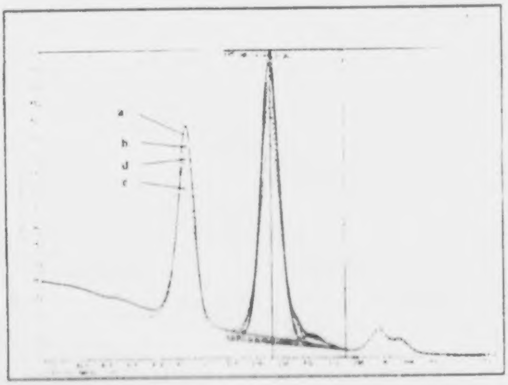

Figure 3. XPS Spectra of Cadmium from CZT samples: a) without H_2O_2, b) one minute H_2O_2 etching, c) five minute H_2O_2 etching, and d) fifteen minute H_2O_2 etching.

Figure 4 is the spectra of zinc. Similar to cadmium, the zinc peak changed only slightly in height, which is shown by the different heights of the backgrounds. This indicates that the zinc on the CZT was not very sensitive to the oxidation.

Figure 5 is the spectra of tellurium, where the two major peaks are $3d_{5/2}$ and $3d_{3/2}$, respectively, and the satellite peaks are to the further right of the spectra. Tellurium was reactive to the oxidation, evident by the shifts in the peaks. The intensity of the initial control peak decreased gradually with H_2O_2 etching length, while the oxidation peak to the right side of each control peak increased sequentially and reached a saturation stage after about five minute of etching.

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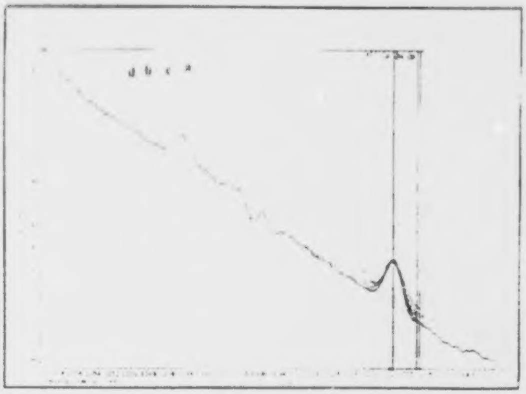

Figure 4. XPS Spectra of Zinc from CZT samples: a) without H_2O_2, b) one minute H_2O_2 etching, c) five minute H_2O_2 etching, and d) fifteen minute H_2O_2 etching.

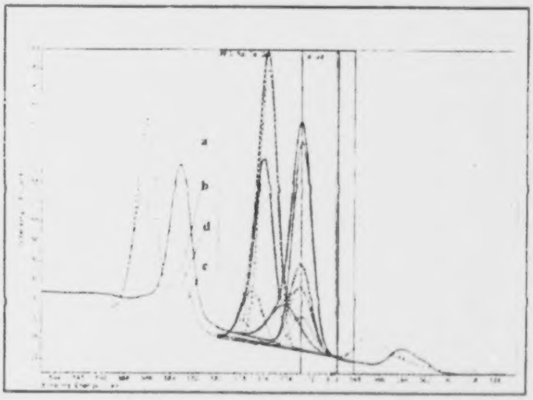

Figure 5. XPS Spectra of Tellurium from CZT samples: a) without H_2O_2, b) one minute H_2O_2 etching, c) five minute H_2O_2 etching, and d) fifteen minute H_2O_2 etching.

The graphs were smoothed where necessary and fitted on the same background, represented by the base line on each figure. Peaks were normalized for easy observation. The elements with contamination from the sample holder were carbon and oxygen. Satellite peaks are obvious in the spectra of cadmium, tellurium and oxygen because the primary peaks in these elements are strong and clean so that the satellite photon from the Mg x-ray source can be easily identified.

The relative atomic concentration of each element was created for each sample and its different rotations as shown in fig.6. The plots were calculated using the quantification data sets of the individual peaks in each element at the different etching lengths. For comparison, three oxygen species (normal surface contaminants, TeO_2 and the effect of the sample holder) and two tellurium species (CZT and TeO_2) were quantified and plotted along with zinc and carbon. The atomic concentration of each peak was normalized to the atomic concentration of the 3d peak of cadmium (not seen in the plot) which is unity. The major peak of each element is considerably larger than cadmium (except zinc), evident by their position on the chart which is above one. The abscissa is coded as AA-BB, where AA represents the minutes of H_2O_2 etching, and BB is the take off angle in degree.

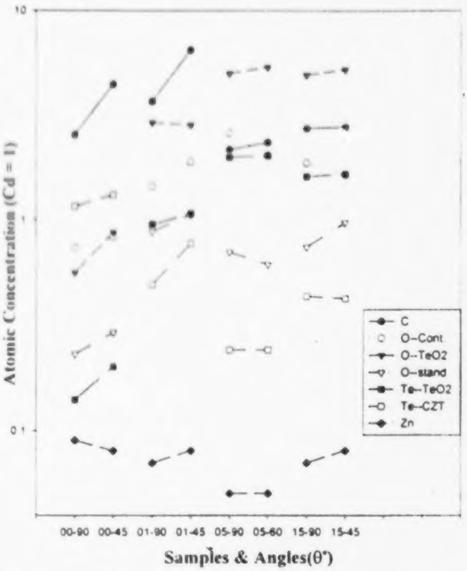

Figure 6. Atomic concentration of surface species on CZT.

Carbon contained primarily two peaks, one peak corresponded to the carbon atoms residing on the surface of the sample, and the other peak was the result of contaminants from the sample holder. The plot of relative atomic concentration shows how carbon was reduced with an increase of etching time. The carbon not etched in H_2O_2 had a slightly lower concentration than when etched for one minute, but generally the concentration decreased. There were three major species of oxygen. The first was the common contaminants, maybe CO_2 or CO. The second peak was assigned to TeO_2, which is small in the first data set of the sample without H_2O_2 etching for both take-off angles 90° and 45°. It first increases and then begins to decrease with increasing etching time. The third peak of oxygen is due to the holder. Cadmium was not sensitive to oxidation. Cadmium peaks were used for normalization because they were clean, strong (to reduce statistical errors), and had little change. Tellurium had two major species. The first species was from the CZT crystal, which steadily decreased as etching time increased. The second species was from the reaction with oxygen, which first increased and then began decreasing with increasing etching length, therefore, making a saturation. Zinc was not sensitive to the oxidation. It was also weak and maintained a small concentration (5-10% of Cadmium).

CONCLUSION

Carbon was residing on the surfaces of all the samples. Its atomic concentration decreased as H_2O_2 etching time increased, which means that H_2O_2 has the effect to remove the surface contaminants. Oxygen displayed three peaks in the untreated sample and four peaks in the treated samples. After a certain time of H_2O_2 etching, one oxygen peak became dominant and related to the surface, which hints that a new oxidation layer was formed on the surface assigned to the TeO_2 layer. Cadmium showed three peaks and Zinc showed one peak. The oxidation of CZT was increased while increasing the H_2O_2 etching time and reached saturation after about five minutes etching. The formed oxidation layer was attributed primarily to TeO_2 and a small amount of Cd oxide. No obvious Zn oxide was found. AFM and I-V measurements revealed that the H_2O_2 oxidation reduced the surface roughness and leakage current so that this treatment can improve the performance of the CZT detector.

ACKNOWLEDGMENTS

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REFERENCES

1. R.B. James, T.E. Schlesinger, J. Lund and Michael Schieber, in Semiconductors for room Temperature Nuclear Detector Applications, ed. by R.B. James and T.E. Schlesinger, Vol. **43**, p.335, Academic Press, San Diego (1995).
2. J.F. Butler, C.L. Lingren and F.P. Doty, IEEE Trans. Nucl. Science, Vol**39**, No 4, 605 (1992).
3. M. Suita and T. Taguchi, Nucl. Instr. and Meth. **A283**, 268 (1989).
4. H. Chen, J. Tong, Z. Hu, D.T. Shi, G.H. Wu, K.-T. Chen, M.A. George, W.E. Collins, A. Burger, R.B. James, C.M. Stahle and L.M. Bartlett, J. Appl. Phys. **80** (5) (1996).
5. C.D. Wagner, W.M. Riggs, L.E. Davis, J.F. Moulder and G.E. Muilenberg, Handbook of X-ray Photoelectron Spectroscopy, Perkin-Elmer Corporation, (1979).
6. K.T. Chen, D.T. Shi, H. Chen, B. Granderson, M.A. George, W.E. Collins, A. Burger, R.B. James, C.M. Stahle, and L.M. Bartlett, to be published in J.V.S.T.

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The Effects of Precocene 2 on The Predatory Insect *Tenodera aridifolia sinensis* Saussure

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Precocene 1 and 2 are naturally occurring secondary products found in the common bedding plant, *Ageratum houstonium*. They cause phytophagous and omnivorous insects to undergo precocious metamorphosis by degrading the corpora allata, thus stopping juvenile hormone synthesis.

This research looked at the effects of Precocene 2 on the praying mantis, *Tenodera aridifolia sinensis* Saussure, when given two different treatment regimens. One hundred fifty juvenile mantids were fed immature crickets treated with Precocene 2. An additional one hundred fifty juvenile mantids were treated topically with Precocene 2. All mantids were then allowed to develop. The mantids fed treated prey died, while those topically treated exhibited greatly lengthened instars. In contrast to published literature, no precocious metamorphosis was observed.

INTRODUCTION

William Bowers and his colleagues found that secondary products, extracted from the common plant *Ageratum houstonium*, (precocene 1 and 2) had antiallatotropic properties for many species of insects. They showed that precocenes degraded the corpora allata, site of juvenile hormone synthesis (Bowers & Pardo, 1977). Juvenile hormone is critical in several physiological functions of the insect, including control of whether the insect remains a juvenile, or metamorphoses to the adult form (Romoser and Stoffolano, 1994). Ecdysone, a hormone secreted by the prothoracic gland, works with juvenile hormone. A spike of ecdysone signals the end of each instar by stimulating molting. If juvenile hormone was present, the insect remained in the immature state (Riddiford and Truman, 1978). In past research, many types of hemimetabolous insects, treated with Precocene 2 showed adult characteristics one intercalary instar after treatment, due to the destruction of the corpora allata and loss of circulating juvenile hormone. These insects included the milkweed bug, cockroach, planthopper, leafhopper, cricket, and locust (Bowers, et al.; 1976, Ayoade, et al.; 1996, Bradley & Haynes, 1991, Eid, et al.; 1988, Bowers & Pardo, 1977). Adult characteristics include the formation of wings, adult color patterning, and external genitalia (Wigglesworth 1972, Romoser & Stoffolano, 1994). The precocious females produced after treatment with precocene 2 were sterile as the corpora allata also plays a role in vitellogenesis and therefore, formation of eggs (Bowers & Pardo, 1977). This raises the possibility of using precocene 2 as a biological control agent, but at present time the cost appears prohibitive.

The purpose of this study was to test the effects of precocene 2 on the praying mantis. Most of the previous research had been done with phytophagous insects and the question was raised as to whether the predatory mantis would be affected in the same way as other insects, and if there would be any effect on them from eating treated prey. The usefulness of precocene 2 as a biological control agent would be compromised if its effects were magnified in the food chain.

METHODS AND MATERIALS

General:

The precocene 2 (6,7-dimethoxy-2,2-dimethylchromene) used for the experiments was obtained from Aldrich Chemical Corp. Precocene 2 was dissolved in acetone under nitrogen and placed in a freezer until use. To control for the use of acetone, separate untreated and acetone-only treated controls were tested.

Animals:

The mantids used in the experiments were captive bred from wild mantids caught from July-September 1996 and individually housed in 180 cm^2 cages in a greenhouse. Ootheca were obtained from mated females and kept at room temperature for one week. The oothecae were transferred to a 5°C refrigerator for one week, a -20°C freezer for one week, then back to the refrigerator. Approximately one month prior to use, the oothecae were removed from the refrigerator and held at room temperature. One week prior to hatching the oothecae were placed in an incubator at 30°C. Hatchlings were kept together in 85 liter aquaria and supplied with *Drosophila* and spring water *ad lib*. Temperatures were kept at 26±4 C with a 16L:8D photoperiod. One week after hatching, the animals were moved into individual 4x10 cm *Drosophila* culture vials (Carolina Biological Supply Company) and fed *Drosophila*, immature crickets, and *Tenebrionidae* larvae. At fourth instar, surviving mantids were transferred to 500 mL clear plastic cups with lids. At sixth instar the mantids were moved into 1 liter clear glass jars. All animals were fed and watered daily.

The crickets were purchased newborn from Catawba Cricket Hatchery, Charlotte, NC. and housed in a 130 liter aquarium with Gerber Stage 2 oatmeal with bananas and water *ad lib*.

Feed Through Experiment: One hundred eighty second instar mantids were randomly selected and placed in groups of thirty, with daily rotation of cages. The mantids were offered immature crickets (ten per mantid), which had been treated with precocene 2 dissolved in acetone and allowed to molt once to remove any residue of acetone or precocene 2 (Table 1). For treatment, the crickets were placed in paper lined petri dishes. One microliter of precocene 2 in acetone was applied to the dorsal surface of each cricket. After 24 hours the crickets were placed in clean cages with fresh water and baby food. The mantids used as untreated controls were offered immature crickets that had no exposure to precocene 2 or acetone.

Table 1. Treatment levels for the feed through experiment

Group #	# in Group	Dosage per Cricket *	Total Dose per Mantid
1	30	0 ug/uL	0 ug precocene 2
2	30	1 uL acetone	0 ug precocene 2
3	30	1uL @ 1 ug/uL	10 ug precocene 2
4	30	1 uL @ 2 ug/uL	20 ug precocene 2
5	30	1 uL @ 3 ug/uL	30 ug precocene 2
6	30	1 uL @ 4 ug/uL	40 ug precocene 2

* The dosage per cricket indicates the amount of precocene 2 dissolved in acetone per uL applied to each cricket.

Topical Experiment: One hundred fifty newly molted second instar mantids were randomly selected and placed into groups of 30, with daily rotation of cages. The mantids were treated with precocene 2 dissolved in acetone and applied with glass micropipets to the ventral surface of the abdomen (Table 2).

Table 2. Dosage levels for topical application of precocene 2 in acetone.

Group	# in Group	Dosage Level
A	30	0 ug/uL
B	30	1 uL acetone
C	30	10 ug/uL precocene 2 in acetone
D	30	20 ug/uL precocene 2 in acetone
E	30	30 ug/uL precocene 2 in acetone
F	30	40 ug/uL precocene 2 in acetone

RESULTS

Feed Through Experiment:

In the feed through experiment, none of the mantids in the treated groups survived to reach third instar. After ingesting part of one treated cricket, the mantids refused all other food. This occurred even in the acetone treated group. Within five days of treatment, all of the mantids except for untreated controls died. Mortality for the untreated controls (data not shown) was within 0.5% of the mortality for the topically treated mantids (Figure 1).

Topical Experiment:

Mortality in the topically treated experiment was considerable throughout each treatment group. Most of the mortality seen was at or just after each molt. The untreated controls showed less overall mortality, with 60% surviving 5th instar (Figure 1). From the data, it appears that the acetone was responsible for part of the mortality in treated groups but that precocene further increased the mortality rate, especially at higher doses. While 46.7% of the acetone treated controls survived through 5th instar, only 33.3% of the 20 ug/uL group survived, and none of the 30 ug/uL survived through 5th instar (Figure 1). Mortality for the group treated with 40ug/uL precocene was 100% prior to any mantid reaching 3rd instar. Most died with in 48 hours of treatment, with the longest surviving 8 days (data not shown).

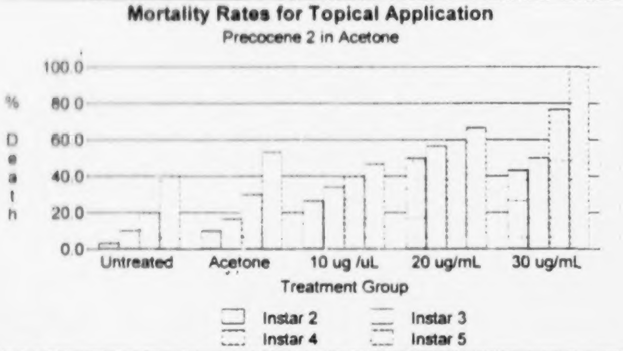

Figure 1. Mortality rates for each instar after topical application of precocene 2 in acetone. Percent of mantids not surviving molt into next instar.

The average length of each instar was affected by treatment with precocene 2 (Figure 2). In the untreated controls, instar length averaged 10.0 days for instar 2 to 30.0 days for instar 5. Acetone treatment increased the instar lengths to 11.9 and 31.8 days respectively. This increase was shown to be statistically significant when repeated measures ANOVA was performed; P values < 0.0001. The remaining statistical analysis compared the acetone treated to the other treatment groups. The 10 ug/uL group showed less lengthening of the instar when compared to the acetone treated mantids, with the 20 ug/uL and 30 ug/uL groups showing a statistically significant lengthening of the respective instars. P-values for the data ranged from <0.005 to <0.0001.

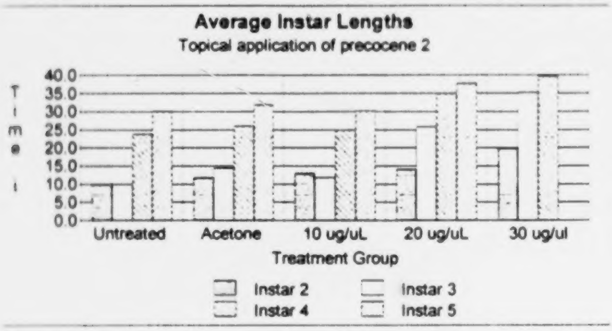

Figure 2. Average instar lengths after topical application of precocene 2 in acetone.

Two animals from each surviving treatment group were dissected at 15 days into 6th instar to compare the sizes of their corpora allata. Length and width measurements were within 0.01mm, regardless of treatment group. Gonad development had not occurred, so fertility was not assessed.

DISCUSSION

The feed through experiment showed that eating treated crickets caused the mantids to be unable or unwilling to feed, thus starving themselves to death. Since the crickets had undergone one molt prior to being used to feed the mantids, there should not have been any acetone or precocene 2 on the exoskeleton. As this occurred even in the acetone controls, it appears that acetone alone has a strong effect on the feeding response in mantids. Acetone may damage or destroy the feeding apparatus, or interfere with regulation of feeding. No effect attributable to precocene was observed.

The mortality in the topically treated mantids shows that precocene 2 is toxic at higher levels. There appears to be an increase in mortality at instar 5 in the untreated and treated controls that is not seen in the 10ug/uL or 20ug/uL groups. The significance of this is not known, but needs to be looked at more closely. There was no precocious metamorphosis observed in any of the treatment groups. Predatory insects appear to contradict the findings of Bowers et al (1976), Unnithan et al (1977), Ayoade et al (1996), and others, which showed that treatment with precocene 2 induced precocious metamorphosis in phytophagous and omnivorous insects after one intervening instar. Lengthening of a single instar was observed by these researchers, but the instar extensions being carried over into each following instar appears to be a new finding.

The known effect of precocene 2 is to destroy the corpora allata thereby eliminating the animal's ability to synthesize juvenile hormone. In the absence of juvenile hormone the animal molts to the adult form after one intercalary instar (Bowers et al, 1976) and that the instar is lengthened. In these experiments, however, all instars were significantly lengthened and no precocious adults were formed. There may be several explanations for this. Mantids may have biochemical pathways not found in the insects tested to date, allowing precocene 2 to be metabolized. It is also possible that in mantids precocene 2 interacts with the corpora cardiaca, which releases prothoracicotropic hormone and stimulates the prothoracic gland, where ecdysone is produced, or with the ecdysone itself. An altered ecdysone metabolism might be expected to result in lengthened instars. Additional experiments are being designed and conducted to help answer these questions.

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WORKS CITED

Ayoade, O., S. Morooka and S. Tojo. 1996. Metamorphosis and Wing Formation in the Brown Planthopper, *Nilaparvata lugens*, After Topical Application of Precocene 2. *Archives of Insect Biochemistry and Physiology* 32: 485-491.

Bowers, W.S., T. Ohta, J. Cleere, and P. Marsella. 1976. Discovery of Insect Anti-Juvenile Hormones in Plants. *Science* 193: 542-547.

Bowers, W.S., and R. Pardo. 1977. Antiallatotropins: Inhibition of Corpus Allatum Development. *Science* 197: 1369-1371.

Bradley, J.T. and H.W. Haynes. 1991. Precocene Induced Effects on Ovarian Development in Crickets. *Comparative Biochemistry and Physiology* 98: 213-219.

Eid, M.A.A., M.S. Salem, and G.Z. Taha. 1988. Effects of Precocene 2 on Morphogenesis of the Desert Locust *Schistocerca gregaria*. *Biochemical Systematics and Ecology* 16: 515-520.

Riddiford & Truman. 1978. *in* Biochemistry of Insects. M. Rockstein ed. Academic Press, London: 308-357.

Romoser W.S. and J.G. Stoffolano Jr. 1994 The Science of Entomology. 3rd ed. Wm. C. Brown. Dubuque. IA. 532 pages.

Unnithan, G.C., K.K. Nair and W.S. Bowers 1977. Precocene-induced degeneration of the corpus allatum of adult females of the bug *Oncopeltus fasciatus*. Journal of Insect Physiology. 23: 1081-1094.

Wigglesworth, V. B. 1972. The Principles of Insect Physiology 7th ed. Chapman & Hall, London, 827 pages.

Interspecific Interference and Resource Partitioning Among Males of Three Dragonfly Species (Odonata: Libellulidae)

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This project examined interspecific interference and resource partitioning among three dragonfly species, *Plathemis lydia*, *Libellula luctuosa*, and *Libellula pulchella*, at common breeding sites in the southern Madison County region of New York. Census data and observations of reproductive behavior indicated that these species overlapped both spatially and temporally, utilizing the same shallow water areas for male patrolling, perching, pair formation, mating, and oviposition. Interspecific interactions accounted for up to 40% of all aggressive interactions between males, depending on the species. However, males showed interspecific differences in both perching and flying behavior. Under natural conditions, *P. lydia* males preferred lower perches than those used by male *L. luctuosa* and *L. pulchella*, moreover, *P. lydia* was the only species that utilized ground perches. Studies with artificial perch sites constructed from dowels showed that *P. lydia* preferred sites less than 40 cm. high, *L. luctuosa*, sites 40-50 cm. high, and *L. pulchella*, sites 90-100 cm. high. With rare exception, dowels with horizontal perch sites at a height of 60 cm. were utilized only by *L. luctuosa*. Observations of flying behavior under natural conditions showed that *P. lydia* was typically active at lower heights (0-0.5 m) when compared to *L. luctuosa* (0.5-1.0 m) and *L. pulchella* (0.5m+). These differences in perching and flying behavior may reflect ways in which resources (perch sites, air space, etc.) are partitioned among these closely-related species, permitting simultaneous use of the same breeding areas and, perhaps, reducing the frequency of interspecific interactions.

BACKGROUND

The simultaneous presence of multiple species of odonates in a particular breeding area has served as the basis for a number of experiments exploring interactions between such species in attempts at cohabitation (Hilton 1983, Michiels 1987). However, little work has been done in the examination of competition and resource partitioning between the overlapping species of *Plathemis lydia*, *Libellula luctuosa*, and *Libellula pulchella*. These species have been intensively studied with respect to territoriality and reproduction (Moore 1989, Koenig 1987, Pezalla 1979). However, a complete understanding of their behaviors cannot be obtained without considering the interactions and encounters which are inevitable for species such as these with similar male territorial requirements of a sunny exposure and sites suitable for perching and female oviposition (Pezalla 1979). It is possible that species such as these are the products of divergence from a common ancestor, resulting in the development of individual niches in the ecosystem in which each species may survive and adequately coexist with each other. The aim of this study is to provide information contributing to a greater understanding of this evolutionary process through observations of the degree of coexistence among these three dragonfly species. In this study, the natural behaviors of *P. lydia*, *L. luctuosa*, and *L. pulchella* were observed both as individual species and as part of a common breeding site in an effort to explore the evolutionary conditions which have developed among these species.

MATERIALS AND METHODS

The natural behaviors of *P. lydia*, *L. luctuosa*, and *L. pulchella* were observed over a period from 10 June to 29 July 1996 at two artificial ponds 4 km east of Hamilton, Madison County, New York. The small pond was roughly 8 by 5 meters and characterized by the presence of grasses, sedges and *Salix* along the shorelines and *Typha latifolia* and *Myriophyllum* in open water areas. The large pond, located 66 meters from the small pond, was roughly 16 by 14 meters, generally devoid of shoreline vegetation, and contained patches of *Myriophyllum* in open water areas. Numbered stakes were placed along the shoreline every 3 m in order to establish a method to identify locations of territories and perching sites. Individuals of each species were captured at the conclusion of each observation day and marked with a unique pattern of enamel paint on the thorax, abdomen, and/or wings. Census observations were also taken on a daily basis to establish relative seasonal densities. In many cases, multiple sets of data were taken from individual dragonflies as they returned to their territories throughout the season. A number of different behavioral characteristics were observed:

Perch distance from shore: Individuals of each species, whether marked or unmarked, were observed for 15 minute periods in their respective territories. The distance from the shoreline of the pond where the dragonfly perched was recorded each time the specimen exhibited perching behavior during the 15 min interval. For the males examined in this study, 1 to 5 observation periods were taken on each individual.

Perch height under natural conditions: The relative height of perching above the level of the shoreline was also observed among individuals for 15 minute intervals in their respective territories. Each time the individual perched, its height above the shoreline was recorded. A height of zero was recorded if the specimen perched on the ground. For the males examined in this study, 1 to 5 observation periods were taken on each individual.

Perch height under artificial conditions: An artificial perching site was constructed from dowels to simulate ideal perching conditions for the dragonflies under study (Pezalla 1979). Two one-meter dowels were connected in a perpendicular fashion at a point 60 centimeters from the end of one of the dowels, creating a cross shape. These dowels were marked with lines of various colors at 10 centimeter intervals to allow for accurate observations of perching height. The dowels were placed in a clear area of the shoreline where there would be little competition from local vegetation for perching sites. Individuals were observed for 15 minute intervals and the height of each perch on the artificial site was recorded. Use of the horizontal perch site created by the cross was recorded separately as a distinct height. For the males examined in this study, 1 to 3 observation periods were taken on each individual.

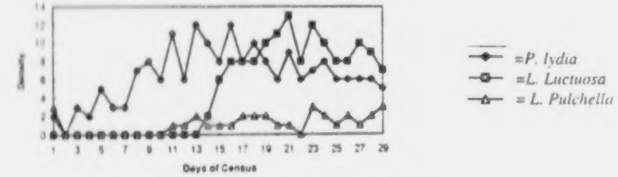
Flying height: Flying height was observed using a beeper adjusted to beep at 3-second intervals. At each beep, its was recorded whether the specimen under observation was flying at a height below 0.5 meters, between 0.5 and 1.0 meters, or above 1.0 meter. This process continued throughout the 5-minute interval of observation for each individual. Dowels with markings at each 10 centimeter interval similar to the ones used in the perching height study were used to accurately observe the relative height of each flight. For the males examined in this study, 1 to 3 observation periods were taken on each individual.

Aggressive behavior: Intraspecific versus Interspecific interactions: Chasing behavior was observed for individuals over 15 minute periods. The number of aggressive interactions, or incidents which resulted in a territorial male defending its territory through the chasing of another male, were recorded. To illustrate the influence of interspecific aggression on effective coexistence, interspecific interactions were recorded separately from intraspecific interactions during each period. For the males examined in this study, 1 to 3 observation periods were taken on each individual.

Statistical Analysis: All results were analyzed through ANOVA and Tukey-Kramer multiple comparison tests. In the case of the flying height and aggressive interaction data, an arcsine transformation was performed on the data to correct for the heterogeneity of variance.

RESULTS

Seasonal and Daily Densities: The daily densities of each species at the large pond are shown in Figure 1:



While *P. lydia* were present in relative abundance throughout the observation season, *L. luctuosa* did not emerge in great abundance until the week of 24 June, and *L. pulchella* was only found in limited quantities throughout the season (see Figure 1). *L. pulchella* tended to remain at their breeding sites for an entire observation day but would usually not return after capture and marking. These observations agree with Pezalla's (1979) and Hilton's (1983) earlier findings. In contrast, *P. lydia* and *L. luctuosa* showed high degrees of site fidelity, returning to the same territorial site for weeks after capture and marking. However, the high population densities of these two species resulted in the ability of males to adequately guard territories for only a few hours each day, observations which concur with the work of Koeing (1990) and Moore (1987).

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TABLE 1: Results of the perching and flying height studies:

Species	Perch distance from shore	Perch heights-Natural Cond.	Perch heights-Artificial Cond.	Flying Height
P. lydia	0.57 m	3.5 cm	35.0 cm	20.0 cm
L. luctuosa	3.14 m	31.5 cm	57.7 cm	36.0 cm
L. pulchella	0.67 m	64 cm	94.9 cm	37.0 cm

Perch distance from shore: *L. luctuosa* (N=24) perched at a significantly different distance from the shoreline than either *P. Lydia* (N=16) or *L. Pulchella* (N=13) (F=167.47, P<.0001). No significant difference was noted between *P. lydia* and *L. pulchella* (See Table 1). This significant difference between *L. luctuosa*'s perching habits and those of the other two species reflects the tendencies of *L. luctuosa* to perch in the vegetation surrounding the pond as opposed to sites closer to the actual shoreline.

Perch heights under natural conditions: A significant difference (F=140.44, P<.0001) was observed between all three species (*P. lydia:* N=16, *L. luctuosa:*N=24, *L. pulchella:*N=13) (See Table 1). These results reflect the high frequency of ground perching for *P. lydia* as opposed to the tendencies of the other two species to seek elevated perch sites.

Perch heights under artificial conditions: As with the natural conditions, significant differences (F=918.86, P<.0001) were observed for all three species in terms of perching on the artificial dowel perch site (*P. lydia:* N=10, *L. luctuosa:*N=10, *L. pulchella:* N=17) (See Table 1). The horizontal perch site at 60 cm above the shoreline was utilized almost exclusively by *L. luctuosa*, although the other two species did make rare appearances at this site.

Flying height: *P. lydia* (N=15) was observed to have a significantly different flying height from the other two species represented in this study (F=80.38, P<.0001) (*L. Luctuosa:*N=15, *L. pulchella:*N=8). No significant difference was noted between *L. luctuosa* and *L. pulchella* (See Table 1). However, *L. pulchella* was also observed to exhibit a wide range of flying heights and was the only one of the three species observed to regularly fly over the pond at heights exceeding 1.0 meters.

TABLE 2: Results of the interspecific versus intraspecific interactions study.

Species	% aggression with *P. lydia*	% aggression with *L. luctuosa*	% aggression with *L. pulchella*
P. lydia	60	37	3
L. luctuosa	32	66	2

Aggressive behavior: Intraspecific versus Interspecific interactions: For *P. lydia*(N=14), a significantly greater number of its interactions were intraspecific in nature rather than interspecific (F=197.78, P<.0001). The same was true for *L. luctuosa* (N=14) (F=479.76, P<.0001) (See Table 2). *L. pulchella* were not abundant enough for a study of aggressive behavior by this species.

DISCUSSION

This study revealed interspecific differences in perching and flying behavior which may help minimize the degree of interaction among *P. Lydia, L. luctuosa*, and *L. pulchella* at common breeding sites. First, the tendency of *L. luctuosa* to perch in the vegetation surrounding the pond at a distance of 3 meters or greater from the shoreline, as opposed to the shoreline itself, allows this species to perch relatively free of territorial interference from either *P. lydia* or *L. pulchella*. Such unique perch sites contribute to the development of interspecific territories similar to those noted by Michiels and Dhondt (1987) for *Sympetrum* species. Since *L. luctuosa* does not directly compete with other species for perch sites close to the shoreline, multiple species may share a common territory with a relatively small degree of interspecific interference (Hilton 1983).

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While *P. lydia* normally perched on the ground or on rocks only a few centimeters from the ground. *L. luctuosa* perched at an intermediate height on vegetation, while *L. pulchella* used the same vegetation at a higher height. These observations suggest behavioral partitoning of perch sites among these three species, thus reducing the degree of interspecific interaction, conflict, and wasted energy.

L. Luctuosa used the horizontal portion of the artificial perch site at a greater frequency than the other two species. However, it is unclear if this reflects *L. luctuosa*'s preference for a perch site of intermediate height or for an elevated horizontal site. Future studies could examine this problem through the use of horizontal perches at varying heights to test the degree of usage by *L. luctuosa* as opposed to other species.

Observations of flying height revealed a lower average height for *P. lydia* than for the other two species, which were relatively similar in this respect. However, these data do not reveal the versatility of flight which characterized *L. pulchella*. Such behavior suggests that these three species possess unique airspace niches similar to those found in the perching studies, with *P. lydia* preferring heights relatively close to the ground, *L. luctuosa* flying at an intermediate height, and *L. pulchella* utilizing the highest airspace. While some degree of overlap between these airspaces is present, such an arrangement reinforces an energy-efficient system which emphasizes a minimum of interspecific conflicts.

The observations of this study showed that even at midday, at peak population densities, intraspecific aggression among *P. Lydia* and *L. Luctuosa* was far more common than interspecific aggression, a conclusion which agrees with studies performed by Koenig and (1990). When interspecific conflict took place, it usually occurred when two dragonflies were flying at similar heights above the water. While interspecific aggression occasionally disrupted mating attempts or oviposition periods of females, such instances were rare, accounting for less than 10 percent of all aborted matings and were almost never the result of an interspecific mating attempt.

Overall, distinct perching and flying behaviors exist between *P. Lydia*, *L. luctuosa*, and *L. pulchella* which may facilitate simultaneous co-habitation. This common utilization of a breeding site allows for a minimum of interspecific interaction, thereby allowing for energy-efficient resource partitioning and coexistence among these species.

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• REFERENCES

Campanella, P.J. and L.L.Wolf (1974). Temporal leks as a mating system in a temperate temperate zone dragonfly (Odonata: Anisoptera). I: *Plathemis lydia* (Drury). Behavior 51: 49-87.

Hilton, D. F. J. (1983). Territoriality in *Libellula julia* Uhler (Anisoptera: Libellulidae). Odonatologica 12(2): 115-124.

Jacobs, M.E. (1955). Studies on territorialism and sexual selection in dragonflies. Ecology 36(4): 566-586.

Koenig, W.D. and S.S. Albano (1985). Patterns of territoriality and mating success in the white-tailed skimmer *Plathemis lydia* (Odonata: Anisoptera). Am. Mid. Natur. 114(1): 1-12.

Koenig, W.D. and S.S. Albano (1987). Lifetime reproductive success, selection, and the opportunity for selection in the white-tailed skimmer *Plathemis lydia* (Odonata: Libellulidae). Evolution 41(1): 22-36.

Koenig, W.D. (1990). Territory size and duration in the white-tailed skimmer *Plathemis lydia* (Odonata: Libellulidae). Jour. Anim. Ecol. 59: 317-333.

McMillan, V.E. (1991). Variable mate-guarding behavior in the dragonfly *Plathemis lydia* (Odonata: Libellulidae). Anim. Behav. 41: 979-987.

Michiels, N.K. and A.A. Dhondt. (1987). Coexistence of three *Sympetrum* species at Den Diel, Mol, Belgium (Anisoptera: Libellulidae). Odonatologica 16(4):

Moore, A.J. (1987). Behavioral ecology of *Libellula luctuosa* (Burmeister) (Anisoptera: Libellulidae): proposed functions for territorial behaviors. Odonatologica 16(4):

Moore, A.J. (1989). The behavioral ecology of *Libellula luctuosa* (Burmeister) (Odonata: Libellulidae): male density, OSR, and male and female mating behavior. Ethology 80: 120-136.

Parr, M.J. (1983). An analysis of territoriality in Libellulid dragonflies (Anisoptera: Libellulidae). Odonatologica 12(1): 39-57.

Pezalla, V.M. (1979). Behavioral ecology of the dragonfly *Libellula pulchella* (Drury) (Odonata: Anisoptera). Am. Mid. Natur. 102(1): 1-22.

Habitat Selection by American Kestrels (Falco sparverius) Wintering in Northwestern Ohio

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The benefits gained by kestrels which overwinter in Ohio, rather than migrating further south, is a poorly studied aspect of their behavior. Examining these benefits requires a thorough understanding of where they are found in their winter range and, ultimately, why they are found there. Intersexual competition is known to occur, displacing males from the more desirable habitat. This may lead to increased predation of males by accipiters.

Cultivated crop land predominated in the study area, and more kestrels were found there as a result; they were not, however, disproportionately represented in cultivated habitat. Female kestrels were significantly more abundant than males in the study area. This supports the hypothesis that females are displacing males to less productive, or less safe, habitats.

INTRODUCTION

Although the habitat preferences of kestrels have been extensively studied, a continuation is warranted. Intensive agriculture continues to influence suitable hunting habitat since widespread pesticide use is still the preferred method of farming. The kestrel is dependent on invertebrate prey (annelids and arthropods) and meadow voles (Microtus spp.) which are adversely affected by pesticides. Many raptorial birds are considered biological indicators because of their position in the foodchain. Kestrels have, thus far, adapted readily to human activities. They are frequently spotted hunting from utility lines across the continent.

Several studies have indicated an intersexual difference in winter habitat use. Koplin (1973) reported significant segregation in northern California. Males predominated in wooded, agricultural habitats and females congregated in pastures or open fields. Mills (1976), Stinson et al. (1981), Smallwood (1981), Bohall-Wood and Collopy (1986) and Smallwood (1988) all reported similar results, but Sferra (1984) and Toland (1987) reported no such segregation. In addition, although unbalanced sex ratios have been reported in numerous studies across North America, there has been no consistent preponderance of one sex in any given geographic range. Roest (1957) and Enderson (1960) reported more males in the northern sites and Smallwood (1981) reported significantly fewer males at southern sites. However, Koplin (1973) reported fewer males in the north and Stinson et al. (1981) reported more males in the south and in Texas and Arizona. Mills (1976) reported a near one-to-one sex ratio.

The intentions of this study were: 1) to supplement available literature on sex ratios and habitat choice; 2) to monitor established populations; and 3) to examine factors that affect these. Although previous population estimates were unavailable for this study area, Bildstein (1978) provided a previous estimate in south central Ohio for comparison.

STUDY AREA AND METHODS

Road surveys were conducted late November through late February, the winter of 1996-1997, in Hardin County, Ohio. Hardin County has a land area of 747 km^2 which were transected on north-south secondary roads, separated by 1.6 to 3.2 kilometers. Roads traveled were chosen according to orientation and to cover maximum area while

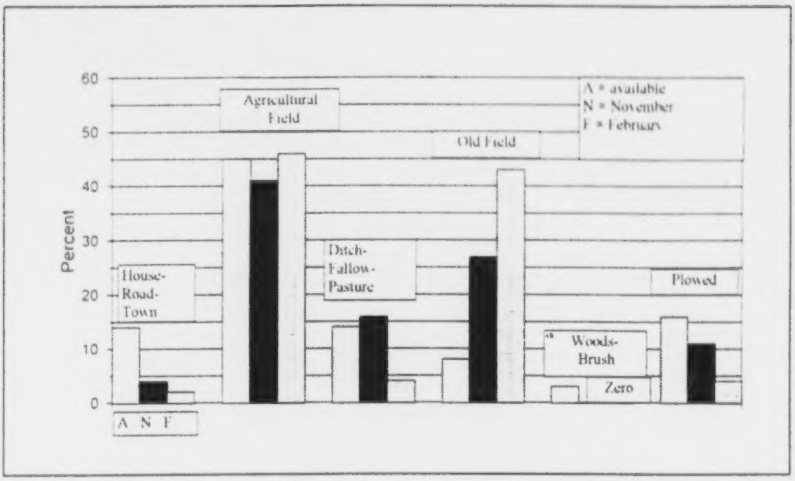

Figure 1 Habitat Available and Habitat Hunted in November and February

minimizing the possibility of spotting the same kestrel twice. Speeds of 27-56 kph were traveled while scanning a distance of approximately 100 m on both sides of the road. Censuses were conducted in precipitation free periods without strong winds since either could affect kestrel activity (Gawlik et al., 1990). Surveys began no earlier than 0900 hours and were concluded before 1630 hours EST. Kestrels display no significant afternoon lull of activity (Bunn et al., 1995), therefore time-of-day correction factors were not needed. Six different types of habitat were distinguished: lawn/town/road; agricultural field; ditch/fallow/pasture/hay; old field; plowed; and, brush/woods. Habitat was sampled on both sides of the road every 1.6 km. When a kestrel was sighted, it was almost always hunting from utility lines. Since both sides of the road were potential hunting grounds, each was counted as that individual's hunting preference. The kestrel's immediate behavior and sex were also noted using 7 X 35 binoculars and plumage characteristics.

To determine if a significant difference in habitat utilization with respect to habitat availability existed, chi square tests for independence were applied on February and November's data independently. To determine if a difference in habitat use between sexes existed, the data were analyzed using chi square tests of independence. Also chi-squared tests of independence were applied to the data collected in November and February with respect to sex ratios to determine if there was a significant difference between early and late winter proportions.

RESULTS AND DISCUSSION

Significant differences between the habitat utilized and the habitat available in both November and February data were obvious (x^2 = 26.6, d.f. = 5; x^2 = 55.0, d.f. = 5 -- respectively). The results were over twice the critical value for November and five times the critical value for February. When proportions were examined it was apparent that kestrels preferred old fields to any other habitat (Fig. 1). Old fields only cover 8 percent of Hardin County, whereas 27 percent in November and 43 percent in February, of the kestrels, were hunting that habitat. They hunted agricultural field proportionately to availability. This demonstrates their ready adaptability. However, no significant difference in intersexual preference were found(x^2 = 2.64, d.f. = 4) although wooded habitat was not included in my statistical analysis because no kestrels were sighted in that habitat. The proportion of wooded habitat was only 4 percent so it cannot be determined if either sex was avoiding that portion.

The analysis of the sex ratio revealed a significant difference in proportion across the winter season ($x^2 = 5.0$, d.f. = 1). Three times the number of females with respect to males were sighted in November, but by February the male population was almost twice that of the female (Table 1). The male population was more stable through the winter (n = 10 for November; n = 13 for February).

Table 1. Sex Ratios of Kestrels Over the Winter Season[a]

	Males	Females	n
November	29	71	35
February	62	38	21

a) Values given as percent population.

Kestrels are the smallest raptor in North America and are difficult to detect despite their use of utility lines. To determine the relative population of my study area, I adopted the correction factor of 3.0 proposed by Craighead and Craighead (1956), and utilized by Bildstein (1978), to accurately estimate the population size. The winter population was 0.14 kestrels per squared kilometer in November and 0.09 kestrels per squared kilometer in February. This deviated from the report of Bildstein of 0.32 kestrels per squared kilometer in 1978. A possible explanation for this deviation is a difference in habitat quality. A local Audubon society has conducted annual Christmas counts in the study area described by Bildstein. Apparently, birds localize in this area. Balgooyen (1973) reports that small birds are an important component of the kestrel diet during the winter when arthropods are absent. Since small birds localize in this area it could explain the high kestrel density reported by Bildstein, the kestrels are utilizing a rich food source. Several other explanations could also explain the difference. The ability to spot or not spot kestrels in dense cover being one of them. Another, less likely and requiring further research, is that since 1978 kestrels are not doing as well.

A couple of explanations have been offered to explain the sex ratio phenomenon. Many raptors exhibit pronounced sexual dimorphism (Koplin, 1973), while kestrels are sexually dimorphic they are much less so. Dividing the habitat may serve to reduce competitive pressure for limited, winter resources. Another, more recent explanation is differential migration. Smallwood (1988) reported that females migrate southward almost a month before males. This could explain the skewed sex ratio toward females in November and markedly reduced by February discovered in the Ohio study area.

Excessive mortality might also have decimated the female population, or possibly the ratio is merely a consequence of the local availability of habitat (Stinson et al., 1981; Mills, 1976). It has been quantified that females are generally found hunting in open habitat, whereas males are found in shrubby, wooded habitat, whether they prefer their chosen habitat or if it is a consequence of differential migration is still an issue of contention. My study area was composed of 96 percent open area. In many birds, the first individual occupying a piece of habitat is usually successful in defending that habitat and in kestrels, defending ownership almost always results in victory, (Smallwood, 1988) regardless of sex. This observation conflicts with Cade (1955)and Roest (1957), they reported that females were more aggressive as nestmates and continued to dominate males as adults.

If excessive mortality is the reason for the female population decreasing, then the benefits of not migrating must be great. Winters in Ohio can be fierce and sub-zero temperatures are common. This creates intense pressure for overwintering birds, but the pressure and costs of migrating must be greater. The mating season of the kestrel is dependent upon female readiness and fitness. She cannot produce viable eggs without suitable health and weight. In the Eurasian kestrel, the counterpart to the American kestrel, early laying females had 49 percent more body reserves than late laying females (Meijer, 1989). The loss of body reserves during migration is understood. Many of these birds travel thousands of miles in a short period of time. Possibly a female can conserve those reserves by "gambling" that a particular winter will be mild. The benefits, if the reproductive triggers of the Eurasian Kestrel are the same, include larger, earlier nests with the possibility of a second brood (Toland, 1985).

Superior prey resources are not the only desired characteristics of preferred habitats. The kestrel is the smallest North American falcon, smaller than the accipitrine (wood inhabitants) hawks. Since most raptors consider anything smaller than themselves prey, this leaves kestrels vulnerable to interspecific predation. The remains of kestrels have been found in the stomach of both Cooper's Hawks and the Sharp-shinned Hawk (Roest, 1957). More studies are needed before a conclusive explanation can be offered and further investigation into the effect of predator/prey dynamics is needed. In my study, Cooper's hawks were uncommon. That forests, their preferred habitat, only covered 4 percent of Hardin County is a probable explanation. In southern Florida the accipiters are basically nonexistent and in southwestern United States, likewise. Possibly geographical differences in habitat segregation exist as a result of predation. Again, further study is needed.

SUMMARY

Selective habitat use, with respect to availability, was observed in my study area. Kestrels significantly preferred old field habitat, although it only covered 8 percent of the area. No significant intersexual preferences were found, possibly because accipiters are uncommon in this portion of their range. Almost three times as many females were sighted in November and almost twice as many males were sighted in February. Independent migration or high mortality are the probable factors affecting this sex ratio. There was a remarkable difference in the population size with respect to a previous estimate because of differences in habitat resources.

LITERATURE CITED

Balgooyen, T.G. 1976. Behavior and ecology of the American Kestrel (Falco sparverius L.) In the Sierra Nevada of California. University of California Publications in Zoology. 103.

Bildstein, K. L. 1978. Ph.D. Dissertation, Columbus, Ohio, Ohio State University.

Bohall-Wood, P. and M. W. Collopy. Abundance and habitat selection of two American Kestrel subspecies in north-central Florida. The Auk. 103: 557-563.

Bunn, A. G., W. Klein and K. L. Bildstein. 1995. Time-of-day effects on the numbers and behavior of non-breeding raptors seen on roadside surveys in eastern Pennsylvania. J. Field Ornithology. 66(4): 544-552.

Cade, T. J. 1955. Experiments on winter territoriality of the American Kestrel, Falco sparverius. Wilson Bull. 67:5-18.

Craighead, J. J. And F. C. Craighead. 1956. Hawks, owls, and wildlife. Stackpole, Harrisburg, Pa.

Enderson, J. H. 1960. A population study of the sparrow hawk in east-central Illinois. Wilson Bull. 72: 222-231.

Gawlik, D. E. and K. L. Bildstein. 1990. Methods of estimating nonbreeding populations of open-habitat diurnal raptors in the southeast. Proc. Southeast raptor management symposium and workshop. Natl. Wildl. Fed., Washington, D.C. Pg. 214-217.

Koplin, J. R. 1973. Differential habitat use by sexes of American Kestrels wintering in

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northern California. Raptor Research. 7(2): 39-42.

Meijer, T., D. Masman and S. Daan. 1989. Energetics of reproduction in female kestrels. The Auk. 106: 549-559.

Mills, S. G. 1976. American Kestrel habitat separation. Auk. 93: 740-748.

Roest, A. I. 1957. Notes on the American sparrow hawk. The Auk. 74: 1-19.

Sferra, N. J. 1984. Habitat selection by the American Kestrel (Falco sparverius) and Red-tailed Hawk (Buteo jamaicensis) wintering in Madison County, Kentucky. Raptor Research. 18: 148-150.

Smallwood, J. A. 1981 Prey size selection by wild American Kestrels (Falco sparverius) wintering in south-central Florida. M.S. thesis, Oxford, Ohio, Miami University.

-------------. 1988. A mechanism of sexual segregation by habitat in American Kestrels (Falco sparverius) wintering in south-central Florida. The Auk. 105: 36-46.

Stinson, C. H., D. L. Crawford, and J. Lauthner. 1981. Sex differences in winter habitat of American Kestrels in Georgia. J. Field Ornithology. 52(1): 29-35.

Toland, B. R. J. The effect of vegetative cover on foraging strategies, hunting success and nesting distribution of American Kestrels in central Missouri. Raptor Research. 21(1): 14-20.

--------. 1985. Double brooding by American Kestrels in central Missouri. The Condor. 87: 434-436.

The Role of Calcium in Wound-Induced Cell Proliferation

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Cell proliferation is important in such processes as normal development, cancer and wound healing. In particular, the growth of endothelial cells to form new blood vessels regulates the rate of wound healing and tumor growth. Exploring the mechanisms involved in the control of cell proliferation aids in finding treatments for diseases such as cancer and for prompting wound healing. The cell model used by our laboratory involves confluent monolayers of calf pulmonary artery endothelial cells grown on glass coverslips. Previously, we found that mechanical wounding induces a transient rise in intracellular calcium which in turn sets the rate of cell motility. This project investigates how a one-time elevation in intracellular calcium concentration ($[Ca^{2+}]_i$) affects proliferation.

Mechanical wounding in HBSS buffer resulted in a control cell proliferation rate of 75%. To test the role of $[Ca^{2+}]_i$ in cell proliferation, we blocked $[Ca^{2+}]_i$ elevation with gadolinium (Gd^{3+}), a Ca^{2+} channel blocker and EGTA, a Ca^{2+} chelator. The rate of proliferation decreased to 18.8% and 37.4% respectively. These results suggest that a transient rise in $[Ca^{2+}]_i$ is necessary for proliferation 24 hours after wounding.

INTRODUCTION

There are many events on the cellular level that depend on the synergistic contribution of cell motility and proliferation. For example, the process of wound healing involves the motility of cells into the open region created by the wound. However, cell motility alone is not sufficient if the wound is too wide. Cell proliferation or the growth of new cells is therefore necessary to fill the denuded space. Similarly, tissue morphogenesis cannot be initiated by cell motility alone and tumor metastasis also involves both cell motility and proliferation.

Previous work in the lab have shown that wounding of confluent monolayers of calf pulmonary artery endothelial cells (CPAE) induces a transient rise in $[Ca^{2+}]_i$ that travels for a short distance through the monolayer. This transient $[Ca^{2+}]_i$ wave was shown to be a rate limiting factor in cell motility measured hours after the initial stimulus. The source of this rise in $[Ca^{2+}]_i$ came from both Ca^{2+} influx and release from intracellular stores (Sammak et al., 1997). Kohn, et al have also shown that the influx of Ca^{2+} from the extracellular space is a necessary component of cellular adhesion pathways which regulate cell motility (Kohn et al., 1995). The induction of endothelial cell motility is an important event which is required for the subsequent induction of cell proliferation (Coomber and Gotlieb, 1990). Calcium has also been shown to play a role in cell proliferation, but these studies were done using high concentrations of extracellular Ca^{2+} or other agonists as a stimulus (Whitfield et al., 1980). With our model, we have found that there is a single, transient but physiologically relevant Ca^{2+} signal which affects the induction of cell proliferation 24 hours after the initial mechanical stimulus. Understanding the mechanism behind this tight regulation of proliferation is important in preventing such deleterious events as tumor metastasis and birth defects.

METHODS/MATERIALS

General cell culture:

Calf pulmonary artery endothelial cells (ATCC, CPAE ccl209 Rockville, MD) were cultured in DMEM containing 20mM HEPES and 1% penicillin/streptomycin (Gibco LifeTechnologies, Grand Island, NY) supplemented with 10% FBS (Hyclone, Logan, UT). All tissue culture incubations occurred in an 8% CO$_2$ humidified incubator at 37°C.

Proliferation assays:

Endothelial cells were grown on glass coverslips (Corning Glass, Corning, NY) to confluency. On the day of the experiment, the media was replaced with one of the following solutions for 30 seconds: Hank's Balanced Salt Solution (HBSS) (Gibco LifeTechnologies, Grand Island, NY), 100µM Gd^{3+} (Sigma Chemicals, St. Louis, MO) in phosphate-free HBSS, 2.5mM EGTA (Sigma Chemicals, St. Louis, MO) in Ca^{2+}-free HBSS, and 2.5mM Ca^{2+} in HBSS. Mechanical wounds were then made using a rubber policeman to remove half of the cells on the coverslip. After 1.5 minutes, the HBSS was replaced with fresh media and the cells returned to the incubator. At 24 hours post-wounding, the thymidine analog, bromodeoxyuridine (BrdU), was added to a final concentration of 10µM and the cells were returned to the incubator. After 6 hours, the cells were fixed with cold ethanol:acetic acid (95:5) at -20°C for 1/2 hour. Immunocytochemistry was done using a mouse anti-BrdU primary antibody and peroxidase-conjugated goat anti-mouse IgG secondary antibody (Sigma Chemicals, St. Louis, MO). After incubation with the peroxidase substrate, 3,3' Diaminobenzidine Tetrahydrochloride (DAB, Sigma Chemicals, St. Louis, MO), images of the wounds were obtained using a cooled CCD camera (Photometrics, Tucson, AZ) controlled by the IPLab Imaging program on an inverted Nikon diaphot 300. The number of proliferating cells was measured using the NIH 1.6 Imaging program.

$$\%\ \text{proliferating cells} = \frac{\text{no. of BrdU incorporated cells}}{\text{total no. of cells}} \qquad (1)$$

RESULTS

First, to determine the time of peak proliferation in our cell model, control cells were wounded as described in HBSS then BrdU was added at 6 hr intervals from 0-36 hours post-wounding. The time during which most cells were proliferating was determined to be at 24-30 hrs post-wounding(results not shown). The control rate of proliferation was 74.5% during this time (S.D.=5.8, n=3 expts; Fig 1 and Fig 2). BrdU was added during this time interval for all subsequent proliferation assays. Interestingly, proliferation was induced in large part in cells located at the wound edge. Fewer cells one field away from the wound edge proliferated compared to the edge (15.7%, S.D.=5.64, n=5 expts).

To see if [Ca^{2+}]$_i$ played a role in the induction of cell proliferation, we blocked [Ca^{2+}]$_i$ elevation with 100µM Gd^{3+}, a calcium channel blocker, or 2.5mM EGTA, a calcium chelator. When extracellular Ca^{2+} was chelated using 2.5mM EGTA, the % proliferating cells decreased to 37.4% (S.D.=0.6, n=3 expts.; Fig 1, 2). A greater decrease in % proliferating cells was observed when the [Ca^{2+}]$_i$ elevation was blocked by 100µM Gd^{3+}, giving only 18.8% proliferating cells (S.D.=1.9, n=3 expts.; Fig 1, 2). Gd^{3+} and EGTA resulted in an approximately 75% and 50% decrease, respectively, in the % proliferating cells compared to the control, showing that an influx of [Ca^{2+}]$_i$ is necessary not only for cell motility (Sammak et al., 1997) but also for normal cell proliferation.

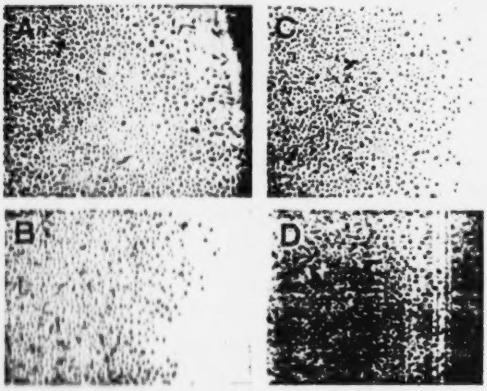

Figure 1: Calcium regulation of cell proliferation Panel A: In register phase contrast microscopy of the wound edge. Panels B-D: Bright field microscopy of BrdU stained nuclei. All cell nuclei were counter-stained with 0.1% thionin.
-Panel B: Control cells grown in DMEM containing 10% FBS (serum media) and wounded in HBSS buffer. 74.5% of cells at the wound edge were proliferating.
-Panel C: Cells wounded in 100uM Gd^{3+}, a calcium channel blocker. 18.8% of cells at the wound edge were proliferating.
-Panel D: Cells wounded in 2.5mM EGTA, an extracellular calcium chelator. 37.4% of cells at the wound edge were proliferating.

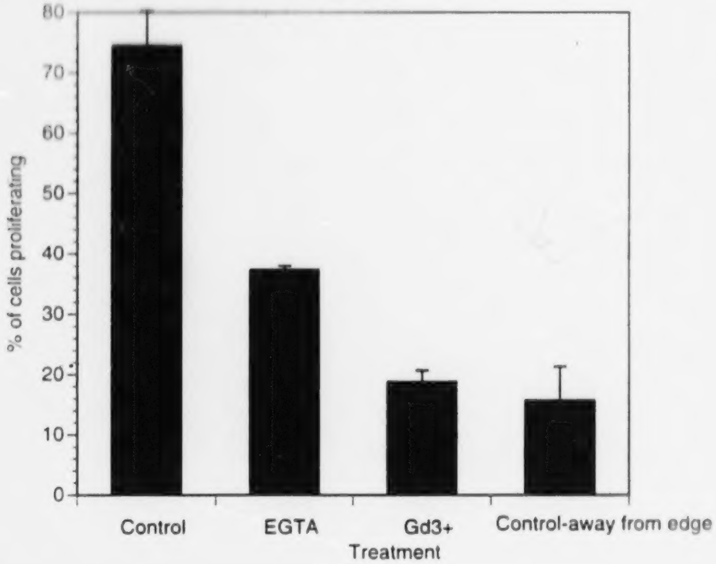

Figure 2: Summary of proliferation data Between 24-30 hr after the initial wound stimulus, 74.5% (S.D.=5.8, n=3 expts) of cells are proliferating. The induction of cell proliferation is also dependent on the Ca^{2+} induced upon wounding. Chelating extracellular calcium with 2.5mM EGTA decreases the % proliferating cells to 37.4% (S.D.=0.6, n=3 expts) while blocking calcium channels with 100uM Gd^{3+} decreased proliferation to 18.8% (S.D.=1.9,

n=3expts). Control cells one field away from the wound edge showed a decrease in proliferation to 15.7% (S.D.=5.64, n=5 expts).

Since normal cell proliferation was shown to require the rise in $[Ca^{2+}]_i$, we wanted to investigate the possibility of increasing the % proliferating cells by adding extra Ca^{2+}. We used $[Ca^{2+}]_i$ measurements with fura-2 to determine the concentration of Ca^{2+} to be used. Fura-2 measurements showed no increase in peak $[Ca^{2+}]_i$ levels with extracellular Ca^{2+} concentrations beyond 2.5 mM (P.O. Tran, personal communication). Mechanical wounding in HBSS containing 2.5 mM Ca^{2+} resulted in 100% of the cells at the wound edge proliferating. This result suggests that the addition of extra Ca^{2+} is sufficient to increase the rate of cell proliferation (Fig 3).

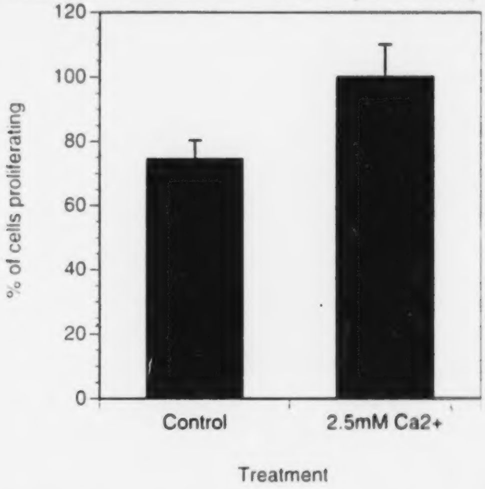

Figure 3: Effect of extra calcium. % proliferating cells was increased to 100% (S.D.=10, n=3 expts) when cells were mechanically wounded in 2.5 mM Ca^{2+} in HBSS.

DISCUSSION

Previous work in our lab has shown that mechanically wounding a monolayer of CPAE cells induces a $[Ca^{2+}]_i$ wave which travels through the monolayer. This $[Ca^{2+}]_i$ wave, however, only occurs in cells around the edge of the wound. Although this $[Ca^{2+}]_i$ wave has been shown to have a long-term effect on cell motility, the long-term effect on proliferation has not been clearly investigated. Since we found that peak proliferation occurred between 24-30hrs post-wounding, the single, transient Ca^{2+} signal induced upon mechanical wounding not only mediates long-term cell motility, but also the induction of proliferation. Although other work on Ca^{2+} signaling has shown that Ca^{2+} is required for cell motility (Kohn, et al., 1995 and Sammak, et al., 1997) and proliferation (Whitfield, et al., 1980), our model is unique in that it allows us to study a physiologically relevant change in Ca^{2+} and its effect on proliferation.

Our results suggest that a rise in $[Ca^{2+}]_i$ is a necessary component of cell proliferation induced upon wounding and extra Ca^{2+} in the extracellular buffer can increase the % of proliferating cells. Addition of different reagents used to block this $[Ca^{2+}]_i$ wave resulted in a reduction in % proliferating cells. Decreasing Ca^{2+} influx by blocking Ca^{2+} channels with Gd^{3+} reduced the % proliferating cells to 18.8% and chelating extracellular Ca^{2+} reduced the % proliferating cells to 37.4% compared to the control, of 74.5%. Increasing Ca^{2+}

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influx by wounding in HBSS containing 2.5mM Ca^{2+} resulted in an increase in the % proliferating cells to 100%. These results suggest that Ca^{2+} influx is required for the induction of cell proliferation following mechanical wounding. We also found that there was a spatial correlation between the wound-induced Ca^{2+} signal and cell proliferation. Only cells that experienced the increase in [Ca^{2+}]$_i$ were induced to proliferate 24 hours after the initial stimulus.

These findings on calcium signaling and its role in the induction of cell motility and proliferation have very important clinical relevance. Understanding the tight regulation of these cellular events is important in the control of such uncontrolled events as tumor metastasis and birth defects. Knowing how a single, transient signal affects long-term events can also aid in improving wound healing and tissue morphogenesis.

REFERENCES

Coomber, Brenda L. and Avrum I. Gotlieb (1990) " In vitro endothelial wound repair: Interaction of cell migration and proliferation, " Arteriosclerosis, 10(2): 215-222.

Kohn, Elise C., et al. (1995) "Angiogenesis: Role of calcium-mediated signal transduction," Proceedings of the National Academy of Sciences, USA 92: 1307-11.

Sammak, Paul J., et al., "Wound-induced endothelial cell motility depends on a localized Ca^{2+} wave," Journal of Cell Biology submitted (1997).

Sammak, Paul J. et al., "How do injured cells communicate with the surviving cell monolayer, " Journal of Cell Science, in press.

Whitfield, J.F. et al. (1980) "The roles of calcium and cyclic AMP in cell proliferation, " Annals of the New York Academy of Sciences, 339:216- 240.

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Isochore Related Amino Acid Substitutional Biases

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ABSTRACT

The genomes of warm-blooded vertebrates comprise compartments with widely differing GC-contents relative to those found in cold-blooded vertebrates. A study of 110 orthologous loci reveals that evolutionary forces creating skewed amino acid fixational biases, particularly within genes embedded in GC-rich regions, operated independently in both lineages. Additionally, inferred ancestral protein sequences indicate that amino acid usage was already skewed to a lesser extent in a common ancestor of humans and chickens. Correlations between the GC-contents of human, chicken and frog genes used in this study further imply that the fixational biases that accompanied the creation and maintenance of contemporary isochore compartmentalization pre-dated the advent of homeothermy and did not originate independently in both the mammalian and avian lineages.

INTRODUCTION

The nuclear genome of warm-blooded vertebrates is a mosaic of long regions of homogenous base composition known as isochores. On the scale of megabases in length (Krane et al., 1991), mammalian and avian isochores typically fall into five or six discrete classes whose base compositions usually range from 35% to 65% G+C (Kadi et al., 1993). The much narrower ranges in the GC-contents of the genomic compartments of frogs (Bernardi and Bernardi, 1990a), a cold-blooded vertebrate, has been taken as evidence that compartmental heterogeneity in GC-content is a derived state that occurred twice and in association with the development of homeothermy in both the mammalian and avian lineages (Salinas et al., 1986; Cacciò et al., 1994).

The creation of genomic compartments with widely different GC-contents within warm-blooded vertebrates from portions of the compositionally homogenous genomes still found within cold-blooded vertebrates conferred a distinctive genome phenotype upon mammals and birds (Bernardi and Bernardi, 1986a). The widely different GC-contents of neo- and paleogenomes are correlated with several important aspects of genome structure, including gene concentration (Mouchiroud et al., 1991), average intron and gene length (Duret et al., 1995), recombination rates (Eyre-Walker, 1993) and distinctive preferential insertion of long and short repetitive elements (Soriano et al., 1981; Hardison et al., 1991).

The fixational biases that created isochores are thought to have been initially driven by thermostability-related selective advantages associated with increased GC-content (Bernardi and Bernardi, 1986a). Perhaps of greater selective importance, differences in GC-content are also accompanied by distinct differences in codon bias and amino acid usage (Bernardi & Bernardi, 1986a; Zoubak et al., 1995). For example, codons which contain only G or C in their first two positions specify amino acids (Ala, Arg, Gly, and Pro) which are thought to increase protein thermostability (Zuber, 1981; Bernardi and Bernardi, 1986a). Indeed, the relative frequency of the seven amino acids that contain only A or T in the first two codon positions have been found to be negatively correlated with GC-content at the first and second codon positions of genes (D'Onofrio et al., 1991). Opposite trends are found for the relative frequencies of the four amino acids whose codons are GC-rich (D'Onofrio et al., 1991).

Since homeothermy is thought to have been developed independently in both the mammalian and avian lineages (Carroll, 1988), it has been assumed that the creation of neogenomes must have begun independently in both lineages as well (Bernardi et al., 1985; Bernardi et al., 1988). In fact, relatively little is known about the duration that the responsible mechanism(s) operated (Bernardi et al., 1988) and even the time frame in which genome compartments first appeared has remained poorly defined. In order to directly examine these issues, we have performed a phylogenetic comparison of 110 orthologous loci from humans and chickens, using frogs and other cold-blooded vertebrate protein sequences as out groups.

MATERIALS AND METHODS

Selection of sequences: The 110 orthologous genes studied in this work represent all the loci for which complete coding sequences in humans (*Homo sapiens*) and chicken (*Gallus gallus*), as well as amino acid sequences for an out group (in 80 cases frog, *Xenopus laevis*) were found in an exhaustive search of the HOVERGEN database (release 21) of homologous sequences (Duret et al., 1994) and were available in either GenBank release 98+ (December, 1996) or PIR (December, 1996). Several additional loci were excluded from consideration due to an insufficient number of amino acid substitutions, disputes regarding their orthology, or because they were closely related paralogs of loci that had already been included.

Inference of amino acid substitutions: Amino acid alignments were made with the CLUSTAL V program (Higgins et al., 1992) and optimized by hand. Only unambiguously alignable homologous genic regions, excluding start and stop codons, were included in the analyses. Additional mammalian and avian protein sequences were used whenever available to resolve ambiguous substitutions in the human and chicken lineages. Amino acid substitutions, as well as the inferred ancestral sequences basal to the radiation of the human and chicken lineages, were scored by a parsimony approach using MacClade 3.05 (Maddison and Maddison, 1993).

The frequency of occurrence of amino acids whose first two codon positions are each either G or C ("GC-class" amino acids: Arg, Ala, Gly and Pro) and those whose first two positions are each either A or T ("AT-class" amino acids: Phe, Tyr, Asn, Lys, Leu, Iso and Met) was scored as two separate classes. Arginine codons were excluded from analyses of GC-class amino acids (Ala, Gly and Pro) and leucine codons were excluded from analyses of AT-class amino acids (Phe, Tyr, Asn, Lys, Iso and Met) since, it was only rarely possible to distinguish between arginine residues coded by GC-class codons (CGA, CGC, CGG, CGU) and intermediate-class codons (AGA, AGG) and leucines encoded by AT-class codons (UUA, UUG) could not usually be distinguished from intermediate-class codons (CUA, CUC, CUG, CUU).

RESULTS

GC-content at the third position of codons (GC_{III}) were highly correlated between loci in humans and chickens (Figure 1a; $r = 0.650$, $p << 0.01$), humans and frogs (Figure 1b; $r = 0.494$, $p < 0.01$) and chickens and frogs (Figure 1c; $r = 0.319$, $p < 0.01$). Values for GC_{I+II} were also highly correlated between humans and chickens ($r = 0.657$, $p << 0.01$), humans and frogs ($r = 0.669$, $p << 0.01$) and chickens and frogs ($r = 0.504$, $p < 0.01$). Further, there was a significant positive correlation between GC_{III} and the *net* number of substitutions which increase GC-class amino acids or decrease AT-class amino acids [(↑GC + ↓AT) - (↓GC + ↑AT)], ΔGC-ΔAT, in humans (Figure 2a; $r = 0.176$; $p < 0.05$) and chickens (Figure 2b; $r = 0.314$; $p < 0.01$).

The total number of substitutions across all loci which either increased the number of GC-class amino acids or decreased the number of AT-class amino acids (↑GC + ↓AT) is significantly different from the total number of substitutions which either decreased GC-class amino acids or increased AT-class amino acids (↓GC + ↑AT) in

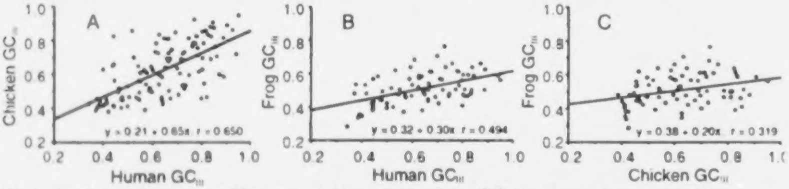

Fig. 1. Correlations between the GC-content of third codon positions (GC_{III}) between 110 loci in humans and chickens (A), 80 loci between humans and frogs (B), and chickens and frogs (C).

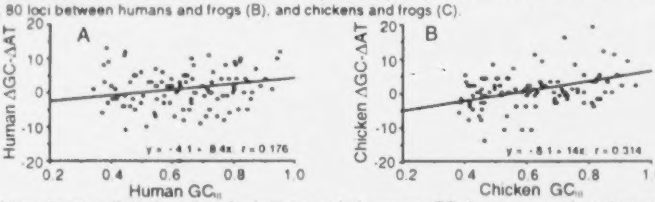

Fig. 2. Correlations between the net number of substitutions which increase GC-class amino acids or decrease AT-class amino acids (ΔGC-ΔAT) and the GC-content of the third codon positions (GC_{III}) among 110 loci in humans (A) and chickens (B).

the human lineage, however the difference is not significant in chickens (Table 1). Division of the loci into two classes, $GC_{III} < 57\%$ and $GC_{III} > 57\%$ corresponding to the L1 + L2 and H1 + H2 + H3 isochores, respectively (Mouchiroud et al., 1991), reveals that the significant excess of substitutions that increases GC-class amino acids and decreases AT-class amino acids in the human and chicken lineages is largely attributable to substitutions within their $GC_{III} > 57\%$ loci (Table 1).

A total of 38,415 amino acids (excluding start codons) across all loci at which substitutions could be unambiguously determined were considered during the course of these analyses. GC-class amino acids account for 7,407 of those residues in humans, 7,396 in chickens and 7,334 in the inferred ancestor of humans and chickens. AT-class amino acids account for 9,426 of those residues in humans, 9,475 in chickens and 9,500 in the inferred ancestor of humans and chickens. The distribution of AT-class amino acids (but not of GC-class amino acids) in the 55 human loci with the lowest GC_{III}-content and the 55 human loci with the highest GC_{III}-content is significantly skewed (Table 2).

Similar excesses of AT-class amino acids were found in the orthologs of the GC-poorest human loci in the chicken as well as within the inferred ancestor of humans and chickens (Table 2). The frequency of AT-class amino acids was negatively correlated with GC_{III}-content across all loci in humans ($r = 0.241$, $p < 0.01$) and chickens ($r = 0.207$, $p < 0.05$) though the frequency of GC-class amino acids was not significantly correlated with GC_{III}-content in either humans ($r = 0.032$, $p > 0.9$) or chickens ($r = 0.148$, $p > 0.1$).

Table 1. Substitutions which change the number of GC- and AT-class amino acids

	$\uparrow$GC + $\downarrow$AT	$\downarrow$GC + $\uparrow$AT	χ^2
Total			
Human	1582	1429	$\chi^2 = 3.596$, $p = 0.05$
Chicken	1438	1342	$\chi^2 = 1.658$, $p < 0.2$
$GC_{III} < 57\%$			
Human	552	521	$\chi^2 = 0.448$, $p < 0.6$
Chicken	585	640	$\chi^2 = 1.235$, $p < 0.3$
$GC_{III} > 57\%$			
Human	1030	908	$\chi^2 = 3.482$, $p = 0.05$
Chicken	853	702	$\chi^2 = 7.332$, $p < 0.01$

Table 2. Amino acid utilization in the GC_{III}-richest and GC_{III}-poorest human loci, their orthologs in chickens and in the common ancestor to chickens and humans

	GC-class amino acids			AT-class amino acids		
	Obs.	Exp.[a]	c^2 (p-value)[b]	Obs.	Exp.[a]	c^2 (p-value)[b]
Human						
GC_{III}-richest loci	3432	3360	3.596 (> 0.2)	4008	4275	16.721 (< 0.001)
GC_{III}-poorest loci	3975	4045	1.658 (> 0.2)	5418	5148	14.169 (< 0.001)
Chicken						
GC_{III}-richest loci	3406	3353	0.835 (> 0.3)	4008	4296	19.259 (< 0.001)
GC_{III}-poorest loci	3990	4039	0.587 (> 0.4)	5467	5174	16.599 (< 0.001)
Inferred ancestor						
GC_{III}-richest loci	3352	3327	0.187 (> 0.6)	4066	4310	13.779 (< 0.001)
GC_{III}-poorest loci	3982	4007	0.155 (> 0.6)	5434	5190	11.441 (< 0.001)

[a] Obtained from the number of amino acids at which substitutions could be unambiguously determined for each set and the observed overall frequency of AT or GC-class amino acids in humans, chickens and the inferred ancestor, respectively.

[b] Goodness of fit for equal distribution (df=1).

DISCUSSION

Isochore compartmentalization represents an integrated structural and functional feature of warm-blooded vertebrate genomes (Bernardi and Bernardi, 1986a). Establishing and maintaining these compartments has had significant evolutionary consequences for the genes that reside within them, particularly within warm-blooded vertebrates, including extensive modification of codon usage and amino acid composition (Bernardi and Bernardi, 1986a; Zoubak et al., 1995). Density gradient and hybridization experiments have revealed that dramatic differences exist between the compositional patterns of both mammals and birds relative to those of cold-blooded vertebrates (Bernardi et al., 1988; Bernardi and Bernardi, 1990a; Kadi et al., 1993). The absence of compositionally distinct, gene-rich neogenomes in primitive vertebrates as well as within reptiles (Bernardi et al., 1988; Bernardi and Bernardi, 1990a) has suggested that the origins of GC-rich compartments within birds and mammals were independent and coincident with their development of homeothermy.

The correlation of GC_{III} values observed between these species (Figure 1) implies that differences in the GC-content of the loci we have analyzed began to be established and maintained before birds and mammals last shared a common ancestor. Variations in GC_{III}, which consists predominantly of synonymous polymorphism due to overlap in the genetic code, should be subject to much less selective constraint than in $GC_{I,II}$, since changes in the first two nucleotides in a codon are more likely to result in amino acid changes and thus protein structure and function. Consequently, GC_{III} is likely to be a sensitive indicator of regional fixational biases at the DNA-level and its conservation suggests that similar forces have shaped the human, chicken and frog genomes since they last shared a common ancestor.

Evidence for a *genome*-wide trend toward a change in the relative abundance of amino acid classes was found across all human loci (Table 1). Analyses of fixational trends in humans since they last shared a common ancestor with rats (80 to 100 million years ago) show a similar but less dramatic skewing of the relative number of substitutions involving GC- and AT-class amino (Krane and Ayala, 1997) indicating that this trend may have been relatively constant over the past 280 million years. Similarly, in chicken loci there is a very significant trend towards decreasing the abundance of AT-class amino acids in favor of GC-class amino acids (Table 1).

The trends apparent in Table 1 are also consistent with the non-random utilization of amino acids observed within the GC_{III}-richest and GC_{III}-poorest human loci and their orthologs in chickens. AT-class amino acids were extremely under-represented in GC_{III}-rich genes and over-represented in GC_{III}-poor genes in both humans and chickens. This skewing of amino acid utilization appears to be a genome-wide phenomenon as the relative frequency of AT-class amino acids was found to be significantly correlated with GC_{III} content across all loci in humans and chickens (Fig. 2). The absence of similarly striking trends for GC-class amino acids implies that substitutions involving them are under greater selective constraint and/or that the mechanism responsible for the maintenance of isochore compartmentalization does not act as strongly upon them.

Of particular interest is the fact that amino acid utilization of the inferred common ancestor of humans and chickens displays a very similar though less dramatic skewing of AT-class amino acid utilization to that seen in its descendants (Table 2). Hence, modern-day correlations between amino acid utilization and GC_{III} content are attributable to significant differences between loci that were already established prior to the divergence of mammals and birds approximately 280 million years ago (McMenamin, 1987). This, together with the correlation between the GC_{III} contents of human, chicken and frog genes, indicates that the fixational biases that have operated within the human and chicken lineages (Table 1) may simply reflect a continuation of an ancient trend that originated very early in (or even before) the history of terrestrial vertebrates some 360 million years ago (McMenamin, 1987).

Two explanations have been postulated to account for the development and maintenance of isochores. First, the GC-contents of non-coding sequences and synonymous codon positions may have been indirectly altered by a mechanism whose primary selective advantage was associated with alterations of the amino acid composition and thermostability of proteins (Bernardi and Bernardi, 1986a; Perrin and Bernardi, 1987). Alternatively, regional differences in base composition could have arisen from a differential accumulation of mutations that are not adaptively-driven (Filipski, 1987; Sueoka, 1988).

Trends contrary to those of the major shift in the rat lineage (Krane and Ayala, 1997) and the existence of dramatically skewed amino acid utilization prior to the development of homeothermy and a corresponding increase in average body temperature undermine the first hypothesis' ability to account for the creation and maintenance of the neogenome within warm-blooded vertebrates. Not only does skewed amino acid utilization pre-date the divergence of humans and chickens, fixational trends over the past 280 million years appear to have primarily affected AT- and not GC-class codons.

The creation of neogenomes has been typically associated with the onset of a regionally acting, relatively short-lived GC-enriching substitution bias (Perrin and Bernardi, 1987; Bernardi et al., 1988). Our analyses indicate however that the shift in genomic GC-content began well before the divergence of humans and chickens and that the differences between the GC-rich neogenome and GC-poor paleogenome have continued to be accentuated since that time. Apparently "compositionally conservative modes of evolution" (Bernardi et al., 1988) may simply be due to the parallel and gradual accumulation of substitutions in several independent lineages while "abrupt transitions" in genome composition may result from the inactivation of the mechanism(s) responsible for those biases early in the history of some lineages.

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REFERENCES

Bernardi, G., Olofsson, B., Filipski, J., Zerial, M., Salinas, J., Cuny, G., Meunier-Rotival, M. and Rodier, F. The mosaic genome of warm-blooded vertebrates. Science (1985) 228:953-958.

Bernardi, G. and Bernardi, G. Compositional constraints and genome evolution. J Mol Evol (1986*a*) 24:1-11.

Bernardi, G., Mouchiroud, D., Gautier, C. and Bernardi, G. Compositional patterns in vertebrate genomes: Conservation and change in evolution. J Mol Evol (1988) 28:7-18.

Bernardi, G. and Bernardi, G. Compositional patterns in the nuclear genome of cold-blooded vertebrates. J Mol Evol (1990*a*) 31:265-281.

Cacciò, S., Zoubak, S., D'Onofrio, G. and Bernardi, G. Nonrandom frequency patterns of synonymous substitutions in homologous mammalian genes. J Mol Evol (1995) 40:280-292.

Carroll, R.L. Vertebrate paleontology and evolution. Freeman, New York (1988).

D'Onofrio, G., Mouchiroud, D., Aïssani, B., Gautier, C. and Bernardi, G . Correlations between the compositional properties of human genes, codon usage, and amino acid composition of proteins. J Mol Evol (1991) 32:504-510.

Duret, L., Mouchiroud, D. and Gouy, M. HOVERGEN: a database of homologous vertebrate genes. Nucl Acids Res (1994) 22:2360-2365.

Eyre-Walker, A. Evidence that both G+C rich and G+C poor isochores are replicated early and late in the cell cycle. Nucl Acids Res (1992) 20:1497-1501.

Filipski, J., Salinas, J. and Rodier, F. Chromosome localization-dependent compositional bias of point mutations in Alu repetitive sequences. J Mol (1987) 206:563-566.

Hardison, R., Krane, D., Vandenbergh, D., Cheng, J.-F., Mansberger, J., Taddie, J., Schwartz, S., Huang, X. and Miller, W. Sequence and comparative analysis of the rabbit a-like globin gene cluster reveals a rapid mode of evolution in a GC-rich region of mammalian genomes. Genomic (1991) 9:742-750.

Higgins, D.G., Bleasy, A.J. and Fuchs, R. CLUSTAL V: Improved software for multiple sequence alignment. CABIOS (1992) 8:189-191.

Kadi, F., Mouchiroud, D., Sabeur, G. and Bernardi, G. The compositional patterns of the avian genomes and their evolutionary implications. J Mol Evol (1993) 37:544-551.

Krane, D.E., Hartl, D.L. and Ochman, H. Rapid determination of nucleotide content and its application to the study of genome structure. Nucl Acids Res (1991) 19:5181-5185.

Krane, D.E. and Ayala, F.J. Minor shifts in genomic GC-contents alter amino acid fixational bias. Mol Biol Evol (1997) submitted.

Maddison, W.P. and Maddison, D.R. "MacClade" version 3.05; Sinauer Associates, Inc. Sunderland, MA (1993).

McMenamin, M.A.S. The emergence of animals. Sci Am (1987) 96:94-101.

Mouchiroud, D., D'Onofrio, G., Aïssani, B., Macaya, G., Gautier, C. and Bernardi, G. The distribution of genes in the human genome. Gene (1991) 100:181-187.

Perrin, P. and Bernardi, G. Directional fixation of mutations in vertebrate evolution. J Mol Evol (1987) 26:301-310.

Salinas, J., Zerial, M., Filipski, J. and Bernardi, G. Gene distribution and nucleotide sequence organization in the mouse genome. Eur J Bioch (1986) 160:469-489.

Soriano, P., Macaya, G. and Bernardi, G. The major components of the mouse and human genomes. Eur J Bioch (1981) 115:234-239.

Suoeka, N. Directional mutation pressure and neutral molecular evolution. Proc Natl Acad Sci USA (1988) 85:2653-2657.

Zoubak, S., D'Onofrio, G., Cacciò, S., Bernardi, G. and Bernardi, G. Specific compositional patterns of synonymous positions in homologous mammalian genes. J Mol Evol (1995) 40:293-307.

Zuber, H. Thermophily. Basic Life Sci (1981) 18:499-512.

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Effects of Thallium on Inositol Polyphosphate Receptors and Nitric Oxide Synthase in Rat Cerebellum

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Abstract:

Thallium (Tl), a heavy metal causes neurotoxicity to rodents and humans. Since Tl and potassium (K) have similar ionic radii, Tl alters K-dependent processes such as inhibi-tion of cellular respiration, and disruption of calcium homeostasis. In this study *in vitro* effects of Tl^{+} and Tl^{3+} on Ca^{2+}-dependent nitric oxide synthase (NOS) activity as measured by a radioactive method in which the rate conversion of ^{3}H-arginine to ^{3}H-citrulline was monitored and $InsP_3$ and $InsP_4$ receptors involved in intracellular and extracellular mobilization of Ca^{2+} respectively were assessed. At μmolar concentrations Tl^{+} (24-54%) and Tl^{3+}(10-98%) significantly inhibited NOS activity in cerebellum. A slight decrease in ^{3}H-$InsP_3$ binding (18-23%) by Tl^{+} (25-100 μM) but not Tl^{3+} was observed. However, at 100-400 μM concentrations both Tl^{+} and Tl^{3+} did not elicit any significant effect on ^{3}H-$InsP_4$ binding. These data suggest that Tl alters Ca^{2+}-homeostasis and nitric oxide (NO) production by inhibiting NOS activity resulting in neuronal dysfunction.

INTRODUCTION

Thallium, one of the most toxic heavy metals is absorbed through the skin and is widely distributed throughout the body and accumulates in bones, renal medulla and eventually in the central nervous system (19). Possible toxic mechanisms of Tl include ligand formation with protein sulfhydryl groups, inhibition of cellular respiration, interaction with riboflavin and disruption of calcium-homeostasis (12). Recently, Barroso *et al.* (1) have demonstrated that Tl-induced cerebellar histological lesions can be protected by prussian blue and D-pencillamine.

The exact metabolic 'lesion' in Tl-intoxication is not yet known. Earlier studies reported that Tl interacts with riboflavin and alters the energy generation mechanisms associated with flavoproteins (3). Thallium behaves quite differently from bivalent heavy metals like Cd^{2+} and Co^{2+}, which act as competitive calcium antagonists at the presynaptic nerve terminal (4). Tl^{+} is unique in possessing an affinity for the K^{+}-activating site that is 10 times greater than K^{+} (7). It has been reported that Tl^{+} can replace K^{+} in the activation of the Na^{+}-K^{+} ATPase (14). Oxidation of Tl^{+} to Tl^{3+} inhibits the ATPase of amine-storing granules, thus causing alterations in the catecholamine metabolism (19).

Though many of the neurotoxic aspects of thallotoxicosis have been described, yet, the primary basis for its neurotoxicity remains unknown. It has been shown that the receptor activation of PI pathway yields $InsP_3$ which regulates the release of Ca^{2+} from endoplasmic reticulum (ER). $InsP_4$, a phosphorylated intermediate of $InsP_3$ metabolism has specific receptors on ER and plasma membrane and is also involved in Ca^{2+} regulation (2). Any interference with the receptor binding and/or Ca^{2+}-release activity of these PI-derived second messengers can have an adverse effect on Ca^{2+}-homeostasis. Nitric oxide is synthe-sized from L-arginine by NOS. Many of the effects of endogenous NO when generated in small amounts are mediated through the activation of guanylyl cyclase (6). Activation of guanylyl cyclase by NO is involved in the control of vascular tone (13), renal function (10) and neural signaling (8). When generated in larger amounts. NO inhibits cellular DNA synthesis and blocks oxidative phosphorylation (5). In the present study, *in vitro* effects of Tl^{+} and Tl^{3+} on Ca^{2+}-mobilizing receptors and Ca^{2+}- and calmodulin-dependent NOS in rat brain has been investigated.

MATERIALS AND METHODS

Adult female Sprague-Dawley rats (300 ± 10 g) from the NCTR breeding colony were used in this study. Animals were housed 2 per cage under controlled conditions. Water and feed were provided *ad libitum*. Animals were sacrificed by cervical dislocation and the brains were removed. The cerebellum of the brain was dissected and stored at -70°C. To study the *in vitro* effects of TlCl (Tl) and $TlCl_3$ (Tl^{3+}) the cerebellum of rat was used.

^{3}H-InsP$_3$ Receptor Binding: ^{3}H-InsP$_3$ receptor binding was determined using the method of Worley *et al.* (17). Briefly, the tissue was homogenized in 50 volumes of buffer A (50 mM Tris-HCl, pH 8.3, 1 mM EDTA) pelleted by centrifugation (35,000 g for 10 min) and resuspended in 50 volumes of buffer A. The reaction mixture contained buffer A (without EDTA and passed through Chelex-100 column), 10 mg wet weight of tissue (0.6 mg of protein) and 2.5 nM [^{3}H]-InsP$_3$ (1 Ci/nmole) in total volume of 1 ml. Assays were incubated for 10 min at 4°C and stopped by centrifugation at 10,000 g for 5 min followed by aspiration of the supernatant. The tips of the microfuge tubes were cut and the pellets were suspended in Scintiverse BD (NEN/Dupont) scintillation fluid and radioactivity was determined. Nonspecific binding was determined in the presence of 1 μM InsP$_3$. Proteins were estimated according to the method of Lowry *et al.* (9).

^{3}H-InsP$_4$ Receptor Binding: ^{3}H-InsP$_4$ receptor binding was determined in the cerebellar membranes by the method of Theibert *et al.* (16). Briefly, the tissue was homogenized in 50 vols. of buffer A (50 mM Tris HCl, pH 7.4, 1 mM EDTA), pelleted by centrifugation (35,000 x g for 10 min) washed twice in buffer A and resuspended in buffer A. Binding assays contained approximately 300-600 μg protein and 10 nM [^{3}H]-InsP$_4$ in a total volume of 250 μl of buffer B (50 mM Tris HCl, pH 8.5, 1 mM ß-mercaptoethanol and the buffer is passed through chelex-100 column). Assays were incubated for 10 min at 4°C and stopped by centrifugation at 10,000 x g for 5 min. followed by aspiration of the supernatant. The tips of the microfuge tubes were cut and the pellets were suspended in scintillation fluid, and radioactivity was determined. Nonspecific binding was determined in the presence of 10 μM InsP$_4$.

Nitric Oxide Synthase Activity: The specific activity of NOS was measured by the method as described by Matsumoto *et al.* (11) with slight modifications. Briefly, the different regions of the brain were quickly dissected and homogenized in 0.5 ml of buffer (pH 7.2) containing 0.32 M sucrose, 20 mM HEPES, 0.5 mM EDTA and 1 mM dithiothreitol and centrifuged at 39,000 X g for 30 min. NOS activity was measured using 50 μl of supernatant incubated with 30 μl of reaction mixture containing the follow (final concentration): 1 mM NADPH, 2 mM calcium acetate, 1 μg of calmodulin, 60 μM tetrahydrobiopterin, 20 μM FAD, 20 μM FMN and 200 μM arginine and [^{3}H]-arginine (5 μCi/ml). After 10 min incubation at 37°C the reaction was terminated by the addition of 1 ml of HEPES buffer (20 mM, pH 5.5) containing 2 mM EDTA and 2 mM EGTA. The incubations were then applied to 1 ml Dowex AG 50 WX-8 columns (Na^{+} form) and eluted. (^{3}H)-L-citrulline was measured by liquid scintillation counting.

Statistical Analysis: The data were analyzed by an analysis of variance (ANOVA). A value of $P < 0.05$ was taken as significant.

RESULTS

In vitro effects of both Tl^{+} and Tl^{3+} were studied on ^{3}H-InsP$_3$ and ^{3}H-InsP$_4$ binding to their receptors in cerebellum of rat (Figs. 1 & 2). Tl^{+} but not Tl^{3+} elicited slight inhibition of ^{3}H-InsP$_3$ binding. The binding of ^{3}H-InsP$_4$ was not significantly affected by both Tl^{+} and Tl^{3+} even at high concentrations (100-400 μM). However, the Ca^{2+}-dependent NOS activity was significantly inhibited by both Tl^{+} and Tl^{3+} in a

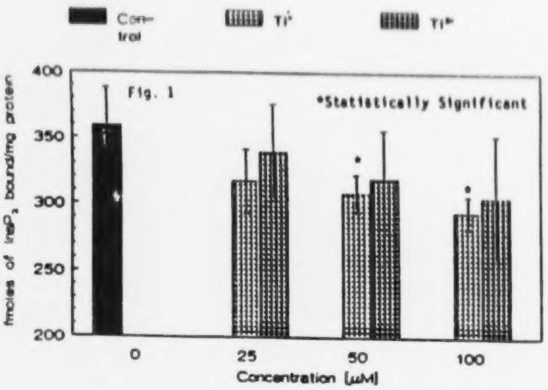

Fig. 1: *In vitro* effects of Tl^{+} and Tl^{3+} on ^3H-$InsP_3$ binding in cerebellum of rat. Each value is mean ± SEM of 6 samples (each assayed in triplicate). *indicates statistically ($P<0.05$) significant when compared with control.

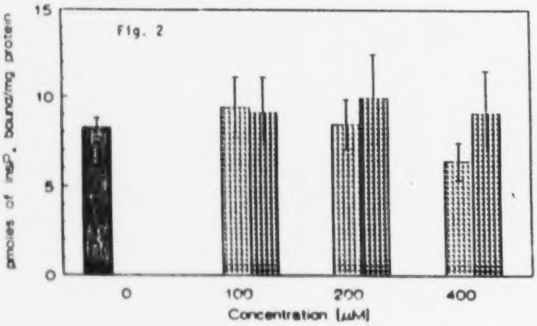

Fig. 2: *In vitro* effects of Tl^{+} and Tl^{3+} on ^3H-$InsP_4$ binding in cerebellum of rat. Each value is mean ± SEM of 6 samples (each assayed in triplicate).

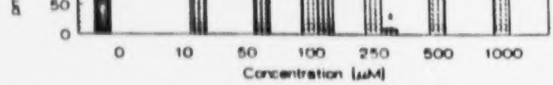

Fig. 3: *In vitro* effects of Tl^{+} and Tl^{3+} on NOS activity in cerebellum of rat. Each value is mean ± SEM of 6 samples (each assayed in triplicate). * indicates statistically ($P<0.05$) significant when compared with control.

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concentration-dependent manner. Pre-incubation of cerebellar NOS with 0.1-1.0 mM of Tl^+ significantly decreased the specific activity in a concentration-dependent manner (Fig. 3). Maximum inhibition of NOS activity was observed at 1.0 mM. The calculated IC_{50} for Tl^+ was 700 μM. No further significant inhibition was observed at greater than 1.0 mM Tl^+. Similar inhibition of NOS activity was observed when pre-incubated with micromolar (10-250 μM) concen-trations of Tl^{3+}. The calculated IC_{50} for Tl^{3+} was 70 μM . These data suggest that NOS was more sensitive to Tl^{3+} as compared to Tl^+.

Inhibition of ^{3}H-$InsP_3$ binding by Tl^+ suggests slight suppression of $InsP_3$-induced Ca^{2+} release from ER. These results suggest that Tl^+ alters binding of ^{3}H-Inositol poly-phosphates by modulating the conformation of their receptor sites. The described effects of Tl^+ on $InsP_3$ will lead to Ca^{2+} imbalance with in the neurones. It is possible, to speculate that disturbance of intracellular Ca^{2+}-homeostasis due to altered key regulatory steps of PI pathway by Tl^+ may be partially responsible for Tl-related neurotoxicity (12). Lack of Tl effect on ^{3}H-$InsP_4$ binding to receptors on plasma membrane and ER suggests that Ca^{2+} release from $InsP_3$-releasable compartment was unaffected by both Tl^+ and Tl^{3+}. Inhibition of NOS activity could be attributed to Tl^+-inhibition of Ca^{2+}-influx in brain.The generation of NO is Ca^{2+}-and calmodulin-dependent and inhibition of NOS suggests possible blockade of calmodulin action by Tl.The decreased production of NO due to inactivation of NOS by Tl results in reduced formation of cGMP (18) and inhibition of cGMP-mediated NMDA receptors (15).

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REFERENCES

1. Barrosoi, M. R, Villeda, H. J, Mendez, A. M, Rios, C. and Monroy, N. A. Combined D-penicillamine and prussian blue as antidotal treatment against thallotoxicosis in rats: evaluation of cerebellar lesions. Toxicology 89(1): 15-24 (1994).

2. Challiss, R. A. J, Willicocks, A. L, Mulloy, B, Potter, B. V. L. and Nahorski, S. R. Characterization of inositol 1,4,5-trisphosphate and inositol 1,3,4,5-tetrakisphosphate binding sites in rat cerebellum. Biochemical Journal 274: 861-867 (1991).

3. Cavanagh, J. B. What have we learnt from Graham Frederick Young? Reflections on the mechanism of thallium neurotoxicity. Neuropathology and Applied Neurobiology 17(1): 3-9 (1991).

4. Csicsakym, M, Wiegand, H, Uhlig, S, Lohmann, H. and Papadopoulos, R. Miniature endplate potentials as a toll in neurotoxicology. Toxicology 49(1): 121-129 (1988).

5. Hibbs, J. B. Jr., Taintor, R. R, Vavrin, Z. and Rachlin, E. M. Nitric oxide: A cytotoxic activated macrophage effector molecule. Biochemical and Biophysical Research Communications 157(1): 87-94 (1988).

6. Ignarro, L. J. Signal transduction mechanism involving nitric oxide. Biochemical Pharmacology 41(4): 485-490 (1990).

7. Inturrissi, C. E. Thallium activation of K^+-activated phosphatase from beef brain. Biochim et Biophysica Acta 173: 567-569 (1969).

8. Knowles, R. G, Palacios, M, Palmer, R. M. J. and Moncada, S. Formation of nitric oxide from L-arginine in the central nervous system: a transduction mechanism for stimulation of the soluble guanylate cyclase. Proceedings of National Academy of Sciences USA 86: 5159-5162 (1989).

9. Lowry, O. H, Rosebrough, N. J, Farr, A. L. and Randall, R. J. Protein measurement with the Folin phenol reagent. Journal of Biological Chemistry 193: 265-275 (1951).

10. Marsden, P. A. and Ballerman, B. J. Tumor necrosis factor alpha activates soluble guanylate cyclase in bovine glomerular mesangial cells via an L-arginine- dependent mechanism. Journal of Experimental Medicine 172(6): 1843-1852 (1990).

11. Matsumoto T, Pollock, J. S, Nakane, M. and Forstermann, U. Developmental changes of cytosolic and particulate nitric oxide synthase in rat brain. Developmental Brain Research 73(2): 199-203 (1993).

12. Mulkey, J. P. and Oehme, F. W. A review of thallium toxicity. Veterinary and Human Toxicology 35(5): 445-453 (1993).

13. Palmer, R. M. J, Ferrige, A. G. and Moncada, S. Nitric oxide release accounts for the biological activity of endothelin-activated relaxing factor. Nature 327(6122): 524-526 (1987).

14. Skulskii, I. A, Manninen, V. and Jarnefelt, J. Interaction of thallous ions with the cation transport mechanism in erythrocytes. Biochim et Biophysica Acta 298: 702-709 (1973).

15. Snell, L. D, Jones, S. M. and Johnson, K. M. Inhibition of N-methyl-D-aspartate-induced hippocampal $[^3H]$norepinephrine release by phencyclidine is dependent on potassium concentration. Neuroscience Letters 78(3): 333-337 (1987).

16. Theibert, A. B, Suppattone, S, Worley, P. F, Baraban, J. M, Meek, J. L. and Snyder, S. H. Demonstration of inositol 1,3,4,5-tetrakisphosphate receptor decreases its release of calcium. Biochemical and Biophysical Research Communications 148: 1283-1289 (1987).

17. Worley, P. F, Baraban, J. M, Supattapone, S, Wilson, V. S. and Snyder, S. H. Characterization of inositol trisphosphate receptor binding in brain. Regulation by pH and calcium. Journal of Biological Chemistry 262(25): 12132-12136 (1987).

18. Wroblewski, J. T, Nicoletti, F, Fadda, E. and Costa, E. Phencyclidine is a negative allosteric modulator of signal transduction at two subclasses of excitatory aminoacid receptors. Proceedings of National Academy of Sciences USA 84(14): 5068-5072 (1987).

19. Zitko, P. T. Toxicity and pollution of thallium. The Science of the Total Environment 4: 185-192 (1975).

Initiation of Expression and Cell-Specific Localization of Nitric Oxide Synthase (NOS) in Pre-Implantation Mouse Uterus

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Nitric Oxide (NO) is a gaseous free radical that causes smooth muscle relaxation and increases capillary permeability. Nitric Oxide Synthase (NOS) is the enzyme that catalyzes the conversion of L-arginine to NO and L-citrulline. Three isoforms of this enzyme have been identified. Previous studies have shown NO is produced by the uterus during pregnancy. The purpose of this experiment was to determine the pattern of localization of the endothelial isoform of NOS (eNOS) during the pre-implantation period, Days 1 through 4 of pregnancy, and in delayed-implanting uteri before and 1 hour after exposure to estrogen. Although this study was not quantitative, the results indicate that uterine localization of eNOS is highest on Day 1 of pregnancy in the epithelial cells and decreases over time and that exposure to estrogen around the time of implantation induces a change in the pattern of expression.

BACKGROUND

Nitric oxide (NO) is a gaseous free radical that interacts with cells and produces a wide variety of responses (1). It has been shown NO modulates inflammatory responses, causes smooth muscle relaxation, vasodilation, and may increase vascular permeability (2).

The enzyme nitric oxide synthase (NOS) converts the amino-acid L-arginine to NO and L-citrulline. NOS has three different isoforms, each named after the region in which it was first discovered. Endothelial NOS (eNOS) was first found in endothelial cells. Inducible NOS (iNOS) was first found in activated macrophages. Brain NOS (bNOS) was first found in the central nervous system. The presence of NOS indicates nitric oxide production (2).

The eNOS and bNOS isoforms are both regulated by intracellular calcium levels via calmodulin activation and are produced constitutively, i.e. they are expressed at low levels at all times. On the other hand, iNOS, due to its higher affinity for calmodulin even when calcium levels are low, produces NO in large and continuous quantities until L-arginine levels become limiting (1).

Several days after fertilization occurs, implantation takes place. Implantation is the process by which a blastocyst attaches and penetrates the epithelial lining of the uterus. This is initiated on the evening of Day 4 of pregnancy in the mouse. The processes involved in initiation of embryo implantation in the uterus are very similar to those involved in tissue inflammation. Implantation requires increased capillary permeability at the site where the embryo first attaches to the uterus. It also requires the muscles of the uterus to remain relaxed to prevent expulsion of the embryo.

Previous studies in our lab have shown that pre-implantation uterine tissues (Days1-4) in culture produce NO. The levels are highest on Day 1 of pregnancy. In addition, in ovariectomized animals 1 hour after exposure to estrogen the production of NO increases over 3 fold. Previous work has shown that the eNOS isoform is present in the post -implantation uteri. In the stroma cells and in decidual cells of the endometrium in Days 5 ,7 and in the myometrium on Day 11. In addition the longitudinal smooth muscles stained positively on all three days (5, 7, 11).

The goals of this study were to determine if the endothelial isomer of NOS is present on Days 1 to 4 and in ovariectomized-delayed implanting mice before and after estrogen exposure, and in what cell types eNOS is produced. The eNOS isomer was used for the following reasons 1) Previous experiments in our lab indicate that pre-implantation uteri in culture consititutively produce NO. 2) Successful implantation requires increased capillary permeability at the site of blastocyst attachment. eNOS has been shown to increase capillary permeability (2).

METHODS AND MATERIALS

Animals - Adult female, CD-I strain, mice (20- 25g), Charles River Laboratories, Raleigh, North Carolina) were mated with males of the same strain to produce pregnancy. The presence of a vaginal plug indicates Day 1 of pregnancy.

For the induction of delayed implantation, female mice were ovariectomized early (before 10:30am) on the fourth day of pregnancy. They received progesterone (2mg/0.1 ml/mouse/day) for four days. On the fourth day of progesterone they received a single injection of E_2 (100ng/0.1 ml corn oil, St. Louis Mo, Sigma Chemical Co.) Animals were sacrificed and uteri were removed, on each day of pregnancy between 12-1pm, and prior to and one hour after estrogen treatment in delayed implanting mice.

Slide Preparation: Slides were acid-washed (100g dichromate, 1L water, 200 ml concentrated sulfuric acid), coated with Poly-L-lysine (25mg/500ml PBS) for 10 minutes, air dried and stored at 4°C.

Immunocytochemical localization of eNOS: Mouse uteri isolated on Days 1 through 4 and from delayed implanting mice were flash frozen in liquid nitrogen. In addition, heart and liver tissues were isolated and flash frozen from non-pregnant animals. The uterine tissues were sectioned (8 microns), immediately formalin fixed for 10 minutes and stored at 4°C. Immunocytochemistry was performed using the Zymed Histostain-SP kit (Zymed Laboratories Inc.; South San Francisco, CA; TABLE 1).

In brief, slides were incubated with primary antibody (rabbit polyclonal anti- mouse eNOS; Affinity Bioreagents ; Golden , CO), biotinylated secondary and then AEC substrate/chromogen mixture was applied. Positive staining is indicated by a red color. The slides were counterstained with hematoxylin. Negative controls where no primary antibody was added were run in parallel. Heart muscles was stained as a positive control. In addition, endothelial cells within uterine sections were utilized as an internal positive control. Sections from the small intestine were used as a mucous epithelial cell negative control.

RESULTS

All uterine sections examined showed the presence of eNOS in the endothelial cells. All the uterine sections examined from Days 1, 2, 3 and 4 of pregnancy stained for the presence of eNOS. However, the intensity and localization of staining varied. Days 1, 2 and 3 of pregnancy stained specifically in the epithelial cells of the lumen with some glandular staining (Figure 1 A, B, C). eNOS was not seen in the stromal or muscle layers on any of these days. The intensity of staining on Day 1 of pregnancy appeared to progressively decrease through Day 3 (Figure 1 C). However on Day 4 of pregnancy some animals exhibited different patterns of expression which included no staining, eNOS localization similiar to that seen on Day 1, or in the longitudinal smooth muscle and stroma (Figure 1 D & 1 E). In the delayed-implanting uteri at one hour after estrogen treatment there was some smooth muscle, glandular epithelial and stromal (primarily antimesometrial) staining also seen (Figure 2 A). Those delayed-implanting uteri that were not exposed to estrogen had only a little epithelial staining (Figure 2 B).

Sections obtained from the heart showed staining only in the endothelial cells lining the blood vessels and ventricles (Figure 2 C). This tissue was used as a positive control because eNOS is known to be produced in endothelial cells. As a negative control, tissue sections were obtained from the small intestine. No staining in the luminal epithelial cells was seen confirming that the eNOS antibody does not bind to mucosal epithelial cells non-specifically (Figure 2 D).

DISCUSSION

The results of this study indicate that eNOS is present in the uterus on all four days of pregnancy and in delayed-implanting animals. On Day 1 the expression of eNOS was seen in the epithelial cells especially of the lumen. On Day 2 & 3 similar patterns, albeit at lower intensities, were seen. On Day 4

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some animals showed a pattern like Day 3 while others showed some smooth muscle staining. In the delayed-implanting mice after estrogen exposure the pattern of expression of eNOS increased and expanded to include stromal cells and longitudinal smooth muscle.

From these data it can be concluded that estrogen has an effect on the pattern of eNOS expression. A pre-ovulatory estrogen surge occurs on the evening of proestrus, before Day 1 of pregnancy (4-7). It is probable that this estrogen secretion induces the expression of the eNOS in uterine epithelial cells seen on Day 1 pregnancy. Uterine sections taken from Days 2 & 3 showed a lower intensity of staining than that seen in Day 1. This may be due to the decline in plasma estrogen levels from the peak at proestrus. On Day 4 of pregnancy the pattern varies with some animals having little to no staining of the lumenal epithelial cells while others show longitudinal smooth muscle and glandular staining. This change in expression may be caused by increasing progesterone levels superimposed upon by pre-implantation estrogen secretion (3). The pre-implantation estrogen surge occurs on Day 4 around noon and induces implantation. Uteri were obtained from Day 4 animals between noon and 1pm making it likely that some animals had already been exposed to the preimplantation estrogen surge while other had not. Therefore, the variation in expression may be due to the variation in timing of the estrogen secretion from mouse to mouse.

This conclusion is supported by data obtained from delayed- implanting mice. In delayed-implanting animals 1 hour after estrogen exposure, longitudninal smooth muscle and glandular staining was seen. Those animals not exposed to estrogen had only small amounts of eNOS staining. These data also correlate with previous work from our lab. In culture, estrogen increases production of NO in the delayed implanting uterus (8). During post-implantation period uterine tissues from Days 5, 7 and 11 of pregnancy stain positively for the presence of eNOS in the longitudinal smooth muscles. Thus, uteri previously exposed to four days of progesterone respond to estrogen by expressing eNOS in the longitudinal smooth muscle.

In conclusion these data supports previous work done in our lab which shows that nitrite production in uterine culture is high on day 1, declines on days 2, 3, and 4 and then following exposure to estrogen, increases. It appears that pre-implantation estrogen increases eNOS expression in uterine epithelial cells while the implantation-inducing estrogen surge causes stromal, glandular and longitudinal smooth muscle expression. This changing eNOS expression pattern responsible for the changing pattern of NO production. However, there are other isoforms of NOS and their expression patterns must still be determined.

Studies using animals that lack only one isoform of the eNOS enzyme have no fertility problems. Therefore, it seems likely that although eNOS is present in the preimplanting uterus, it is possible that other isoforms of NOS are present and are regulated by estrogen. However, since there is a distinct pattern of eNOS expression that changes in response to the estrogen surge that also induces implantation, it is probable that NO production is a regulator of early pregnancy.

REFERENCES

1. Gross, Steven S., and Wolin Michael S., Annual Reviews of Physiology. Nitric Oxide: pathophysiological mechanisms. Vol. 57, 1995. pg. 737.
2. Mocada,S., Palmer, R. and Higgs, E. Pharmacologial Reviews. Nitric Oxide: physiology, pathophysiology, and pharmacology. Vol. 43, 1991 pg 109.
3. Griffin, J. and Ojeda, S. Textbook of Endocrine Physiology. 2nd ed., (1992) Oxford University Press, New York, pg. 192.
4. Finn, C.A., and Martin, L. Journal of Endocrinology. Patterns of cell division in the mouse uterus during early pregnancy. Vol. 39, 1967 pg. 593.
5. Martin L., and Finn C.A. Journal of Endocrinology. Hormonal regulation of cell division in epithelial and connective tissues of mouse uterus. J Endocrinol Vol. 41, 1968 pg. 363.
6. Psychoyos, A. "Endocrine control of egg implantation". Handbook of Physiology. (1973) American Physiological Society, Washington, DC, pp 187.
7. Finn, C.A., and Martin, L. Journal of Endocrinology. The role of the oestrogen secreted before oestrus in the preparation of the uterus for implantation in the mouse. Vol. 47, 1970 pg. 431.

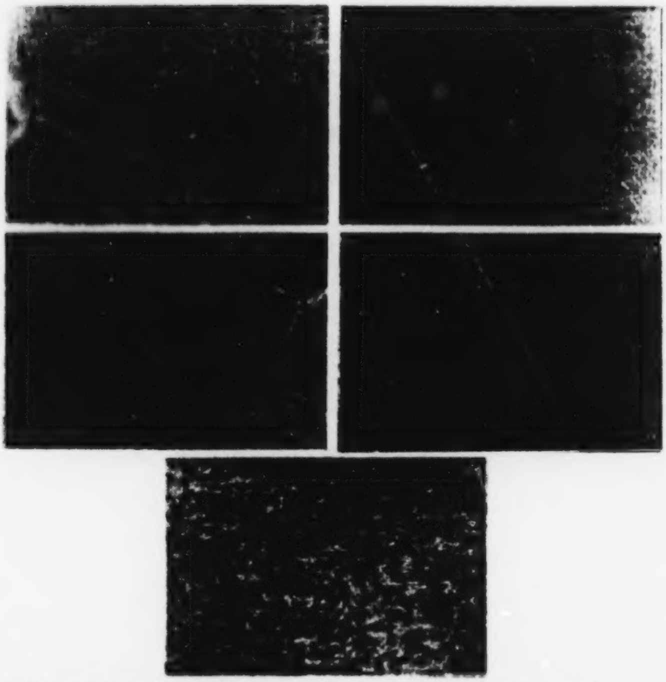

FIGURE 1 Immunocytochemical Localization of eNOS in pre-implantation mouse uterus. 20X. Expression of eNOS indicated by red staining. A) Day 1; B) Day 2; C) Day 3 D) Day 4. EP = epithelium; LSM = longitudinal smooth muscle.

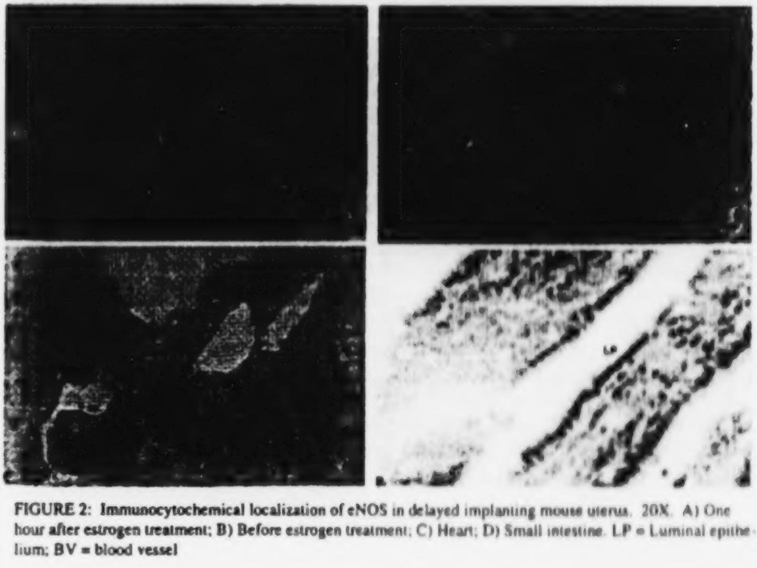

FIGURE 2: Immunocytochemical localization of eNOS in delayed implanting mouse uterus. 20X. A) One hour after estrogen treatment; B) Before estrogen treatment; C) Heart; D) Small intestine. LP = Luminal epithelium; BV = blood vessel

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Characterization of Urethral Blockage in a New Mutant Diabetic/Obese Mouse

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ABSTRACT

Diabetes has a significant impact not only on the health of the individual affected, but also on the health care system of the United States. During recent years diabetes and obesity have increased at an alarming rate; 5% of the nation's population is currently affected and this number is increasing at a rate of 6% annually. Type I diabetics experience a variety of symptoms ranging from early onset of disease, polyuria, glycosuria, and most significantly hyperglycemia from the inadequate production of insulin by the beta cells of the pancreas. In a colony of CD-1 mice at North Carolina State University a new mutation for type I diabetes has been identified. Studies on these mice indicate that there are additional complications associated with this mutation not previously described in the literature. Preliminary histological observation has shown a reduction or disappearance of the beta cells in the Islets of Langerhans and chronic renal disease. Most notable is an obstruction of the urethra resulting in a massive dilation of the bladder, hydronephrosis, and hydroureter. Tests have indicated that this obstruction is the result of a bacterial infection which is responsible for the formation and accumulation of a pyoid substance that partially blocks the urethra. Consequently, the ability to urinate is dramatically decreased in affected mice. Copious amounts of bladder urine were collected from affected mice ranging from 1.0 ml to 2.0 ml in volume. Interestingly, a comparison of two affected mice showed that one was infected with *Escherichia coli* and the other with *Pasturilla multicida*. Histological description of the urethra and bladder from control and affected mice will be presented. The similarities between mouse and human type I diabetes indicate that this mutant mouse might serve as a significant diagnostic model for humans.

BACKGROUND

Diabetes is a chronic disorder of carbohydrate metabolism as a consequence of inadequate production of insulin by the beta cells in the pancreas. The disease is generally characterized by excessive urination and high blood glucose levels. Diabetes occurs in two forms which are type I and type II. In addition to hyperglycemia and polyuria type I diabetes is also characterized as having an early age of onset of disease (prepubescent), normal body weight, and insulin dependency. In comparison, type II diabetes is characterized as being insulin independent, obese, and usually it appears after puberty. An affected family of CD-1 mutant mice show a type I diabetic phenotype and obesity apparently due to a mutation in the gene expressing the leptin receptor. In combination to being obese, affected mice have distended bladders due to a urethral blockage. This characteristic has not yet been described in literature. The urethral blockage is due to an apparent sloughing of the bladder epithelium combined with the presence of bacteria in the urine.

METHODS

- Sterile extraction of bladder urine from control and affected mice.
- Collection of bladder, kidney, and pancreatic tissue from control and affected mice.
- Urine sample was placed on a chocolate agar plate and incubated overnight @ 37 °C. Representative colonies of bacteria were then chosen and identified by through specific biochemical patterns. (*with the assistance of Dr. Paul Orndorff, CVM*)
- Preparation and analysis of histological slides. (*with the assistance of Dr. Richard Miller, CVM*)

RESULTS

Escherichia coli was found in urine samples of two affected mice and Pasturilla multicida was present in the urine samples of four affected mice. Bacteria was notably absent from all control urine samples that were tested. In the pancreas there was a reduction or loss of the beta cells in the Islets of Langerhans of affected mice. Next, the kidneys of affected mice showed tubular dilation, pyelitis, hydronephrosis, and glomerulersclerosis. All affected mice with distended bladders that were examined displayed damage to the bladder wall, cellular sloughing into the bladder lumen, and hyperplasia of the transitional epithelium. Figure 1 illustrates the occurence of bladder enlargment among control and affected mice.

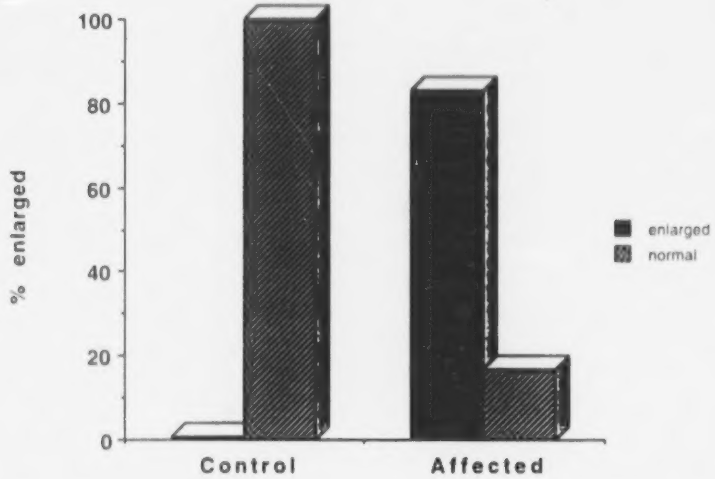

Figure 1: Incidence of Bladder Distention

CONCLUSION

There were several differences between the control mice and the affected mice. No bacteria was present in the bladder urine of control mice, in contrast the bladder urine of affected mice showed lesions of one of two species of bacteria. Next, histological comparison between affected and control mice showed clear lesions in all samples examined from affected mice, but none in control mice. None of the control mice had enlarged bladders, however 83% of the affected mice were afflicted with bladder distention ($p < 0.003$, Fishers Exact test). These results show a significant difference in the occurrence of bladder distention between diabetic/obese mice and normal mice, probably due to a bacterial infection.

REFERENCES

Chen, H., Charlat, O., and Tartaglia, L.A. 1996. "Evidence That the Diabetes Gene Encodes the Leptin Receptor: Identification of a Mutation in the Leptin Receptor Gene in *db/db* Mice", Cell 84:491-495

Chua, S.C. Jr., W.K. Chung, X.S. Wu-Peng, Y. Zhang, S-M. Liu, L. Tartaglia, and R.L. Leibel. 1996. "Phenotypes of Mouse *Diabetes* and rat *Fatty* Due to Mutations in the OB (leptin) Receptor", Science 271:994-996.

Zhang, Y., R Proenca, M. Maffei, M. Barone, L. Leopold, and J.M. Friedman. 1994. " Positional Cloning of the Mouse obese Gene and its Human Homologue", Nature 372:425-432.

One-dimensional and two-dimensional SDS-PAGE of total protein in the fungus *Ustilago maydis*

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Ustilago maydis is a plant-pathogenic fungus that infects corn to complete its life cycle. In order for two compatible strains to mate and infect the plant successfully each strain must have different alleles at two loci *a* and *b*. The *a* locus encodes a pheromone and receptor system which the cells use to locate each other. The *b* locus encodes a DNA-binding regulatory protein involved in the infection cycle. To date there has been no evidence that these loci have any function in vegetatively-growing cells, despite the fact that morphological differences are seen between strains with different alleles of *a* and *b*. In this experiment, cells from each of three strains of *U. maydis* were lysed by a variety of methods: acetone extraction, French Pressure Cell lysis, and mechanical disruption over glass beads. The resulting protein was then precipitated using cold trichloroacetic acid and separated using one-dimensional and two-dimensional SDS-polyacrylamide-gel-electrophoresis. Protein yields were consistently best using the mechanical disruption method. The French Press released some proteins from the cells. There was little or no protein recovered by the acetone extraction method. Although on two-dimensional gels, no obvious differences in proteins were seen between strains, this method of protein extraction makes analysis of patterns of protein synthesis much easier, and will allow for the study of developmentally-regulated proteins.

INTRODUCTION

The common corn smut disease, characterized by galls of teliospores on the meristematic parts of the plant host, is caused by the fungus *Ustilago maydis*. The two compatible laboratory mating strains of the haploid form, designated as FB1 and FB2, reproduce vegetatively by budding. They must mate, however, in order to infect their corn host and reproduce sexually. Mating of the two strains produces a dikaryotic infection filament, a long filament protruding from the mating pair (Banuett and Herskowitz, 1988, Snetselaar, 1993). This filament grows into the stigmas of the corn and ultimately infects the ovaries of the plant.

This organism is well-suited for in vitro study, because cells can be grown easily in the lab. Some mating-type functions can even be induced in vitro by mixing compatible strains in sterile water. The two cells form mating filaments which fuse forming a dikaryon, the first stage in the infection of the plant (Snetselaar, 1993). Most plant pathogens, such as wheat rust, cannot be grown in culture, let alone be induced to display mating behavior.

Mating and infection in the life cycle of *U. maydis* is controlled by two different genetic loci, designated *a* and *b*. The *a* locus has two alleles that encode a pheromone, and a pheromone receptor for the pheromone produced by compatible cells. The *b* locus has many alleles, and encodes a DNA-binding regulatory protein. For mating and infection to occur successfully, each strain must have different alleles at each locus. The FB1 strain has the genotype *a1b1*, while the FB2 has the genotype *a2b2*. Since they differ in the alleles at both loci, they can mate and infect corn successfully. It has been hypothesized that the *a* locus is primarily responsible for mating, while the *b* locus is primarily responsible for pathogenicity (Rowell and DeVay, 1955; Holliday, 1961). Thus, if two strains have the same allele at the *a* locus, no mating will occur between the strains, even if the *b* alleles are different. Similarly, if the *b* alleles of each strain are the same, no infection will occur, even if the *a* alleles are different.

To date, no roles have been established for these two genetic loci in vegetatively-growing cells of *U. maydis*. Wild-type strains and mutants in which the *b* locus has been deleted exhibit some morphological differences during vegetative growth, suggesting that these loci may play other roles in addition to their involvement in mating and infection. There may also be interactions between the products of the *a* and *b* loci and other loci, even in non-mating cells.

These interactions can be observed by analyzing the patterns of protein synthesis. This can be done by one-dimensional SDS-polyacrylamide-gel-electrophoresis (SDS-PAGE), which separates proteins on the basis of molecular weight. To provide further resolution of these proteins, two-dimensional SDS-PAGE can be performed, to separate proteins on the basis of both isoelectric point and molecular weight. The two-dimensional SDS-PAGE provides a more sensitive approach to separating proteins, as one thick band on a one-dimensional gel may in fact be several different proteins of similar molecular weight. Also, proteins produced in smaller amounts may be obscured on the one-dimensional SDS-PAGE, leaving only the proteins produced in larger amounts, such as structural proteins, visible. Since the different strains of *U. maydis* are expected to have the same structural proteins, there should be little difference on the one-dimensional gels. The two-dimensional gels, however, could yield much more information on the differences in proteins between these strains.

One problem that *U. maydis* presents is that protein extraction cannot be done by direct trichloroacetic acid (TCA) precipitation as is done with other types of cells, due to the thickness of the cell walls. Instead, the cells must be lysed mechanically, or by sudden pressure changes, as in a French Pressure Cell. This study has focused on the optimization of these disruption techniques to isolate total protein from *U. maydis* for subsequent analysis by one- and two-dimensional SDS-PAGE.

MATERIALS AND METHODS

Strains used and culture conditions

The laboratory strains FB1 and FB2 were used, as well as an FB2 mating-factor mutant (*mfa2*). This mutant strain does not produce pheromone due to deletion of the pheromone-encoding gene *mfa2*. Cell cultures were routinely grown on Difco potato-dextrose agar (PDA) plates for at least 48 hours before use. A flask containing 15ml of potato-dextrose broth (PDB) was aseptically inoculated with the appropriate strain of *U. maydis*, and allowed to grow at 28 degrees C with shaking at 150 rpm. After approximately 18 hours, one ml of this culture was used to inoculate 200ml PDB. This culture was then grown as described above for 24 hours. The cells were harvested by centrifugation at 1500 x g for 3 minutes, and resuspended in lysis buffer (1mM Tris, 0.1mM magnesium chloride) in one-tenth of the original volume.

Acetone extraction

Centrifuged cells were resuspended in ice-cold incubation buffer (90% acetone, 10% TCA, 0.07% Beta-mercaptoethanol) and incubated at -20 degrees C for 2 hours. They were then centrifuged for 15 minutes at 33,000 x g, and the supernatant was discarded. The cells were then washed twice with ice-cold acetone wash buffer (100% acetone, 0.07% Beta-mercaptoethanol) by incubating the cells for 30 minutes at -20 degrees C in the acetone buffer, centrifuging the solution at 1500 x g for 3 minutes, and discarding the supernatant. The resulting pellet was then air-dried in a vacuum-dessicator, and was weighed. Forty microliters of one-dimensional sample buffer (see below) were added per milligram of pellet. The solution was then centrifuged at 14,000 x g for five minutes to remove any debris. The supernatant was then run on a one-dimensional gel.

French Pressure Cell lysis

Cells in lysis buffer were subjected to a force of approximately 20,000 psi in the French Pressure Cell. Pressate was collected dropwise over ice. Typically, 20ml of cells in buffer would yield about 12ml of usable pressate. The pressate was then prepared for electrophoresis as described below.

Disruption by glass beads

About 500uL of cells in lysis buffer were added to an equal volume of glass beads in a screw-cap microfuge tube. The tube was then vibrated for three minutes in a Braun tissue disrupter (model #853303). The lysate was decanted from the beads into a clean tube. The beads were then washed with an equal volume of lysis buffer, and the wash was pooled with the lysate. The lysate was then processed as described below for either one-dimensional or two-dimensional SDS-PAGE.

Protein isolation

The lysate produced by either French Pressure Cell lysis or disruption by glass beads was collected and centrifuged at 27,000 x g for 10 minutes to remove unbroken cells and cellular debris. Proteins were then precipitated by mixing the lysate with two volumes of cold 50% TCA and centrifuging at 27,000 x g for 6 minutes. Pellets were then washed with cold 10% and cold 5% TCA, and then delipidated with ice-cold acetone. Pellets were allowed to air-dry, and were resuspended in the appropriate gel sample buffer. Proteins were then separated by either one-dimensional or two-dimensional SDS-PAGE.

One- and two-dimensional SDS-PAGE

Cellular proteins were prepared for one-dimensional SDS-PAGE by resuspending in Biorad sample buffer, heating at 50 degrees C for 2 minutes, centrifuging at 27,000 x g for 2 minutes to remove debris, and heating for 5 minutes at 90 degrees C.

Proteins were prepared for two-dimensional SDS-PAGE by resuspending in isoelectric focusing sample buffer. Samples were then loaded onto an isoelectric-focusing tube gel, and separated for 15 hours at 400V, followed by one hour at 1000V. The tube gels were then equilibrated with SDS-PAGE sample buffer and placed onto the second-dimension gels, where they were run for one hour at 125V, and then for 15 hours at 50 milliamps (O'Farrell, 1975).

All one-dimensional and two-dimensional gels were stained with Coomassie R-250 for two hours, and then destained (40% methanol, 10% acetic acid).

RESULTS

Pressate from the French Pressure Cell method and lysate from the disruption method were both centrifuged to remove debris and unbroken cells, yielding a viscous pellet, which was discarded. Addition of 50% TCA yielded another pellet, which was kept and washed. It was assumed that this second pellet was a mixture of chromosomal DNA and proteins.

Microscopic observation by Differential Interference Contrast (DIC) of cell suspensions after use of the French Pressure Cell indicated partial or complete cell lysis of a majority of cells. Many cell ghosts were seen and the number of intact cells was very low. Most cells appeared vacuolate after this treatment.

Comparison of the protein yields using the French Pressure Cell method or the acetone extraction method can be seen in Figure 1. The acetone extraction method resulted in a few, very faint bands on the one-dimensional gels. Processed pressate from the French Pressure Cell method using a comparable number of cells was run on the same gel. Numerous bands are clearly visible (Fig. 1).

Disruption by glass beads was compared with the French Pressure Cell method. The disruption method resulted in many more bands than the French Pressure Cell method (Fig. 2). DIC microscopy of the cell suspension at thirty-second intervals

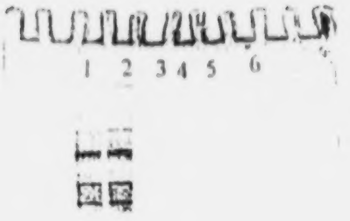


Fig 1 - One-dimensional SDS-PAGE of proteins isolated by French Press or acetone extraction. Proteins were isolated from FB2 cells using either the French Press or the acetone extraction method. Isolated proteins were separated using a 10% SDS-PAGE gel. Lanes 1 and 2 contain proteins isolated from these cells using the French Press. Lanes 3 through 6 contain proteins isolated from a comparable number of cells using the acetone extraction method.

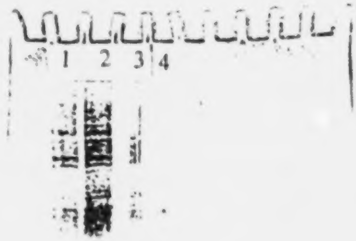


Fig 2 - One-dimensional SDS-PAGE of proteins isolated by French Press or tissue disrupter. Proteins were isolated from FB2 cells using either the French Press or the tissue disrupter and glass beads. Isolated proteins were separated as in Fig. 1. Lanes 1 and 2 contain proteins isolated using the tissue disrupter. Lanes 3 and 4 contain proteins isolated from a comparable number of cells using the French Press.

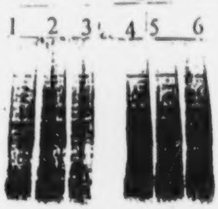
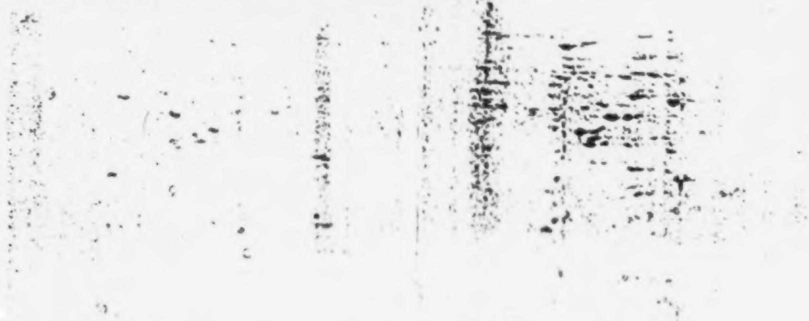


Fig 3 - One-dimensional SDS-PAGE of proteins isolated from FB1 and FB2 cells using the tissue disrupter. Proteins were isolated from comparable numbers of FB1 (lanes 4 - 6) and FB2 (lanes 1 - 3) cells using the tissue disrupter and glass beads. Isolated proteins were separated as in Fig. 1. Note the very similar yield obtained from both cell types. No differences in the number or relative intensity of any bands were detected between the two strains.



Figs. 4 and 5 - Two-dimensional gels of proteins isolated from cells of the mfa2 strain. The isoelectric focusing dimension is from left to right; the molecular weight separation is from top to bottom. Protein from approximately 3X as many cells was used in the gel in Fig. 4 compared to the gel in Fig. 5. Many spots of differing molecular weight and isoelectric point are evident. Note that the two gels are inverted relative to each other with respect to their isoelectric focusing dimensions.

showed that partial or complete disruption of cells occurred quickly. There was nearly complete disruption of all cells after three minutes of treatment. Disruption performed for longer than three minutes yielded little increase in the number of lysed cells (data not shown). Figure 3 shows the typical one-dimensional gel of proteins from cells lysed by this method.

Two-dimensional SDS-PAGE of proteins isolated from cells of *U. maydis* using the tissue disrupter produced a number of spots (Figs. 4 and 5). No differences in the total protein patterns were detected between the strains analyzed (data not shown).

DISCUSSION

Disrupting the cells using glass beads gave better yield of protein than either the French Pressure Cell or acetone extraction, even though these methods have been reported to work with other fungi. The amount of staining seen in disruption-extracted proteins, when compared to the French Pressure Cell method, was far greater. It also appears that the French Pressure Cell, although giving reproducible results, and certainly much more protein than the acetone extraction, did not release the same amount of proteins that the Braun tissue disruption method did. Numerous bands can be seen on the gels of disruption-extracted proteins, indicating the presence of different-sized proteins that the French Pressure Cell and acetone extraction methods did not efficiently extract in this experiment. Therefore, the tissue disruption method was chosen to isolate proteins for two-dimensional SDS-PAGE.

Thus far, two-dimensional SDS-PAGE of these proteins has only been used to visualize the total proteins present in the cells. It may be possible to use this technique to look for differences in protein content between different strains, as well as differences between mating and non-mating cells. Presumably, cells with morphological differences may have some differences in their patterns of protein expression.

This method can also be used to lyse cells whose proteins have been radiolabeled with a radioactive amino acid. This will be useful in the analysis of patterns of protein synthesis during the developmental cycle, and in a characterization of mutants in either the *a* or *b* locus. Labeling these cells with radioactive methionine has been tried, with moderate incorporation obtained thus far. Unfortunately, the levels of activity detected after labeling were insufficient for electrophoresis, but it is hoped that some progress can be made by altering the conditions of the labeling. This method of tissue disruption is preferred over the French Pressure Cell lysis method, not only due to apparently higher yield, but because the radioactive isotope is not aerosolized in this method, as it can be in the French Pressure Cell. Future directions for this experiment include a labeling of developmentally-regulated proteins using this method, and a characterization of different mutants.

LITERATURE CITED

1. Banuett, F. and Herskowitz, I. Genetics of Phytopathogenic Fungi. Vol.6, 1988, p.427-455.
2. Holliday, R. Genetics Research. Vol.2, 1961, p.204-230.
3. O'Farrell, P.H. Journal of Biological Chemistry. High resolution two-dimensional gel electrophoresis of proteins. Vol.250, 1975, p.4007-4021.
4. Rowell, J.B. and DeVay, J.E. Phytopathology. Vol.44, 1954, p.356-362.
5. Snetselaar, Karen. Experimental Mycology. Microscopic Observation of *Ustilago maydis* Mating Interactions. Vol.17, 1993, p.345-355.

1332

Regulation of superoxide dismutase synthesis in *Candida albicans*.

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ABSTRACT

The synthesis of superoxide dismutase (SOD: EC 1.15.1.1) in response to various cultural conditions was examined in *Candida albicans*, an opportunistic yeast which causes candidiasis in immunosuppressed patients. SOD plays an important role in protecting cells from the oxidative damage of superoxide radicals. Maximum SOD activity was found after 72 hrs of growth. The optimum pH and temperature for the SOD activity were 7 and 40°C, respectively. The major SOD activity was found in the cytosol fraction and the level of extracellular SOD was very low. The enzyme was stimulated to varying degrees by cholic acid, procaine and tocopherol. On the basis of inhibitor studies and other enzyme properties, the isolated enzyme from *C. albicans* is identified as copper and zinc superoxide dismutase.

INTRODUCTION

Superoxide dismutase (SOD; EC1.15.1.1) is found in most aerobic and many anaerobic organisms and is used to catalyze the superoxide radical, O^{-2}, to produce dioxygen and hydrogen peroxide $(2O_2^{-}+2H^{+}\text{->}O_2+H_2O_2)$ hence SOD plays a key role in protecting cells from the superoxide ion toxicity (18) which oxidizes membrane fatty acids and proteins and damage DNA (10). The concentration of SODs in an organism is dependent on the amount of oxygen exposure by the organism and its sensitivity to exposure to oxygen (2). SOD is a metallo-enzyme with a molecular weight range of 16 kDa to 26 kDa that is classified into three groups: copper-zinc, manganese, and iron (18).

Copper-zinc superoxide dismutase is mostly found only in eukaryotes in the mitochondrial inner membrane, cytoplasm, or chloroplasts, (9) but CuZnSOD has also been found in the prokaryotic symbiotic marine bacterium *Photobacterium leignathi* (19). CuZnSOD is a homodimer with a molecular weight of approximately 32 kDa with one subunit of copper and one of zinc (3). The zinc atom organizes the active site structure while also structuring the catalytic center. The copper atom work to reduce and oxidize the O_2 (19). MnSOD is found primarily in the mitochondrial matrix of prokaryotes (3) and eukaryotes (19) while FeSOD is found only in prokaryotes (3). MnSOD and FeSOD are usually dimers or tetramers composed of identical subunits (17). Structurally, MnSOD and FeSOD are very similar while CuZnSOD's structure is very different (18). The activity of SOD in response to temperature and pH and presence of oxygen has been studied in various species. In porcine Cu-Zn SOD (15), the catalytic activity was shown to be pH independent in the range of pH 5-9 but reversibly decreases at about pH 10. Enzyme activity was shown to drop linearly by increasing pH from 7.5 to 12. However in bovine enzyme, the activity decreased above pH 9.0 (1). The Cu-Zn SOD from vertebrate, fungi and plants was not affected by high temperatures (70°C) or by exposure to chloroform and ethanol. Elevated temperatures (42°C) induced FeSOD but not MnSOD in *E. coli* (8). In *E. coli* , cells grown on glucose as a sole source of carbon was found to contain lower amounts of SOD than cells grown on succinate, lactate or trypticase peptone medium (6). SOD activity is inhibited and stimulated by many substances. CuZnSOD is inhibited by cyanide and FeSOD is inhibited by peroxide while MnSOD is not affected by either of these but by ethanol in *Streptococcus suis* (11). In anaerobic *E. coli*, nitrate stimulated FeSOD activity at elevated temperatures while MnSOD was not affected (8). In *Saccharomyces cerevisiae*, CuZnSOD activity increased in the presence of copper while it is slightly inhibited by cadmium (16). Additionally, methanol induced SOD activity in methylotrophic yeasts (14).

It is well known that *Candida albicans* is a dimorphic pathogenic yeast capable of producing yeast (Y) or mycelial (M) forms in response to environmental conditions. The pathogenicity of this organism is linked to its dimorphic behavior. Since the target for SOD has been shown to be a component of immune and inflammatory cell responses, the enzyme has a potential role in the parasite-host interaction to modulate the host cell reactions. Since very little information has been available about SOD in *C. albicans* the present study has been made on its regulation in detail and the results are presented in this communication.

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MATERIALS AND METHODS

Chemicals.

All the chemicals used in this study were reagent grade and purchased from Fisher Scientific, PA. and Sigma Chemicals, MO.

Organism and growth condition.

Candida albicans, (3153A) an opportunistic yeast was grown in Lee synthetic medium (12) as a shake culture in yeast form at 25°C. Cells were harvested by centrifugation and suspended in 50 mM potassium phosphate, pH 7.8 with 1mM EDTA. The cells were ground in pre-chilled mortar with liquid nitrogen. The disrupted cells were centrifuged at 18,000 x g for 20 min at 4°C. Culture filtrates concentrated by ultrafiltration, and cell-free extracts were used to measure the intracellular and extracellular SOD activities, respectively.

Superoxide dismutase assay.

SOD activity was determined spectrophotometrically at 560 nm by measuring the superoxide generated by xanthine-xanthine oxidase reaction and the rate of reduction by nitro blue tetrazolium (NBT). One unit of SOD activity is defined as the amount that causes 50% inhibition of the reduction of cytochrome C (13). Protein content of the extract was estimated by the method of Bradford (4).

Effect of carbon and nitrogen sources on growth and SOD activity

By growing *C. albicans* in Lee medium at pH 4.5 at 25°C, the effect of the carbon source on SOD activity was determined by substituting the carbon source on equimolar basis for glucose, with sucrose, lactose, and N-acetyl glucosamine individually. Similarly, the effect of the nitrogen source was also measured by substituting the nitrogen source for ammonium sulfate, with glutamate, arginine, glutamine, ornithine, or homoarginine. In the control, glucose and ammonium sulfate were used as carbon and nitrogen sources, respectively.

Effect of oxygen (aeration) on yeast growth and SOD activity

The effect of aeration on the growth of *C. albicans* was determined by growing yeast cells in Lee medium at 25°C at different volumes of media (15 ml, 25 ml, 50 ml, 100 ml, and 150 ml) in 250 ml Erlenmeyer flasks under stationary and shaking conditions.

Identification of SOD Type

To identify the type of SOD present in *C. albicans*, we measured the SOD activity in the presence of KCN, H_20_2, and NaN_2 at 1 and 10 mM concentrations.

Changes in SOD levels in yeast and pseudohyphal phases

The growth and intracellular activities of SOD in *C. albicans* in yeast phase were measured at 24 hour intervals for 120 hours at 25°C and in pseudohyphal phase at 37°C over a period of 12, 24, 36, and 48 hours. To measure the extracellular SOD activity the culture (spent) media was concentrated by ultrafiltration and used as enzyme source.

Effects of oxidants and antioxidants on SOD activity

The effects of various compounds such as glutathione, cholic acid, procaine, and tocopherol on SOD activity were determined by preincubating the enzyme with compounds in the reaction mixture. Their effect were measured on the enzyme activity by comparing with the control. Data was collected and the average of three trials is shown in the tables and figures.

RESULTS AND DISCUSSION

The enzyme isolated from the cell free extracts of *C. albicans* was identified as copper-zinc containing superoxide dismutase which was remarkably similar and distinguishable by only minor differences from the Cu-Zn SOD enzymes isolated from other organisms (3, 18, 19). Most of the SOD activity was detected from the cell free (soluble) extract and very little extracellular enzyme activity (<2% of total activity) from the culture media. The study on the influence of carbon source is shown in Figure 1 and reveals that the culture grown in glucose showed the greatest SOD activity. The culture grown in lactose media supported the most yeast growth but least support for SOD synthesis. Glutamate was found to the best nitrogen source for both the growth and enzyme production, but at the same time, the same generalization cannot be made for the rest of the tested nitrogen sources in that some of the other sources such as arginine and ornithine had more yeast growth but has less enzyme activity than glutamine (Fig. 2). To determine the optimum pH for *Candida* Cu-Zn SOD, enzyme was incubated in various buffers ranging from pH 4 to 10 in the reaction mixture for 10 min at 40 C. The optimum pH for the maximum enzyme activity was found at 7 which is very similar to other yeasts (15,16).

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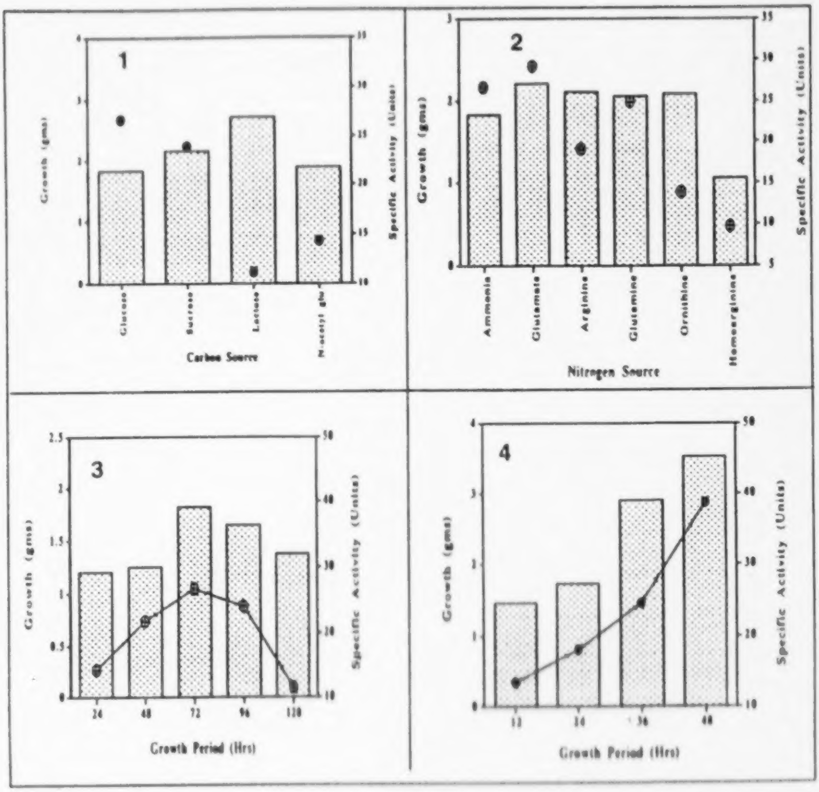

FIGURES: 1-4. Effect of carbon (1) and nitrogen (2) sources on SOD synthesis in *Candida albicans*. Changes in SOD activity during yeast (3) and mycelial growth (4).
▨ = Growth ; ⊕ = Specific Activity in units

Table 1. Effect of aeration on superoxide dismutase activity in *C.albicans*.

Media Volume (ml)	Culture	Specific Activity (Units/mg protein)
15 ml	Shake	22.25
15 ml	Stationary	25.96
25 ml	Shake	25.18
25 ml	Stationary	21.68
50 ml	Shake	26.67
50 ml	Stationary	27.19
100 ml	Shake	25.14
100 ml	Stationary	52.64
150 ml	Shake	37.17
150 ml	Stationary	52.62

Table 2. Effect of inhibitors on superoxide dismutase activity in *C.albicans*.

Chemicals	Concentration (mM)	Specific activity (Units/mg protein)	Relative activity	Percent of Inhibition
Control	0	15.05	100	0
H_2O_2	1	12.46	83	17
H_2O_2	10	2.46	16.4	83.6
KCN	1	0	0	100
KCN	10	0	0	100
NaN_2	1	13.94	92.6	6.4
NaN_2	10	6.92	46	54

Table 3. Effect of oxidants and antioxidants on superoxide dismutase activity in *C.albicans*.

Chemicals	Concentration (mM)	Specific Activity (Units/mg protein)	Percent*
Control	0	26.67	100
Glutathione	1	26.48	99
	10	24.94	94
Cholic acid	1	29.29	110
	10	35.06	131
Procaine	1	24.86	93
	10	30.20	113
Tocopherol	1	31.83	119
	10	34.80	130

* represents the inhibition (<100%) or stimulation (>100%) of SOD activity

The effect of temperature on enzyme activity was determined by preheating the enzyme in the assay mixture for 10 min at temperatures from 25 to 60°C . Maximum activity was found at 40°C whereas only 30% activity remained at 50°C for 10 min. As illustrated in table 1, it is found that as the oxygen content decreases, the SOD activity increases which is concurrent with the behavior of SOD in *Anabaena cylindrica* (5). The study on the influence of various known SOD inhibitors was revealed that potassium cyanide was completely inhibited the SOD activity in *C.albicans* even at 1mM (Table-2). Earlier studies have been proven that only CuZn-SOD is inhibited by cyanide while the other two are not affected (9). Additionally it was shown that the enzyme was also partially inhibited by the peroxide and azide. Similar observations have been made with CuZn-SOD in other organisms (7). In *C. albicans*, addition of glutathione in reaction mixture inhibited the SOD activity whereas cholic acid and tocopherol stimulated the enzyme activity is stimulated (Table-3). No clear conclusions could be made about procaine effect due to the fact that the data were inconsistent.

The changes in yeast growth and SOD activity during the growth period are shown in figure 3. Maximum growth and enzyme activity was observed at 72 hours of growth. In pseudohyphae, the growth and SOD activity (Fig. 4) are increased steadily and reached a maximum at 48 hours.

ACKNOWLEDGMENTS

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REFERENCES

1. Argese, E., Rigo, A., Vigilino, P., Orsega, E., Marmocchi, F., Caco, D. and Rotilo, G. 1984. A study of pH dependance of the activity of Porcine Cu-Zn SOD. Biochim. Biophys. Acta. 787: 205-207.

2. Barkley, K. B. and Gregory, E. M. 1990. Tetrameric Manganese Superoxide Dismutases from Anaerobic *Actinomyces*. Arch. Biochem. Biophys. 280:192-200.

3. Borders, C. L. and Fridovich, I. 1985. A Comparison of the effects of cyanide, hydrogen peroxides and Phenylglyoxal on Eukaryotic and Prokaryotic Cu,Zn superoxide dismutase. Arch. Biochem. Biophys. 241:472-476.

4. Bradford, M. M. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem. 72: 248-254.

5. Caiola, M., Canini, A., Galiazzo, F. and Rotilio, G.1991. Superoxide dismutase in vegetative cells, heterocysts and akinetes of *Anabaena cylindrica* Lemm. FEMS Microbiol. Lett. 80: 161 -166.

6. Hassan, H. M. and Fridovich, I. 1977. Regulation of superoxide dismutase synthesis in *E.coli* : glucose effect. J. Bacteriol. 132: 505-510.

7. Hassan, H. M. and Fridovich, I. 1980. Superoxide dismutase:detoxication of a free radical. Enzymatic Basis of Detoxication 1: 311-332.

8. Hassan, H. M. and Lee, S.F-J. 1989. Effect of temperature and htp Ron biosynthesis of superoxide dismutase in *E.coli*. FEMS Microbiol. Lett. 58: 133-138.

9. Jackson, C. 1978. Subcellular Localization and identification of Superoxide dismutase in the Leaves of higher plants. Eur. J. Biochem. 91:339-344.

10. Kim, J., Lee, W.Y. and Young, J. Y. 1994. Biosynthesis of SOD by Carrot Hairy Roots. Biotech. Letters 16:581-586.

11. Langford, P., Williams, A.E. and Kroll, J. S. 1990. Superoxide dismutases of pathogenic and non-pathogenic *Streptococcus suis* type 2 isolates. FEMS Microbiol. Lett. 77:347 - 350.

12. Lee, K. L., Buckley, H. R. and Campbell, C. C. 1975. An amino acid liquid synthetic medium for the development of mycelial and yeast forms of *Candida albicans*. Sabouridia 13 148-153.

13. McCord, J. M. and Fridovich, I. 1969. Superoxide dismutase. J. Biol. Chem. 244: 6049-6055.

14. Manzano, M. 1992. Interaction among heavy metals and methanol affecing Superoxide dismutase activity in *Saccharomyces cerevisiae*. Comp. Biochem. Physiol. 105C:175-178.

15. Oneill, P., Davies, S., Fielden, E. M., Calabrese, L., Capo, C., Marmocchi, F., Natoli, G. and Rotillo, G. 1988. The effects of pH and various salts upon the activity of a series of superoxide dismutases. Biochem. J. 251: 41-46.

16. Romandini, P. 1992. Effects of copper and cadmium on growth, superoxide dismutase and catalase activities in different yeast strains. Comp. Biochem. Physiol. 103C: 255-262.

17. Sato, S., and Leuan - Harris, J. 1976. Superoxide dismutase from *Thermus aquaticus*. Eur J. Biochem. 73:373-381.

18. Tesfa-Selase, F. and Hay, R. J. 1995. Superoxide dismutase of *Cryptococcus neoformans*: purification and characterization. J. Med. & vet. Mycol. 33: 253-259.

19. Vignais, P. M.1981. Isolation and Characterization of a protein with cyanide-sensitive superoxide dismutase activity from the prokaryote, *Paracoccus denitrificans*. Biochim. Biophys. Acta. 701:305-317.

Antifungal resistance in opportunistic fungi: Isolation and Characterization of Amphotericin B-resistant mutants

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Amphotericin B, which acts on the cytoplasmic membrane of the fungal cell, is the most effective treatment against *Aspergillus* infection. Extensive use of amphotericin B for the management of mycotic infection in recent years has significantly increased the potential for selecting amphotericin B-resistant clinical isolates. To study the possible mechanisms for the emergence of resistance to amphotericin B in *A. fumigatus* amphotericin B-resistant mutants in the laboratory were selected. A total of 18 colonies that grew in the presence of amphotericin B (8 µg/ml and 16 µg/ml) were tested for their susceptibility to amphotericin B, nystatin and various azoles by broth macrodilution technique. Approximately 55% of the isolates showed low level resistance to amphotericin B (MIC = 4 µg/ml) whereas the remaining isolates showed medium level resistance (MIC = 8-16 µg/ml). Subculturing of representative members of the low and medium level resistance groups showed that the resistance trait was stably expressed for several cycles of subculturing. None of the isolate showed cross resistance to other commonly used antifungals. These data suggest that amphotericin B resistant mutants of *A. fumigatus* can be isolated in the laboratory by a single step UV light induced mutagenesis.

INTRODUCTION

Aspergillus fumigatus is an opportunistic filamentous fungus that causes local as well as disseminated infection in immune compromised patients, namely, cancer patients undergoing chemotherapy (Hutter *et al.*, 1964; Iwen *et al.*, 1993; Wingard, 1995) organ transplant recipients (Pannuti *et al.*, 1991; Tolkoff-Rubin *et al.*, 1992; Morrison *et al.*, 1995) and AIDS patients (Pursell *et al.*, 1992; Khoo and Denning, 1994). Since *A. fumigatus* infection is often fatal in these patient populations, antifungals are increasingly used now to manage nosocomial mycoses in compromised hosts. Although fungal infection has increased significantly during the past 10 years (Bodey, 1988; Andriole, 1993; Beck-Sague *et al.*, 1993) the antifungal agents currently available to treat severe local and disseminated *Aspergillus* infection is very limited. Amphotericin B (AMB) which acts on the cytoplasmic membrane by interacting with ergosterol is the preferred choice of treatment for fungal infection, in particular against *A. fumigatus* because of its fungicidal activity. Increased use of AMB against fungal infection has greatly enhanced the chance for the emergence of resistance against this antifungal agent. We therefore sought to study the mechanism(s) for the emergence of resistance to AMB in *A. fumigatus* by selecting AMB-resistant mutants of *A. fumigatus* in the laboratory. The selection and characterization of AMB-resistant *A. fumigatus* isolates in the laboratory are described in this paper.

MATERIALS AND METHODS

Organisms and culture conditions: *Aspergillus fumigatus* W73355 (a clinical isolate obtained from the Detroit Medical Center; DMC) highly virulent to cause pulmonary aspergillosis in immune compromised mice was used in this study. Working cultures were maintained on peptone yeast extract glucose (PYG; peptone 1 g; yeast extract 1 g; glucose 3 g; per liter of distilled water) agar at room temperature. The primary culture obtained from the DMC was subcultured on PYG agar to assure the purity of the culture. Long term storage of the culture was done as conidial suspension in 25% glycerol at -70 °C.

Preparation of conidial suspension: Conidial suspension from *A. fumigatus* W73355 was prepared as previously described (Manavathu *et al.*, 1996). Briefly, for the preparation of conidial suspensions, cultures were grown on PYG agar plates for 6-7 days at 30 °C until the whole plate was covered with fungal growth, and the conidia were collected by flooding the agar surfaces with sterile growth medium (20 ml) followed by gentle scraping with a sterile rubber policeman. The resulting fungal suspension containing fragments of mycelia, small pieces of agar, and other cellular debris, was collected by aspiration. The aspirate was vortexed vigorously to release conidia from the conidiophores and was filtered through a sterile cotton plug fitted in a sterile Nalgene filtration funnel. In general, a single filtration step was sufficient to obtain a clarified conidial suspension. Failure to vortex the cell

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suspension vigorously resulted in a poor yield of conidia as well as in the presence of large aggregates of conidia which often produces under-estimation of the cell density.

The cell density was determined by hemocytometer count. Each sample was counted four times independently, and the mean value of the quadruplicate was used for the calculation of the cell density. If the cell suspension was too concentrated for counting, a 1:10 dilution was prepared and the diluted suspension was used for the hemocytometer count. Under these conditions we routinely obtained approximately 1-3 x 10^7 conidia per ml when 20 ml of growth medium was used for resuspension. Fresh conidial suspension was used for the determination of minimum inhibitory concentration (MIC). However, conidia stored at 4 °C were completely viable for several months and the use of the conidia stored at 4 °C for several weeks yielded identical MIC values. The relationship between cell density estimated by hemocytometer count and the number of colony forming units was determined by plating appropriately diluted cell suspensions on PYG agar. The cell density estimation by colony forming units (CFU) production was approximately 10 to 20 percent lower than the value obtained by hemocytometer count. Although the determination of cell density by hemocytometer count is more time-consuming than the optical method (Espinel-Ingroff *et al.*, 1995), the hemocytometer count was preferable, since it seemed to provide a more accurate estimation of the cell density.

Construction of UV dose-survival curve: Fresh conidia were resuspended in PYG broth at a cell density of 1 x 10^6 conidia per ml (total of 20 ml) in a standard size (100 mm in diameter) petri dish. The conidial suspension was exposed to a UV lamp (Model UVL-21 Blak Ray Lamp, Longwave UV-366 nm, Ultraviolet Products, Inc., San Gabriel, CA) held at 6 inches from the bottom of the petri dish by a retort stand. Aliquots of the cell suspension were removed at various time intervals, diluted appropriately (100 fold serial dilutions), and 0.1 ml aliquots were spread on PYG medium for growth. CFU were estimated after 48 hr of incubation at 35 °C. The number of CFU per ml was plotted against time of exposure to estimate percent survival.

Selection of resistant colonies: Conidial suspension was exposed to UV irradiation as described above for 6 hr (≈ 90 percent cell death), collected by centrifugation, washed and resuspended in fresh PYG medium (1 x 10^8 conidia per ml) and 0.1 ml aliquots were plated (estimated to have ≈1 x 10^6 viable cells) on PYG agar containing 8 µg per ml and 16 µg per ml AMB. The plates were incubated at 35 °C in plastic sleeves for 7 days and colonies that grew on the plates were collected and stored as individual cultures for further study.

MIC determination: Conidial suspensions were prepared from colonies selected on the AMB containing PYG agar plates and the MICs of various antifungal agents for the AMB-selected isolates were determined as described previously (Manavathu *et al.*, 1996). Briefly, fresh conidia were collected from *A. fumigatus* and *A. niger*, and resuspended in PYG medium at a density of 2 x 10^4 conidia per ml. Two times the required concentrations of the drugs were prepared in PYG medium (0.5 ml) by serial dilution in sterile 6-ml polystyrene tubes (Falcon 2054) and inoculated with an equal volume (0.5 ml) of the conidial suspension. The tubes were incubated at 35 °C for 48 hr and scored for visible growth after vortexing the tubes gently, or scraping the walls of the tube followed by vortexing. The MIC was defined as the lowest concentration of the drug in which no visible growth occurred. The MIC determination for each isolate was repeated at least once, and the data were always within ±one dilution. The results given here is obtained for a typical experiment.

Kill curve experiment: Five ml of conidial suspension prepared in PYG broth (1 x 10^6 conidia per ml) was incubated at 25 °C in the presence of various concentrations of AMB (0 µg per ml to 4 µg per ml). At various time intervals 0.1 ml aliquots of the cell suspension were removed, diluted appropriately to obtain 10^2 to 10^4 fold dilution, and 0.1 ml aliquots were spread in duplicate on PYG agar plates. The plates were incubated at 35 °C for 48 hr and the number of CFU per ml of conidial suspension were calculated and plotted against the time of exposure to AMB to construct the kill-curve.

Antifungal agents: Ketoconazole (R41 400, Batch No. G3A747), miconazole (R14 889, Batch No. G5707), and itraconazole (R51 211, Batch No. STAN-9304-005-1) were obtained from Janssen Pharmaceutica, Belgium. Amphotericin B (Batch No. 20-914-29670) was obtained from the Squibb Institute for Medical Research, Princeton, NJ. Nystatin was obtained from Sigma Chemical Company, St. Louis, MS. All the antifungal agents were dissolved in dimethyl sulfoxide (DMSO) at a concentration of 1 mg per ml and stored as 0.5-ml aliquots at -20 °C. The frozen stock was thawed at room temperature and vortexed gently several times to ensure that any remaining crystals were completely dissolved before use. For MIC determination the following drug concentrations were used: amphotericin B, miconazole and itraconazole, 0 µg per ml to 16 µg per ml; ketoconazole, 0 µg per ml to 32 µg per ml; nystatin, 0 µg per ml to 25 µg per ml. Comparable concentrations of DMSO were tested to examine its effect on the growth of *A. fumigatus*. No detectable inhibition of growth occurred at the concentrations used.

RESULTS AND DISCUSSION

Effect of UV Irradiation: The effectiveness of UV mediated mutagenesis in *A. fumigatus* was investigated by monitoring the viability of mutagenized conidia by constructing a UV-dose response curve for the survival of conidia. As shown in Fig. 1, the survival of the conidia was inversely proportional to the time of exposure to the UV light. Within 6 hr of exposure greater than 90 percent of the cells were killed. UV mediated killing was effective only when the cells were physiologically active and underwent multiplication. For this reason, we incubated the conidia in PYG growth medium so that the effect of UV will be greatly enhanced as the conidia germinate. The fact that 6 hr of exposure to UV light was required to obtain ≥90 percent cell death was perhaps because of the initial period of inactivity of the conidia. The first morphological indication of the germination of dormant conidia (an increase in volume by swelling followed by the emergence of a small pertuberance) usually takes 3 hr of incubation in PYG at 25 °C. Since 6 hr of incubation resulted in ≥90 percent of cell death (which assures that there is a possibility that greater than 99.9 percent of the conidia will be affected by UV) we used 6 hr of irradiation under these conditions in all subsequent experiments for the selection of AMB-resistant *A. fumigatus*.

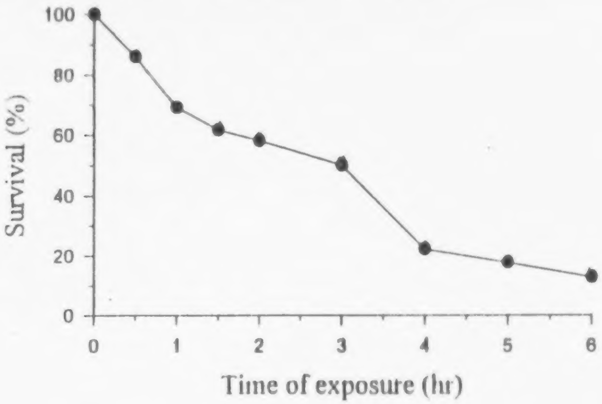

Fig. 1. Effect of UV irradiation on the survival of *A. fumigatus* conidia: Dose response curve.

Susceptibility studies: The susceptibility of eighteen *A. Fumigatus* colonies isolated on AMB containing plate to various antifungal agents is shown in Table 1. All the *A. fumigatus* isolates selected on AMB containing agar plate showed significantly higher MIC values for AMB than the susceptible parent. The mean MIC value for the 18 isolates shown in Table 1 was 6.0 ± 3.14 µg per ml which was approximately 12 fold higher than that of the parent W73355. A comparison of the susceptibility of these isolates to other antifungal agents showed that a significant rise in the MIC was obtained only in the case of nystatin (NYS) that is structurally related to AMB (Fig. 2), but not to the azole family of compounds. A series of subculturing of the resistant isolates was performed followed by determining the susceptibility to AMB to assess the genetic stability of the resistance trait. Even after 6 cycles of subculturing for every isolate the same MIC of AMB was obtained indicating that the resistance trait is genetically stable.

Table 1. Susceptibility of AMB-resistant laboratory isolates (n=18) of *Aspergillus fumigatus* to various antifungal agents

Antifungal	Mean MIC (µg/ml) ±S.D.	Range of MIC value	Fold increase in MIC
AMB	6.0 ± 3.14	4-16	12
NYS	10.06 ± 4.85	6.25-25	6.44
ITZ	0.63 ± 0.27	0.25-1	2.52
KTZ	11.11 ± 4.01	8-16	1.38
MCZ	2.44 ± 0.85	2-4	1.22

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Note: MICs (µg/ml) of AMB, NYS (nystatin), ITZ (itraconazole), KTZ (ketoconazole) and MCZ (Miconazole) for the AMB-susceptible parent W73355 were 0.5, 1.56, 0.25, 8 and 2, respectively. The fold increase in MIC was calculated by comparison with the MIC of the respective antifungal for the susceptible parent strain.

Kill-curve studies: AMB is a fungicidal agent and exposure of the organism to this fungicide will kill the organism in a concentration dependent manner. The higher the MIC of an isolate is the lower the amount of killing. We therefore determined the fungicidal activity of AMB against two resistant isolates (AB8.6 and AB16.4) and compared the results with those obtained for the parent strain W73355. Four different concentrations of the drug representing 1 to 8 fold higher than the MIC of the susceptible parent W73355 but significantly below the MIC of the resistant isolates were included in our studies.

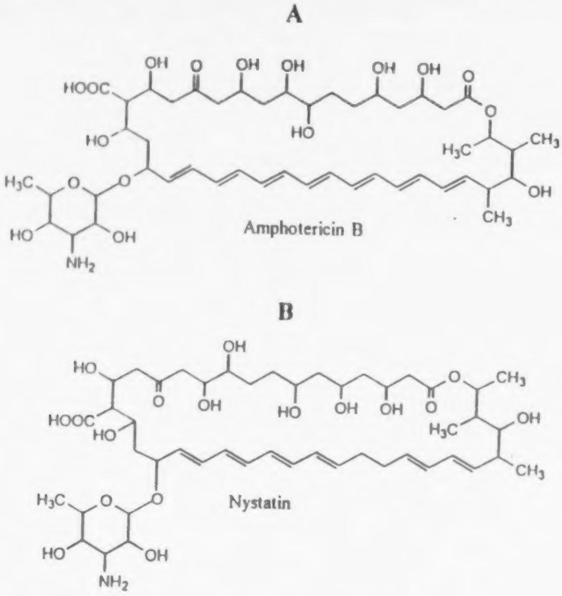

Fig.2. Chemical structures of amphotericin B and nystatin.

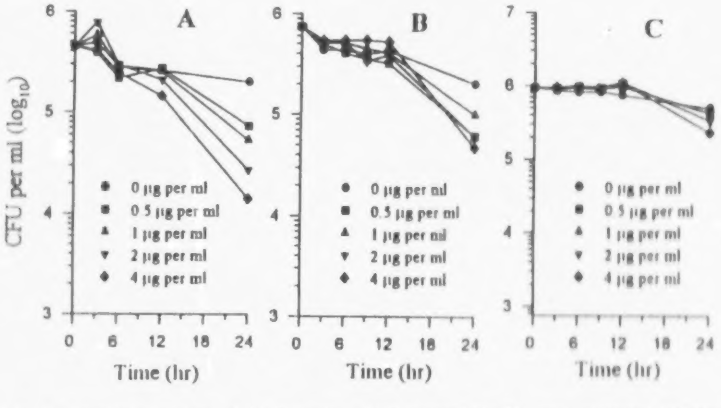

Fig. 3. Fungicidal activity of AMB against AMB-susceptible (A) and -resistant isolates (B and C).

As shown in Fig. 3, the susceptible parent W73355 (panel A) was killed more rapidly than the resistant isolates AB8.6 (panel B) and AB16.4 (panel C). For example, at 4 µg per ml

24 hr of exposure to the drug resulted in 93 percent killing of W73355 but only 76.5 percent and 35.8 percent for the resistant isolate AB8.6 and AB16.4, respectively.

Although AMB has been used as the premier antifungal agent for treating severe mycotic infection for the last 20 years, no significant level of emergence of resistance to AMB has occurred in the past. There may be several reasons: (1) Because the target of AMB is ergosterol, the end product of sterol synthetic pathway in fungi, the chances of acquiring mutagenic changes that lead to structural alteration of the target is less likely to occur. (2) Significant alteration to ergosterol molecule, which may impair the inhibitory activity of AMB, may also result in cell death. (3) Since AMB acts at the membrane level, its penetration to the cell is not required for its action. This may prevent the emergence of resistance because of a permeability barrier or by efflux proteins. (4) Last, but not least significance, is the fact that AMB may have more than one mode of action in which case emergence of resistance to AMB by counter acting all possible mode(s) of action is difficult. However, we have recently screened 180 clinical isolates of *Aspergillus* obtained from the DMC have been screened for their susceptibility to AMB. Several low level resistant isolates (MIC = 4 μg per ml) have been obtained suggesting that resistant mutants could emerge under selection pressure.

ACKNOWLEDGMENTS

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REFERENCES

Andriole, V. T. (1993). Infections with Aspergillus species. Clin. Infect. Dis., 17: (Suppl. 2) S481-S486.

Beck-Sague, C. M. and Jarvis, W. R. (1993). National Nosocomial Infections Surveillance System. Secular trends in the epidemiology of nosocomial infections in the United States. 1980-1990. J. Infect. Dis. 167: 1247-1251.

Bodey, G. P. (1988). The emergence of fungi as major hospital pathogens. J. Hosp. Infection, 11: 411-426.

Espinel-Ingroff, A., Dawson, K., Pfaller, M., Anaissie, E., Breslin, B., Dixon, D., Fothergill, A., Paetznick, V., Peter, J., Rinaldi, M. and Walsh, T. (1995). Comparative and collaborative evaluation of standardization of antifungal susceptibility testing for filamentous fungi. Antimicrob. Agents Chemother., 39: 314-319.

Hutter, R. V. P., Lieberman, P. H. and Collins, H. S. (1964). Aspergillosis in a Cancer a Hospital. Cancer, 17: 747-756.

Iwen, P. C., Reed, E. C. and Armitage, J. O. (1993). Nosocomial invasive aspergillosis in lymphoma patients treated with bone marrow or peripheral stem-cell transplants. Infect. Control Hosp. Epidemiology, 14: 131-139.

Khoo, S. H. and Denning, D. W. (1994). Invasive Aspergillosis in patients with AIDS. Clin. Infect. Dis. 19: (Suppl. 1) S41-S48.

Manavathu, E. K., Alangaden, G. J. and Lerner, S. A. (1996). A comparative study of the broth micro- and macro-dilution techniques for the determination of the in vitro susceptibility of Aspergillus fumigatus. Can. J. Microbiol. 42: 960-964.

Morrison, V. A., Haake, R. J. and Weisdrof, D. J. (1994). Non-candida fungal infections after bone marrow transplantation: Risk factors and outcome. Am. J. Med., 96: 497-503.

Pannuti, C. S. Gingrich, R. D., Pfaller, M. A. and Wenzel, R. P. (1991). Nosocomial pneumonia in adult patients undergoing bone marrow transplantation: a 9-year study. J. Clin. Oncol., 9: 77-84.

Pursell, K.J. and Telzak, E. E., Armstrong, D. (1992). Aspergillus species colonization and invasive disease in patients with AIDS. Clin. Infect. Dis., 14: 141-148.

Talkoff-Rubin, N. E. and Rubin, R. H. (1992). Opportunistic fungal and bacterial infections in the renal transplant recipient. J. Am. Soc. Nephrol., 2: (Suppl. 3) S264-S269.

Wingard, J. R. (1995). Aspergillus infections in immunocompromised cancer patients. Internal Medicine. Aspergillus Special Report. pp. 4-10.

IN VITRO SUSCEPTIBILITY OF CLINICAL ISOLATES OF OPPORTUNISTIC FUNGI TO ANTIFUNGAL AGENTS

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The in vitro susceptibility of 74 clinical isolates of *Aspergillus* (55 *A. fumigatus*, 10 *A. niger*, 3 *A. flavus* and 6 isolates not identified at the species level) to itraconazole and amphotericin B (two most commonly used antifungal agents against *Aspergillus* infection) was investigated using a broth macrodilution technique. All but two isolates of *A. fumigatus* were susceptible to itraconazole (mean minimum inhibitory concentration = 0.47 ± 0.37; range 0.25-2.0 μg/ml) whereas 54 of the 55 isolates examined were susceptible to amphotericin B (mean minimum inhibitory concentration = 1.28 ± 0.70; range 0.5-4.0 μg/ml). The three isolates less susceptible to itraconazole, and amphotericin B had minimum inhibitory concentrations of 2 μg/ml and 4 μg/ml, respectively. A comparison of the mean minimum inhibitory concentration values of itraconazole (2.7 ± 2.47 μg/ml) and amphotericin B (3.2± 1.73 μg/ml) for non-*fumigatus* isolates with those obtained for *A. fumigatus* showed that the former are approximately 6 fold and 2.5 fold less susceptible to itraconazole and amphotericin B, respectively. The data also suggest that clinical isolates of *Aspergillus* less sensitive to itraconazole and amphotericin B treatment can emerge in patients and such less susceptible isolates may contribute to the clinical failure of therapy against *Aspergillus* infection in immune compromised hosts.

INTRODUCTION

Members of the genus *Aspergillus* are opportunistic fungi that cause severe local and disseminated infection in immune compromised individuals, namely, cancer patients undergoing cytotoxic chemotherapy (Hutter *et al.*, 1964; Iwen *et al.*, 1993; Wingard, 1995), recipients of solid organ and bone marrow transplantation (Pannuti *et al.*,1991; Tolkoff-Rubin *et al.*, 1992; Morrison, *et al.*,1995) whose immune system is intentionally suppressed to prevent organ rejection and AIDS patients (Pursell *et al.*, 1992; Khoo and Denning, 1994) whose immune system is severely debilitated by human immune deficiency virus infection. Among the numerous species of *Aspergillus* described to date, only a selected few such as *A. fumigatus*, *A. niger* and *A. flavus* are the most commonly found species associated *Aspergillus* infection (Bodey, 1988; Andriole, 1993; Beck-Sague *et al.*, 1993). The main portals of entry for these organisms are the respiratory tracts and often they colonize these organs without causing apparent disease. At times the colonized organism is spread through the circulatory system to various organ systems and causes severe disseminated aspergillosis that often results in very high mortality rate among immune compromised patients.

Amphotericin B (AMB) and itraconazole (ITZ) are the most commonly used antifungal agents for the treatment of *Aspergillus* infection in man. AMB is a member of the polyene class of compounds known to interact with ergosterol of the fungal cytoplasmic membrane and brings about irreversible changes to the cell membrane which results in cell death. Thus, AMB is a fungicidal agent and remained as the premier antifungal agent for the treatment of aspergillosis. The main disadvantage of AMB is its severe toxicity to the renal function of the host at high doses. In contrast to the fungicidal activity of AMB, ITZ acts as a fungistatic agent by inhibiting the synthesis of ergosterol. The target of action of this compound is the cytochrome P450 dependent lanosterol 14-α-demethylase ($P450_{14DM}$), an enzyme that catalyze the removal of the methyl group on C14 of lanosterol for the subsequent synthesis of fecosterol. Although the exact mechanism is not fully understood, it is believed that azoles, including ITZ, bind to the active site of the enzyme thus preventing the binding and subsequent processing of the substrate. The mammalian system also contain $P450_{14DM}$ and catalyze the 14- α-demethylation of lanosterol, the affinity of the mammalian enzyme to ITZ (for that matter to all the azoles) is very low and only at very high concentration of the drug it inhibits the mammalian enzyme (Purcell *et al.*, 1995).

1993

The incidence of *Aspergillus* infection has increased significantly during the past 10years due to an expanding population of immune suppressed patients (Andriole, 1993; Beck-Sague *et al.*, 1993). In many Medical Centers in the United States management of fungal infection due to *Aspergillus* is a major clinical problem in bone marrow transplant, cancer and AIDS patients. The use of AMB and ITZ is significantly expanded for prophylaxis as well as treatment. Increased use of these antifungal agents resulted in the emergence of resistance to these drugs which often suspected to be in part for the failure of therapy in patients suffering from aspergillosis. A significant increase in the frequency of isolation of *Aspergillus* occurred in the Detroit Medical Center for the last 7 years. Thus, the main purpose of this study was to evaluate the in vitro susceptibility of various *Aspergillus* isolates obtained in the Detroit Medical Center for their susceptibility to both AMB and ITZ to evaluate whether drug resistance played any role in the failure of treatment in immune compromised patients. In this paper we describe the in vitro susceptibility to AMB and ITZ of all the clinical isolates of *Aspergillus* obtained in the Detroit Medical Center for a 2-year period from January 1994 to December 1995.

MATERIALS AND METHODS

Organisms and culture conditions: All the *Aspergillus* isolates used in this study were obtained from the Detroit Medical Center for a 2-year period from January 1994 to December 1995. Approximately 48 percent of the isolates were from bone marrow transplant patients, 32 percent from cancer patients and the remaining 20 percent from patients suffering from other serious medical problems (e.g. AIDS, metabolic disorder, etc.). The primary cultures received on potato dextrose agar slants were subcultured on peptone yeast extract glucose agar (PYG; peptone 1 g; yeast extract 1 g; glucose 3 g; per liter of distilled water) for 6 days at 30 °C for ensuring the purity of the cultures as well as for the production of conidia. Working cultures were maintained on PYG agar at room temperature, and long term storage of the cultures were done as conidial suspension in 25 percent glycerol at -70 °C.

Preparation of conidial suspension: Conidial suspensions from various *A. fumigatus* isolates were prepared as previously described (Manavathu *et al.*, 1996). Briefly, cultures were grown on PYG agar plates for 6 days at 30 °C until the whole plate was covered with fungal growth, and the conidia were collected by flooding the agar surfaces with sterile growth medium (20 ml) followed by gentle scraping with a sterile rubber policeman. The resulting fungal suspension containing fragments of mycelia, small pieces of agar, and other cellular debris, was collected by aspiration. The aspirate was vortexed vigorously to release conidia from the conidiophores and was filtered through a sterile cotton plug fitted in a sterile Nalgene filtration funnel. In general, a single filtration step was sufficient to obtain a clarified conidial suspension. Failure to vortex the cell suspension vigorously resulted in a poor yield of conidia as well as in the presence of large aggregates of conidia which often produces under-estimation of the cell density.

Cell density was determined by hemocytometer count. Each sample was counted four times independently, and the mean value of the quadruplicate was used for the calculation of the cell density. If the cell suspension was too concentrated for counting, a 1:10 dilution was prepared and the diluted suspension was used for the hemocytometer count. Under these conditions approximately 1-3 x 10^7 conidia per ml was obtained when 20 ml of growth medium was used for resuspension. Fresh conidial suspension was used for the determination of minimum inhibitory concentation (MIC). However, conidia stored at 4 °C were completely viable for several months and the use of the conidia stored at 4 °C for several weeks yielded identical MIC values. The relationship between cell density estimated by hemocytometer count and the number of colony forming units was determined by plating appropriately diluted cell suspensions on PYG agar. The cell density estimation by colony forming units (CFU) production was approximately 10 to 20 percent lower than the value obtained by hemocytometer count. Although the determination of cell density by hemocytometer count is more time-consuming than the optical method (Espinel-Ingroff *et al.*, 1995), the hemocytometer count was preferable, since it seemed to provide a more accurate estimation of the cell density.

MIC Determination: The susceptibility of various *Aspergillus* isolates to ITZ and AMB was tested by determing the MICs of the antifungals using a broth macrodilution technique according to the procedures of Manavathu *et al.*, (1996). Briefly, fresh conidia were resuspended in PYG medium at a density of 2 x 10^4 conidia per ml. Two times the required concentrations of the drugs were prepared in PYG medium (0.5 ml) by serial dilution in sterile 6-ml polystyrene tubes (Falcon 2054) and inoculated with an equal volume (0.5 ml) of the conidial suspension. The tubes were incubated at 35 °C for 48 hr and scored for visible growth after vortexing the tubes gently, or scraping the walls of the tube followed by vortexing. The MIC was defined as the lowest concentration of the drug in which no visible growth occurred. The MIC determination for each isolate was repeated at least once, and the data were always within ±one dilution.

Antifungals: ITZ (R51 211, Batch No. STAN-9304-005-1, Janssen Pharmaceutica, Belgium) and AMB (Batch No. 20-914-29670, Squibb Institute for Medical Research, Princeton, NJ) were dissolved in dimethyl sulfoxide (DMSO) at a concentration of 1 mg per ml and stored as 0.5-ml aliquots at -20 °C. The frozen stock was thawed at room temperature and vortexed gently several times to ensure that any remaining crystals were completely dissolved before use. Comparable concentrations of DMSO were tested to examine its effect on the growth of *A. fumigatus*. No detectable inhibition of growth occurred at the concentrations used. Since AMB is light -sensitive, the stock solutions and the MIC tubes were covered with aluminum foil to prevent from light exposure.

RESULTS AND DISCUSSION

Frequency of *Aspergillus* isolates in Detroit Medical Center: The frequency of isolation of *Aspergillus* in the Detroit Medical Center showed a steady increase from 1990-1996 (Fig.1). The overall increase in the number of isolates of *Aspergillus* was mainly due to increase in *A. fumigatus* isolates until 1995, but the frequecy of isolation of non-*fumigatus* species almost quadrupled in 1996. This significant increase in number of *Aspergillus* isolates in 1996 is perhaps attributable to the many construction projects taking place in and around the Detroit Medical Center. Although the incidence of *Aspergillus* infection is low compared to the *Candida albicans* infection rate, the high morbidity and mortality associated with *Aspergillus* infection make it a significant clinical problem.

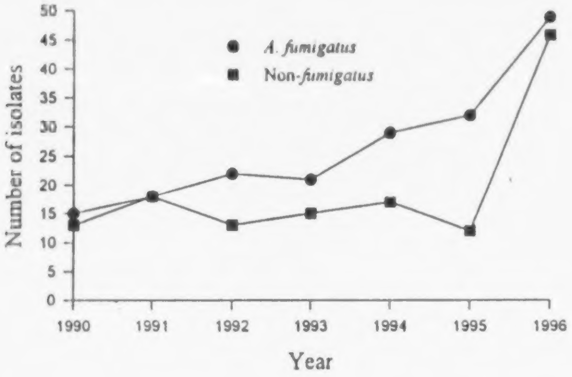
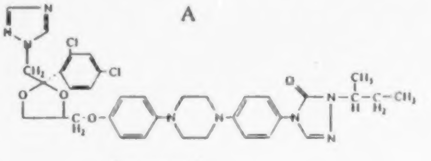


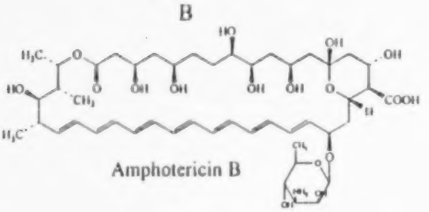
Figure 1. The frequency of isolation of *Aspergillus* species in the Detroit Medical Center from January 1990 to December 1996. The non-*fumigatus* group includes *A. niger*, *A. flavus* and non-speciated *Aspergillus*.

Susceptibility studies: The susceptibility of 55 *A. fumigatus* and 19 non-*fumigatus* isolates to ITZ (Fig. 2A) and AMB (Fig. 2B) was determined by the macrobroth dilution technique. The MIC determination for each isolate was repeated at least once and the values were within ±1 dilution of the value reported. The MIC values of ITZ for the 55 clinical isolates of *A. fumigatus* examined in our study is shown in Fig. 3A. The majority (87 percent) of the isolates had MICs of ITZ between 0.25 µg per ml and 0.5 µg per ml whereas the remaining 13 percent of the isolates had MICs between 1 µg per ml and 2 µg per ml indicating that ITZ MIC range for *A. fumigatus* is very narrow (mean MIC = 0.47±0.37 µg per ml). The susceptibility of *A. fumigatus* isolates to AMB is shown in Fig. 3B. Similar to the data obtained for ITZ, majority (63 percent) of the isolates had MICs between 0.5 µg per ml and 1 µg per ml. However, in contrast to the MIC values of ITZ, a significant number of isolates (35 percent) provided an MIC value of 2 µg per ml for AMB, and 1 isolate had an MIC of 4 µg per ml, generally considered to be low level resistance of clinical significance. The data obtained for AMB revealed that *A. fumigatus* isolates had a wider range of susceptibility to AMB (mean MIC =1.28 ± 0.70 µg per ml) compared to that obtained for ITZ.

The number of non-*fumigatus* clinical isolates obtained were lower than that of *A. fumigatus* during 1994-1995. In contrast to the low MIC values obtained for *A. fumigatus*, the non-*fumigatus* isolates were less susceptible to both ITZ (Fig. 4A) and AMB (Fig. 4B). The majority of the isolates showed an MIC value of 4 µg per ml for both compounds. The mean MIC values for ITZ and AMB were 2.70 ± 2.47 µg per ml and 3.2 ± 1.73 µg per ml, respectively indicating that the non-*fumigatus* species of *Aspergillus* were less susceptible to both ITZ and AMB.



Itraconazole



Amphotericin B

Figure 2. Chemical structures of AMB and ITZ. Both AMB and ITZ are hydrophobic molecules insoluble in aqueous solutions. AMB is an amphipathic molecule with hydrophobic and hydrophilic regions, and has the ability to interact with cell membrane. On the other hand ITZ possesses a polar head associated with a hydrophobic aliphatic tail which plays a key role in the proper binding and alignment of the molecule to the active site of $P450_{14DM}$.

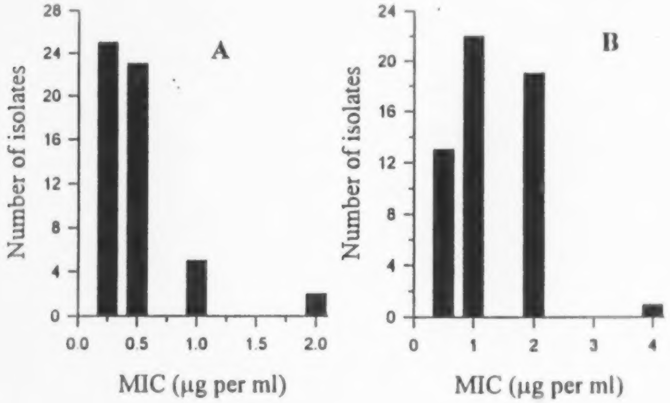


Figure 3. MIC pattern of 55 *A. fumigatus* isolates obtained from Detroit Medical Center during 1994-1995 to ITZ (A) and AMB (B).

The data on the susceptibility of various clinical isolates of *A. fumigatus* to ITZ and AMB showed that none of the 55 isolates we examined possessed high level resistance to either drugs. Only one isolate showed an in vitro MIC of greater than 2 µg per ml which is generally considered to be the breakpoint for these drugs. On the other hand, the susceptibility data showed that non-*fumigatus* species of *Aspergillus* in general are less susceptible to both ITZ and AMB, and almost 50 percent of the isolates showed an MIC ≥4 µg per ml which is above the break-point for these antifungal agents. Thus it is likely that aspergillus infection caused by non-*fumigatus* species may respond poorly to antifungal treatment with ITZ and AMB, and the presence of low and moderate level resistant isolates may be responsible for the failure of therapy.

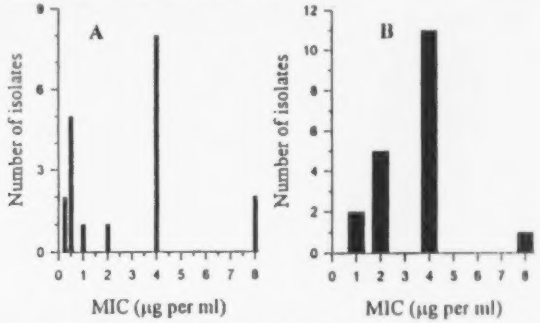


Figure 4. MIC patten of 19 non-*fumigatus* isolates of *Aspergillus* obtained from the Detroit Medical Center during 1994-1995 to ITZ (A) and AMB (B).

ACKNOWLEDGMENTS

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REFERENCES

Andriole, V. T. (1993). Infections with Aspergillus species. Clin. Infect. Dis., 17: (Suppl. 2) S481-S486.

Beck-Sague, C. M. and Jarvis, W. R. (1993). National Nosocomial Infections Surveillance System. Secular trends in the epidemiology of nosocomial infections in the United States. 1980-1990. J. Infect. Dis. 167: 1247-1251.

Bodey, G. P. (1988). The emergence of fungi as major hospital pathogens. J. Hosp. Infection, 11: 411-426.

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Hutter, R. V. P., Lieberman, P. H. and Collins, H. S. (1964). Aspergillosis in a Cancer a Hospital. Cancer, 17: 747-756.

Iwen, P. C., Reed, E. C. and Armitage, J. O. (1993). Nosocomial invasive aspergillosis in lymphoma patients treated with bone marrow or peripheral stem-cell transplants. Infect. Control Hosp. Epidemiology, 14: 131-139.

Khoo, S. H. and Denning, D. W. (1994). Invasive Aspergillosis in patients with AIDS. Clin. Infect. Dis. 19: (Suppl. 1) S41-S48.

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Purcell, I.F. And Corris, P.A. 1995. Use of nebulised liposomal amphotericin B in the treatment of Aspergillus fumigatus empyema. Rthorax 50: 1321-1322.

Pursell, K.J., Telzak, E. E., and Armstrong, D. (1992). Aspergillus species colonization and invasive disease in patients with AIDS. Clin. Infect. Dis., 14: 141-148.

Talkoff-Rubin, N. E. and Rubin, R. H. (1992). Opportunistic fungal and bacterial infections in the renal transplant recipient. J. Am. Soc. Nephrol., 2: (Suppl. 3) S264-S269.

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Aye-Aye Gruel Presentation Preference

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ABSTRACT

The Aye-ayes at the Duke University Primate Center (DUPC) practice sorting and selective feeding which leads to nutritional deficiencies. To prevent these deficiencies, the DUPC began feeding the Aye-ayes commercial primate chow in gruel form. The Aye-ayes still prefer their fruits and vegetables and eat little gruel. A preference trial was conducted using three container-types (bowl, bamboo, and coconut) to determine if gruel intake could be increased by its presentation method. Eight Aye-ayes, housed in four different enclosures, were used in the study. Preference trials were conducted on Thursday, Friday and Saturday, and replicated for three consecutive weeks. On a given day, each of the three container-types, filled with 364 g gruel, was represented in an Aye-aye enclosure, with the exception of one container-type, which was presented to two enclosures. Every week, each enclosure was exposed to each container-type once. Average daily consumption for the bowl, bamboo and coconut was 132.7 g, 163.4 g, and 178.5 g respectively. Planned comparisons were used to test for treatment differences. Consumption of gruel in the bowl was less ($P<.08$) than the average of the other two containers. There was no difference ($P>.10$) in consumption between bamboo and coconut. In comparison to the stainless steel bowl, Aye-aye gruel intake was increased when gruel was presented in a bamboo stalk or coconut shell, two containers natural to the Aye-ayes' environment.

BACKGROUND

In the past, the Aye-aye at the Duke University Primate Center (DUPC) were offered a diet which would meet their nutritional needs. However, their practice of sorting and selective feeding resulted in protein and essential vitamin and mineral deficiencies. To prevent these deficiencies, the DUPC began feeding the Aye-ayes commercial primate chow in gruel form (Haring, 1994). Despite the nutritional importance of the gruel, the Aye-ayes still prefer their fruits and vegetables and eat little gruel. In an attempt to increase their gruel intake, I wanted to present the gruel in different containers that enhance natural foraging behavior of the Aye-aye. In addition to increased gruel intake, the different containers will serve as a behavioral enriching device for the Aye-aye.

OBJECTIVE

To determine whether presenting the food in different containers could have potential benefits by increasing the Aye-ayes' gruel intake, and therefore providing the animals with a healthier diet. If the gruel intake is increased, the appropriate container could be incorporated into husbandry protocol practices.

HYPOTHESIS

The Aye-aye will have a greater intake of the gruel if presented in either a bamboo stalk or a coconut shell compared to the gruel presented in the stainless steel bowl. In addition, the intake will be higher in the bamboo stalk than the coconut shell because it requires more work for the Aye-aye to obtain the gruel.

METHODS

Number of animals/Housing A total of eight Aye-ayes were used in the experiment. They were housed in their existing enclosures, which are located indoors at DUPC. Two animals were in each enclosure. A total of four enclosures were used in the experiment. In order for the enclosures to be housed exclusively by Aye-ayes, all other nocturnal inhabitants were removed temporarily.

Diet The DUPC diet for the Aye-aye included primate chow, fruits, vegetables, grubs, and slightly boiled eggs. They were fed once daily between 1200 and 1400 hours. The gruel recipe included six cups of Mazuri primate chow (leaf eater primate chow), four and a half cups of hot water, and one-half cup of natural honey. The mixture was stirred until equal consistency was achieved. During this study, 364 g of the leaf eater primate chow gruel was used in each container. The Aye-ayes were given the usual offering of fruits and vegetables, grubs, and slightly boiled eggs. The only difference the Aye-ayes experienced was the gruel presentation method.

Treatments There were three compared variables; the stainless steel bowl, bamboo stalk, and coconut shell. The stainless steel bowl was approximately five inches in diameter and three inches tall. The gruel was placed inside the container. The bamboo stalk was cut just below each plant joint. This created a one-sided closed stalk or shaft of bamboo with one end opened. The gruel was spooned into the bamboo shaft until shaft was full. The gruel was packed into the shaft by 1) banging the closed end on the counter and/or 2) pushing the gruel into the shaft with a long spoon. Two bamboo shafts were needed to contain all 364 g gruel. The coconut shell container was prepared by using a jig-saw to cut out a quarter section of the shell. Then, the coconut meat inside was removed with a chisel. The gruel was spooned into the coconut.

Procedures An informal introduction period with each container variable was used to familiarize the animals with the container and therefore eliminate the novelty factor. The introduction period was completed the day before the preference trials. Both the bamboo stalk and the coconut shell were presented to the Aye-ayes with 364 g gruel for one day. During the introductory trial and for each preference trial, the appropriate container was placed in the same location on the Aye-aye enclosure food stand.

The preference trial intake measurements began on a Thursday. After randomizing the order of presentation of the variables, the stainless steel bowl was presented first to the animals in enclosure one and two. The coconut shell was presented first to animals in enclosure three, and the bamboo stalk was presented first to the animals in enclosure four. This presentation schedule allowed each container-type to be represented on a given day (See Table 1). Therefore, it eliminated any possible bias the animals might have demonstrated during any particular day. For example, if the temperature of the building changed, causing a constant environmental change throughout all four enclosures, then the effect was represented in all the container-type weigh-back measurements. The gruel intake measurements were taken every twenty-three hours at the same of the day (1300 hours). This allowed the presenter adequate time to prepare the containers for the next day's trial.

In addition, observations of the Aye-aye's feeding behavior were made and noted for a minimum of forty minutes after the containers were presented to the Aye-ayes. Enclosures four, three and one were observed on consecutive days for one week's trials. Enclosure two was not observed. The observational data was used to better understand the Aye-ayes feeding behavior, and it acted as background for future research experiments. No quantitative observational data was collected.

Table 1: Aye-aye Gruel Presentation Preference Trial Schedule

Week 1

Enclosure 1	Enclosure 2	Enclosure 3	Enclosure 4	
Bowl	Bowl	Coconut	Bamboo	Thursday
Coconut	Coconut	Bamboo	Bowl	Friday
Bamboo	Bamboo	Bowl	Coconut	Saturday

Week 2

Enclosure 1	Enclosure 2	Enclosure 3	Enclosure 4	
Coconut	Coconut	Bamboo	Bowl	Thursday
Bamboo	Bamboo	Bowl	Coconut	Friday
Bowl	Bowl	Coconut	Bamboo	Saturday

Week 3

Enclosure 1	Enclosure 2	Enclosure 3	Enclosure 4	
Bamboo	Bamboo	Bowl	Coconut	Thursday
Bowl	Bowl	Coconut	Bamboo	Friday
Coconut	Coconut	Bamboo	Bowl	Saturday

Specific data collection The data collected was the weight of the gruel before and after each specific container was presented to the Aye-ayes. The weight of the container, the gruel, and the combined weight of the two were recorded daily before the containers was presented. The next day only the combined weight of the container and the gruel were measured. The differences between the combined gruel and container weight before and after it was presented to the animals was equal to the total animal intake for that enclosure. All weights were recorded in a notebook and the differences were calculated. All measurements were in grams and were carried to the 1/10 of a gram. These measurements were taken at 1300 hours.

Data Analysis Data were analyzed by analysis of variance using a model containing enclosure, week, day and container as main effects. Planned comparisons were used to test for differences among containers. The average of the bamboo stalk and coconut shell were compared to the bowl. The data were considered significant if $P<.1$.

RESULTS

On one occasion, Wednesday, December 11, 1996, the Aye-ayes in enclosures three and four were removed from their enclosure and kept in temporary kennels while their enclosures were being thoroughly cleaned. The Aye-ayes were released back into their rearranged enclosures thirty minutes prior to the beginning of the second week's trails. The weighbacks for Thursday, December 12, 1996, were high (Enclosure three = 26.2 g consumed and Enclosure four = 22.4 g consumed) and obviously affected by the new environment adjustments. While observing the Aye-ayes initial feeding habits, it was evident that their behavior was abnormal. Instead of immediately feeding and foraging through their food at the food stand, the Aye-ayes paced along the branches of the enclosure. Increased inspection behavior; including smelling, third digit probing, and visual activity was observed. The Aye-ayes were distracted by the novelty of the new enclosure environment, which resulted in decreased food consumption. After reviewing all the data it was decided that intakes for

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those days would not be included in the final data analysis because of their unjust representation of the Aye-ayes' normal feeding behavior.

Feeding behavior and container interactions were observed and recorded. Generally, the Aye-ayes ate all their eggs, fruits, and vegetables before approaching and eating their gruel. However, on some occasions gruel consumption was observed before some of the other daily offerings were eaten. Gruel consumption was never observed before any other Aye-aye food offerings. The Aye-ayes always first ate some other food offering before their gruel. Both the bamboo stalk and coconut shell had more physical contact than the bowl. In some cases the Aye-ayes bit the coconut shell through the bottom to get to the gruel. However, it was also observed that the Aye-ayes treated the coconut shell as a bowl and scooped the gruel directly out of the shell opening. The Aye-ayes removed both the coconut shell and bamboo stalk from the food stand, which sometimes lead to it being carried to the top of enclosure branches. This behavior was not observed with the stainless steel bowl. The numerical data supports these observations.

The average daily consumption for the bowl, bamboo and coconut was 132.7 g, 163.4 g, and 178.5 g respectively. Consumption of gruel in the bowl was less ($P<.08$) than the average of the other two containers. There was no difference ($P>.10$) in consumption between gruel in the bamboo and coconut.

DISCUSSION

Some possible errors were encountered during the preference trials. On one occasion, an uninformed DUPC technician removed the bamboo container from one enclosure and disposed of it. The containers were retrieved and the enclosure floors and food stands were checked extensively for any remaining gruel. All remains were weighed and recorded as weighbacks. After a number of hours, the gruel becomes dehydrated and hardens. This had two affects on the experiment. 1) This helped the gruel remain intact during its collection and disposal by the DUPC technician. The weighbacks for that day (Saturday, enclosure 1 and 2) should be accurate, although, it is recognized that errors in the results could have originated from the containers' temporary disposal. 2) The Aye-aye overall intake of gruel could be reduced when the gruel becomes dehydrated because of its hard physical characteristics. This is an area for further study. The gruel consistency which promotes the most Aye-aye overall gruel intake could be determined and applied to the results of this study. In addition, the introduction period could be extended to minimize possible increase in gruel intake because of a novelty factor. Also, the experiment itself could be extended to gather more data and hence decrease the possibility for error or chance. Finally, it is assumed that the Aye-ayes are in good health. The data could be inaccurate if an Aye-aye was in poor health and it affected its appetite.

Despite the above concerns, it can be concluded that in comparison to the stainless steel bowl, Aye-aye gruel intake is increased when gruel is presented in a bamboo stalk or coconut shell, two containers natural to the Aye-ayes' environment To ensure the Aye-ayes nutrition health and to increase their behavior enrichment, the bamboo stalk and coconut shell containers should be incorporated into husbandry protocol practices. Use of the stainless steel bowl as a gruel container should be avoided for the health benefits of the Aye-ayes. This is recommended because the Aye-ayes' proper nutrition is compromised when their gruel intake is lowered. In addition, future container types can be researched and compared to determine the container that best promotes Aye-aye gruel consumption.

References:

Haring, Hess, Coffman, Simons, and Tina M. Owens. "Natural History and Captive Management of the Aye-aye at Duke University Primate Center, Durham." International Zoo TB 33 (1994): 201-219.

Further Readings:

Charles-Dominque, Pierre. Ecology and Behavior of Nocturnal Primates, Prosimians of Equatorial West Africa. Trans. R.D. Martin. New York: Columbia University Press, 1977.

Durrell, Gerald. The Aye-Aye and I, A Rescue Mission in Madagascar. New York: Arcade Publishing, 1993.

Modification of the Binary TBP-DNA Complex by Pluramycins

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ABSTRACT:

In this series of experiments we probed the TBP-DNA binary complex. We wanted to try and understand how a symmetric molecule like TBP could initiate asymmetric transcription. To do this, we used the pluramycin family of drugs as molecular probes to indicate Areas of conformational change in DNA. The DNA sequences we used were those of the Adeno-Virus Major Late Promoter (AdMLP-54mer) and the Human Myoglobin Promoter (HmP-64mer).

INTRODUCTION:

To gain an understanding of transcription, we must remember that eukaryotes possess three different type of RNA polymerases, RNA polymerases I, II, and III, each with its own function. The function of RNA polymerase I (RNAP I) is to transcribe ribosomal RNA. The function of RNA polymerase II (RNAP II) is to catalyze the synthesis of eukaryotic messenger RNA, and the function of RNA polymerase III (RNAP III) is to transcribe both transfer and ribosomal RNA (review 4-6). The functions of all three polymerases are aided through the recruitment of various other protein cofactors, collectively known as Transcription Factors (review 4-6). For RNAP II, which recognizes the TATA promoter, among the most important transcription factors is Transcription Factor IID (TFIID).

Transcription Factor IID contains the TATA-Binding Protein (TBP), and is the only transcription factor that has been found to be site specific and to bind directly to DNA (4). What makes TFIID, and TBP, an area of such intense interest is that TBP binds to the TATA promoter in an unusual manner. It recognizes and binds to DNA through the minor groove (1). This is very unusual since the majority of proteins interact with the major groove of DNA. The major groove of DNA has a larger number of possible chemical interactions. This makes it a much more attractive site for protein-DNA interactions. But TBP binds to the minor groove, and as a result of TBP binding, the DNA helix is unwound at the TATA region and bent towards the major groove (1). In addition to bending and unwinding at the TATA site, there is a widening of the minor groove to facilitate TBP binding (1, 6). This unique type of protein-DNA interaction and the radical conformational changes induced in DNA as a result of TBP binding, make it an area of great interest.

How TBP interacts to produce these unusual changes is equally unique. The 5' end of the B-form DNA molecule comes in contact with the C-terminal end of the TBP molecule (6). TBP inserts a pair of phenylalanine side chains between the first T-A:A-T of the TATA-box (1, 6). This insertion induces the B-form DNA molecule to unwind and present a smooth unwound minor groove to the rest of the TBP molecule (1, 6). The unwound minor groove interacts with the anti-parallel beta-sheets along the bottom of the TBP molecule, causing the helix to bend (1, 6) and allows the side chains of TBP to interact with the minor groove. Insertion of another pair of phenylalanines from the N-terminal end of TBP, between the last two bases in the TATA-box, cause the helix to return to B-form DNA (1, 6).

TBP is known to be a quasi-symmetric molecule, but binding of TBP leads to asymmetric transcription. This means there must be some kind of directional modification induced in the DNA helix, which allows a symmetric TBP molecule, bound to a symmetric DNA molecule, to initiate asymmetric transcription. This was the basic premise behind this series of experiments.

OBJECTIVES:

- To investigate how a symmetric molecule directs asymmetric transcription.
- To investigate the drug-modification cavity using varying flanking sequences and drug molecules having different substituent groups.

METHODS:

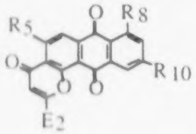
We took the different DNA sequences and 5' labeled them with ^{32}P. After labeling, we incubated some of the DNA with TBP and left some to act as the control. After allowing complex formation, we added either no drug, hedamycin, or altromycin B to the samples. We allowed time for drug modification to occur and then ran the samples out on a separation acrylamide gel. We eluted the control, the bound drug modified DNA and the free drug modified DNA and purified them. Next we ran a strand breakage assay and then ran out the samples on a sequencing gel and looked for areas of modification.

RESULTS:

The pluramycin family of drugs are known to be an antibiotic-antitumor family of drugs. They are cytotoxic to all cells but act preferentially upon cancer cells. The reason for this is unknown, but the mechanism through which they act is well documented. They are intercalating-DNA-alkylators which alkylate the N^7 of guanine (7). Because of this fact, they are often used as small molecular probes through which structural changes in DNA can be seen. This is how they were employed in our experiment.

In order to probe the changes induced by TBP, we used member of the pluramycin family of drugs as molecular probes. We isolated free DNA and DNA bound to TBP and treated them with hedamycin or altromycin B, in order to view areas of altered configuration.

The Stucture of Pluramycins and their Substituent Groups



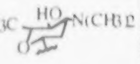
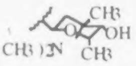
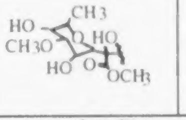
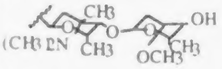
	R_5	R_8	R_{10}
Hedamycin	H		
Altromycin B		H	

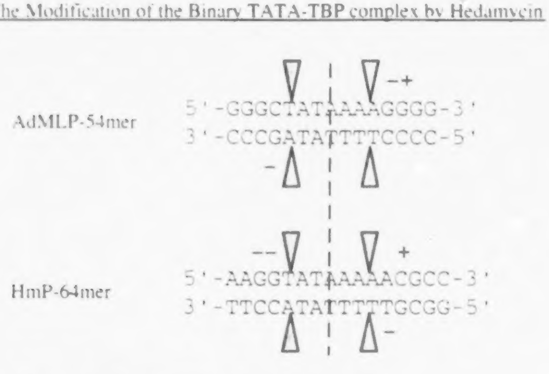
Figure 1: Structure of the Pluramycin Family and their Substituent Groups

In Figure 1 we can see the basic structure of the pluramycin family of drugs. The basic difference between members of this family are the substituent groups present at the different R-positions. The R_5 substituent interacts with the major groove of DNA and the R_8 and R_{10} substituents interact with the minor groove of DNA. Hedamycin has a hydrogen at the R_5 position and bulky sugar groups at the R_8 and R_{10} positions. For altromycin B, the hydrogen is present at the R_8 position and there are sugar groups at the R_5 and R_{10} positions. The E_2 is the epoxide that alkylates the N^7 of guanine.

For the top strand of the DNA-TBP complex of the Adeno-Virus Major Late Promoter (AdMLP-54mer), hedamycin showed enhanced modification of the third guanine, after the second phenylalanine insertion site of TBP. Hedamycin also showed a decreased enhancement of the second guanine, after the second insertion site of TBP on the top strand and a decreased enhancement of the guanine upstream of the first insertion site on the bottom strand.

The DNA-TBP complex for the top strand of the Human Myoglobin Promoter (HmP-64mer) showed enhancement of the CG base-step, after the second phenylalanine insertion site of the top strand of the HmP-64mer, after treatment with hedamycin. This guanine is in the same position as the enhanced guanine in the AdMLP-54mer. Both are the third base downstream of the insertion site on the top strand. There was also decreased enhancement of the guanines on the top strand, immediately upstream of the first insertion site.

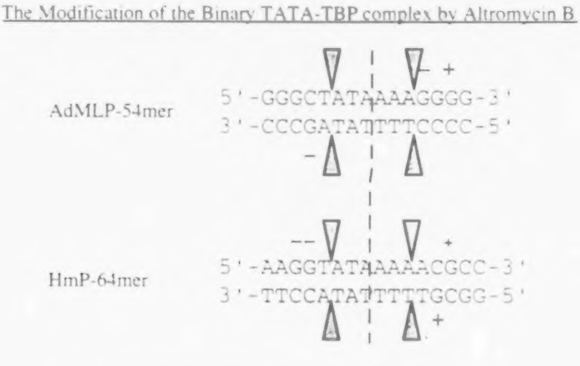
For the modification due to altromycin B, the same guanine that was modified by hedamycin in both the AdMLP-54mer and the HmP-64mer was modified by altromycin B as well. The difference between them was that the top strand guanine was modified to a much lesser degree in the HmP-64mer than in the AdMLP-54mer. The top strand of the HmP-54mer also showed a reduction in enhancement of the two guanines upstream of the first phenylalanine insertion site after treatment with altromycin B. This is the same result that was achieved after treatment with hedamycin.


The Modification of the Binary TATA-TBP complex by Hedamycin

-Wedges indicate phenylalanine insertion sites.
-Plus and minus signs indicate a change in the level of modification.
-Dashed line indicates plane of symmetry.

Figure 2: Modification of the AdMLP-54mer and HmP-64mer by Hedamycin

The result that stands out though, is that there was a large increase in enhancement of the bottom strand guanine, immediately downstream of the insertion site, after treatment with altromycin B. After treatment with hedamycin this guanine showed a reduced enhancement, but with altromycin B there is an increase in modification. This increase was much greater than that for the top strand guanine. The difference in the levels of modification by altromycin B, between the top and bottom strand, suggests that there is a preference for alkylation of the bottom strand as opposed to the top strand.


The Modification of the Binary TATA-TBP complex by Altromycin B

-Wedges indicate phenylalanine insertion sites.
-Plus and minus signs indicate a change in the level of modification.
-Dashed line indicates plane of symmetry.

Figure 3: Modification of the AdMLP-54mer and HmP-64mer by Altromycin B

All these results suggest site -specific modification of DNA by pluramycins (review 7). This site is centered around the second base-step, downstream of the second phenylalanine insertion site. This change is caused by TBP binding, which results in a change in the DNA conformation. This change can be visualized using the pluramycin family of drugs.

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DISCUSSION:

From these results we propose that there is an asymmetric effect induced in the DNA helix as a result of TBP binding. This conformational change occurs at the second base-step downstream of the 3' phenylalanine insertion site. This was confirmed using the family of intercalating-DNA-alkylating drugs known as pluramycins. What we saw was that the asymmetric modification of the sequence was a result of conformational changes induced in DNA. Despite different flanking sequences, different drugs and different TATA promoters there was an area of conformational change at the second base step downstream of the second phenylalanine insertion site that was not present upstream of the TATA site (refer to Figures 1 and 2).

The reason for this asymmetric conformational change in DNA could be due to the nature of the second half of the TATA sequence. Alternating TA's, which are present in the first half of the sequence, are much more flexible than a rigid A-tract. Insertion of a pair of phenylalanines distorts the helix, but this distortion is contained within this flexible alternating TA sequence.

In contrast, the second half of the sequence is made up of a rigid A-tract. This A-tract is not as flexible due to the close proximity of the thymine methyl groups. The fact that the thymines are next to each other result in the methyl groups having steric interactions with each other and the phosphate backbone (9). As a result, the distortion forced into the helix is propagated downstream of the TATA-sequence. The resulting change in the helix can then be visualized using pluramycins. As a result we see a patterns which suggests unwinding in the DNA helix, downstream of the TATA-site. The patterns were similar despite different flanking sequences and varying substituent groups. Of course this is a hypothesis and further tests must be performed to either confirm or deny its validity.

Although, the patterns of modification were similar for the same sequence, there were slight differences. This is partially due to the dependency of the drugs upon the sequence. The strand that was modified was dependent upon the flanking sequences. The reason is largely due to the sugar substituents of each drug. The interaction of the sugars at the R_8 and R_{10} positions with the minor groove, dictate the pattern of modification. Steric interactions with the phosphate backbone cause one strand to be modified as opposed to the other. So the presence or absence of sugars in these positions can lead to preferential modification of one strand over another.

This is exemplified by the modification of the HmP-64mer by altromycin B and hedamycin. The same guanine on the top strand is modified by both drugs, although altromycin B enhancement is not as pronounced (refer to Figures 2 and 3). But the guanine on the bottom strand show a decrease in modification by hedamycin, and an increase in modification by altromycin B. This is because the sugars of hedamycin interact with the phosphate backbone, precluding modification of the bottom strand. Modification of the top strand does not result in such steric interactions, and as a result there is an increase in enhancement.

On the other hand, the bulky sugar groups of altromycin B interact with the phosphate backbone when the top strand guanine is modified. Admittedly the steric interactions are not so inhibitory as to prevent modification, but they do decrease the level of enhancement to a great degree. But we see a large increase in modification of the bottom strand guanine. This is because when altromycin B moves in to modify the bottom strand, the sugar substituents fall with in the minor groove. There are no detrimental steric interactions to prevent modification. As a result we see a preferential modification of the bottom strand as opposed to the top strand.

All these results provide a starting point from which we can describe the DNA-drug cavity induced in DNA by TBP binding. Molecular modeling of the cavity will provide more information on the structural pattern of the unwinding site and how pluramycins interact with it. In addition, these results also provide a starting point from which studies on how the symmetric TBP molecule initiates asymmetric transcription.

REFERENCES:

1. Kim. J. L., Nikolov D. B., Burley S.K., *Nature* **365**, 520-527 (1993)
2. Nikolov D. B., et. al., *Nature* **377**, 119-128 (1995)
3. Lee D. K., Horikoshi M. Roeder R. G., *Cell* **67**, 1241-1250 (1991)
4. Hernandez N., *Genes and Development* **7**, 1291-1308 (1993)
5. Zawel L., Reinberg D., *Annual Review of Biochemistry* **64**, 533-61 (1995)
6. Burley S. K., Roeder R. G., *Annual Review of Biochemistry* **65**, 769-799 (1996)
7. Sun D., Hurley L. H., *Chemistry and Biology* **2**, 457-469 (1995)
8. Imbalzano A. N., et. al., *Journal of Biological Chemistry* **269**, 8280-8286 (1996)
9. Suzuki M., et. al., *Nucleic Acid Research* **24**, 2767-2773 (1996)

20.5

CHARACTERIZATION OF A MUTANT *dnaA-dnaN* GENE REGION THAT SUPPRESSES A TEMPERATURE SENSITIVE DEFECT IN THE *dnaX* GENE OF *Salmonella typhimurium*

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DNA polymerase III holoenzyme, the primary replication enzyme in *Salmonella typhimurium* and *Escherichia coli*, is composed of two dimeric subunits: a core dimer for polymerization and proofreading, and a β clamp dimer for enhancing the holoenzyme's processivity. Monomeric components of the β clamp are encoded by the *dnaN* gene, and assemble around the DNA strand in a process known as β clamping. One of the products of the *dnaX* gene, the γ subunit, joins four other subunits to form the γ complex that is responsible for β clamping. In order to fully understand the role of the γ complex in β clamping, we attempted to identify potential interacting domains of β with the γ subunit. The approach used was the characterization of a previously mutagenized region that contains *dnaN*, and its upstream gene, *dnaA*. This region has been shown to suppress a temperature sensitive (Ts) defect in the *dnaX* gene of *S. typhimurium* (4), which suggests that the product of one of its two genes interacts with the mutant *dnaX* product. The results verify that the mutagenized region suppresses the defect in the *dnaX* gene. In addition, it was observed that the region fails to suppress when the *dnaA* gene is deleted. These findings indicate that *dnaA* is the *dnaX* (Ts) suppressor, and suggest that the *dnaA* product, besides its function as the initiator of DNA replication, might also be involved in DNA polymerization.

INTRODUCTION

DNA replication in *E. coli* and *S. typhimurium* begins when DnaA, the replication initiation protein, binds, unwinds, and recruits polymerization enzymes to the replication origin. Elongation then occurs in a bi-directional and primer dependent manner (5). DNA polymerase III holoenzyme is the the primary replication enzyme in *E. coli* and *S. typhimurium* that elongates the replication forks. This holoenzyme is composed of two dimeric subunits: a core dimer for polymerization and proofreading, and a β clamp dimer for enhancing the processivity of the core (1, 10).

The assembly of the DNA polymerase III holoenzyme onto the DNA-primer template begins when the β clamp dimer is assembled by the γ complex, a protein composed of the subunits γ, δ, δ',ψ, and χ. This reaction is followed by the loading of the core dimer. Although clues exist as to how the core dimer binds to DNA, the mechanism of β clamping is almost

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entirely unknown (9). In order to elucidate the mechanism by which the γ complex loads the β clamp dimer, we attempted to identify potential interaction domains between the β clamp dimer and the γ subunit.

APPROACH

Allele specific extragenic suppression was used to identify an interaction domain between the γ subunit and the β clamp dimer. This type of suppression occurs when a non-lethal site specific mutation on one gene suppresses a conditional-lethal site specific mutation of another gene (6). Direct interaction between the mutant sites of the gene products is the most likely explanation for suppression, and implies that the wild type proteins also interact at the same domains (7,8,13).

A previous laboratory (4) located an extragenic suppressor of an *S. typhimurium* temperature sensitive (Ts) *dnaX* gene in the region that contains the *dnaA* and *dnaN* genes. This finding is useful because *dnaN* encodes the β clamp monomer (9), and *dnaX* encodes the γ subunit (3). Hence, in order to find an interaction domain between the β clamp dimer and the γ subunit, this region was further characterized.

The results of the experiments verified that the mutagenized *dnaA-dnaN* region suppresses *dnaX* (Ts). In addition, it was observed that when *dnaA* is absent from the region, suppression is lost. These findings suggest that *dnaA* is the suppressor of *dnaX* (Ts).

MATERIALS AND METHODS

All the bacterial strains and plasmids used in this experiment were provided by Engstrom *et al.* (4), and are described in detail in Tables 1 and 2 respectively. The growth media used are described in Table 3.

Strain	Relevant Genotype	References
RM 212 *S.typhimurium*	*dnaX* (Ts)	4
DB4894 *E. coli*	*dnaN* (Ts)	4
E 177 *E. coli*	*dnaA* (Ts)	14

Table 1: Bacterial Strains

Plasmid	Origin	Cloned Fragment	References
PFF20	PUC 8	*dnaA-dnaN* (Suppressor)	4
PFF52	PUC 8	*dnaA-dnaN* (Wildtype)	4
PFF42	PUC 8	*dnaN* (Suppressor)	4
PFF48	PUC 8	*dnaN* (Wildtype)	4
PUC 18	N/A	N/A	15

Table 2: Plasmids

Medium	Composition
Yeast Extract Tryptone (YET) Broth	0.5% yeast extract, 1% tryptone, and 0.5% NaCl.
YET Ampicillin Broth	YET Broth with 200 µg/ml of ampicillin.
YET Plates	0.5% yeast extract, 1% tryptone, 1.5% agar, and 0.5% NaCl.
YET Ampicillin Plates	YET Plates with 200 µg/ml of ampicillin.

Table 3: Growth Media

The methods described by Maniatis *et al.* (11), and O'Callagan *et al.* (12) were used to transform *E. coli* and *S. typhimurium* strains respectively. Each of the plasmids were transformed into *E. coli dnaA* (Ts), *dnaN* (Ts) and *S. typhimurium dnaX* (Ts) strains. After the transformants were purified three times, their ability to restore the growth of their temperature sensitive defects at the non-permissive temperature of 39 ℃ was checked. It was reasoned that if a plasmid restored the growth of a *dnaN* (Ts) strain, then its cloned fragment contained a functional *dnaN* gene. Likewise, if a plasmid restored the growth of a *dnaA* (Ts) strain, it was reasoned that its fragment contained a funtional *dnaA* gene. Finally, if a plasmid restored the growth .of a *dnaX* (Ts) strain, it was reasoned that its fragment had suppression activity.

Growth restoration of the transformants was checked by the efficiency of plating (EOP) method. This method quantitatively compares the amount of growth at the non-permissive temperature with the amount of growth at the permissive temperature (30 °C) to determine growth restoration.

The EOP method was used by growing the purified transformants in YET Ampicillin broths to an absorbance of 1-1.5. The cells were then serially diluted, plated on YET Ampicillin plates, and incubated for 24-36 hours at 30 °C and 39 °C. Next, the colony forming units per 1 ml of broth (CFU/ml) plated on each plate was calculated by the following formula:

$$\text{CFU/ml: } \frac{[\text{ Number of colonies }]}{[\text{Dilution factor}]\ [\text{ml plated}]}$$

Finally, the EOP was calculated by the following formula:

$$\text{EOP: } \frac{[\text{ CFU/ml at } 39\ ^\circ\text{C}]}{[\text{ CFU/ml at} 30^\circ\text{C }]}$$

RESULTS

As summarized in Table 4, the results verify that the supressor region with *dnaA* and *dnaN* suppresses *dnaX* (Ts). The results also indicate that when the *dnaA* gene is absent from the region, suppression is eliminated.

The suppressor region with *dnaA* and *dnaN* suppresses *dnaX* (Ts) because the plasmid with that region (PFF20) had a much higher *dnaX* (Ts) EOP than the plasmid with the non-supressor *dnaA-dnaN* region (PFF52).

In addition, the PFF20 plasmid had a higher *dnaX* (Ts) EOP than the uncloned plasmid (PUC 18).

Suppression is lost when *dnaA* is absent from the suppressor region because the plasmid with the suppressor region that lacked *dnaA* (PFF42) had a very low *dnaX* (Ts) EOP. This *dnaX* (Ts) EOP was as low as the negative control EOPs of the plasmid with wildtype *dnaN* (PFF48), and PUC 18.

PLASMID	*Cloned Fragment* (Origin)	*E. coli dnaN (Ts)*	*E. coli dnaA (Ts)*	*S. typhimurium dnaX* (Ts)
PFF52	*dnaA-dnaN* (Wild type)	+	+	-
PFF20	*dnaA-dnaN* (Suppressor)	+	+	+
PFF42	*dnaN* (Suppressor)	+	-	-
PFF48	*dnaN* *(Wild type)*	+	-	-
PUC 18	*NONE*	-	-	-

Table 4: Summary of experiments

CONCLUSION

In summary, this study characterized an extragenic suppressor of *dnaX* (Ts) that was located in the *dnaA-dnaN* gene region. Results indicate that extragenic suppression occurs when *dnaA* and *dnaN* from the region are present, but not when *dnaA* is absent.

From these data, we propose that *dnaA* is the suppressor, and suggest an additional role of the DNA replication initiation protein in elongation.

Currently, work is under way to separate *dnaA* from the *dnaX* (Ts) suppressor region and test its suppression activity. Further studies of this suppressor region should promise new insights into DNA replication.

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REFERENCES

1. Blinkova, A., C. Hervas, P.T. Stukenberg, R. Onrust, M.E. O'Donnel, and J.R. Walker. 1993. The *Escherichia coli* DNA polymerase III holoenzyme contains both Products of the *dnaX* gene, τ and γ, but only τ Is Essential. Journal of Bacteriology. 175: 6018-27.
2. Brock, T.D., and M.T. Madigan. 1994. Biology of microorganisms. Prentice Hall. 270-284.
3. Chen, K.S., P. Saxena, and J.R. Walker. 1993. Expression of the *Escherichia coli dnaX* gene. Journal of Bacteriology. 175: 6663-6669.
4. Engstrom, J., A. Wong, and R. Maurer. 1986. Interaction of DNA polymerase III γ and β subunits in vivo In *Salmonella typhimurium*. Genetics. 113: 499-515.'
5. Garret, R.H., and C.M. Grisham. 1995. Biochemistry. Saunders College Publishing. 900-960.
6. Hartman, P.E. , and J.R. Roth. 1973. Mechanisms of suppression. Advancements in genetics. 17: 1-105.
7. Hill, C.W. 1975. Informational suppression of missense mutations. Cell. 6: 419-427.
8. Jarvik, J., and D. Botstein. 1975. conditional-lethal mutations that suppress genetic defects in morphogenesis by altering structural proteins. Proceedings of the National Academy of Sciences of the United States of America. 72: 2738-42.
9. Kelman, Z., and M. O'Donnel. 1995. DNA polymerase III holoenzyme: structure and function of a chromosomal replicating machine. Annual Review of Biochemistry. 64: 171-200.
10. Kong, X.P., R. Onrust, M. O'Donnel, and J. Kuriyan. 1992. Three-dimensional structure of the β subunit of *E. coli* DNA polymerase III holoenzyme: a sliding DNA clamp. Cell. 69: 425-37.
11. Maniatis, T., E.F. Fritsch, and J. Sambrook. 1989. Molecular cloning: a laboratory manual. Cold Springs Harbor Laboratory. Cold Springs Harbor, N.Y.
12. O'Callaghan, D., And A. Charbit. 1990. High efficiency transformation of *Salmonella typhimurium* and *Salmonella typhi* by electroporation. Molecular and General Genetics. 223:156.
13. Roth, J.R. 1981. Frameshift suppression. Cell. 24: 601-602.
14. Weschsler, J.A., and J.D. Gross. 1971. *Escherichia coli* mutants temperature sensitive for DNA synthesis. Molecular and General Genetics. 113: 273-283.
15. Yarisch-perron, C., J. Vierra, and J. Messing. 1985. Gene. 33: 103-119.

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Conservation of Proto-Oncogenes, Tumor Suppressor Genes, and V(D)J Recombinase Genes Across Species

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Research on sharks has provided significant insights into the struggle against human disease. These studies may reveal how its distinct immune system works through studies of its genetic makeup. Identification of genes conserved throughout evolution may help in the discovery of new ways to battle cancers by determining how potentially lethal genes are conserved in divergent organisms. Three proto-oncogenes (SCL, MLL, CBFβ), two tumor suppressor (p53 and Rb), and two V-D-J recombinase genes (RAG-1 and RAG-2) were radiolabled and used as probes to identify conserved sequences in *Mustelus canis*, the smooth dogfish. All of the proto-oncogenes were conserved while other genes were not found to be conserved at a nucleotide level in the shark. Sharks have existed relatively unchanged for 450 million years. One of the keys to its disease resistance and survival may lie in the genetic makeup and how these genes function.

INTRODUCTION

Certain genes which are associated with basic biological functions have remained intact throughout the evolutionary process. The amount of genetic variance among homologous sequences in different species depends on how long ago the two shared a common ancestor (O'Brien and Clegg, 1993). Only recently has genome evolution become traceable by gene mapping and the identification of relic vestigial sequences, recombination sites, and repeats. Molecular evolution of virus sequences implies cross-species development of viral pathogens. Elasmobranchs (sharks, rays and skates), are phylogenetic descendants of placoderms. The elasmobranch immune system has probably changed little since their appearance 450 million years ago. This may give some insight to a defined, distant but extraordinary period in evolution (Litman, 1996).

It has been speculated that sharks do not get cancer. However, the Smithsonian Institute has records of at least 20 known cases of cancer in sharks (Beardsley, 1993). Despite this observation, it remains possible that development of malignancies may be less common in sharks than in mammals. Data describing malignancies in sharks are not yet well defined and a study of proto-oncogenes, tumor suppressor genes, and V(D)J recombinase genes conserved through evolution may give more insight to the shark's genetic pre-disposition toward cancer.

Immunity in sharks is different from later organisms such as frogs, monkeys, and humans. The ancient immune system of sharks may be as effective if not more effective than that of their more modern counterparts. In the 1980s the horned shark was the first to have genes isolated that encode for immunoglobulins. Studies thus far show, like all homologues for the immunoglobulin genes the shark's also undergoes rearrangement, yet the organization of gene segments within the shark genome differs greatly from that of mammals (Litman, 1996). Sharks have endured exposure to many detrimental infections. Their ability to thwart off these potentially life threatening diseases may be why they have survived for 450 million years. Certain proto-oncogenes (SCL, MLL, CBFβ), tumor suppressor genes (p53, Rb), and V(D)J recombinase genes (RAG-1, RAG-2) are known to be conserved throughout evolution in organisms ranging from chickens to mice to humans.

Proto-oncogenes can be defined as normal cellular genes, which when dysregulated, are associated with malignant transformation. The normal functions of these genes are often crucial for the development and growth of the organism. SCL, MLL, and CBFβ are all proto-oncogenes identified by virtue of their disruption and activation by chromosomal translocation in human leukemias. All these human genes have sequences that are conserved in mouse and *Drosophila* genomes, suggesting that they supply some necessary function for the organism. However, when dysregulated and dysrupted by chromosomal translocation, they are associated with malignant transformation.

The tumor suppressor gene p53 is inactivated in approximately half of all human cancers (Cho et. al., 1994). This gene is part of a pathway that is responsible for damage repair in DNA; this function helps protect genomic balance (Friend, 1994). The Rb gene is a tumor suppressor gene first identified due to its disruption in human retinoblastomas. Since then, this gene has been shown to be an important regulator of morphogenesis and mammalian cell growth; its function clearly is more widespread than simply within the developing retina (Bernards et. al., 1989). Human Rb homologues have been detected in brook lamprey, cat-shark, swordtail, chicken and mouse. Fragments of this gene seem to be present to some degree in genomes of all chordates (Bernards et. al., 1989).

The generation of diverse T cell receptors and immunoglobulins is in large part due to recombination of discrete V (variable), D (diversity) and J (joining) segments in the lymphocyte genome. One of the genes whose product mediates V(D)J recombination, the recombination activity gene (RAG-1), has been found to be conserved to some degree in chickens, frogs, rabbits, horses, goats, dogs, and mice(Schatz et. al., 1989).

This paper uses cross-species hybridization to determine if three representative proto-oncogenes (SCL, MLL, CBFβ), two tumor suppressor genes (p53 and Rb), and the V(D)J recombinase genes (RAG-1 and RAG-2) are conserved in the elasmobranch *Mustelus canis*, commonly known as the Smooth Dogfish. By determining if some of these vital genes are conserved in the shark, this information will enhance the genetic library of one of the oldest classes of vertebrates on the planet. Furthermore, studying how and to what degree these genes are expressed may show the ways different organisms fight cancer.

METHODS AND MATERIALS

DNA from the urogenital, heart, gills, liver and spleen tissue of *M. canis* was extracted using a standard DNA salting out technique. The cells were pelleted and resuspended in 3 mL lysis buffer (0.2 mol/L NaCl, 20 mmol/L EDTA, 40 mmol/L Tris HCl pH 8.0, 0.5% sodium dodecyl sulfate [SDS], and 20 μL proteinase K) and incubated at 50°C for three hours. RNase A was added to a final concentration of 10 μg/mL and the sample incubated at 37°C for 30 minutes. Saturated NaCl (1.5 ml; > 5 mol/L) was added and the sample centrifuged at 5,000 RPM. The supernatant was aspirated and DNA spooled out of solution after precipitation with 2 vol of ethanol (Aplan 1996).

The Southern blots used 10 μg genomic DNA from *M. canis* (heart and spleen), human and mouse digested with EcoRI size fractionated using an 0.8% agarose gels (Aplan, 1996). The human DNA is from the Jurkat T-cell leukemia cell line and the mouse is from the F4-6 murine erythroleukemia cell line. The probes for SCL, MLL, CBFβ, p53, Rb, RAG-1 and RAG-2 were ^{32}P-labeled using a Prime-It II kit (Stratagene, La Jolla, CA) as per manufacturers instructions (cell lines for probes available upon written request). Each blot had one human, one mouse, and two shark lanes for probing. The washes used in hybridizing the probes to the nitrocellulose filter for the Southern blots were washed at 42°C that results in a 75-85% homology to the human gene.

RESULTS

Conserved sequences can be identified by hybridization of discrete restriction endonuclease fragments to radiolabeled probes derived from cloned genes. The human SCL, MLL, and CBFβ probes hybridized to specific fragments in both mouse and shark genomic DNA, indicating that these gene sequences had been conserved throughout evolution. As expected, the conservation between human and mouse was more obvious than between human and shark for these probes. The MLL probe generated a more intense signal than either the SCL or the CBFβ probe, suggesting that MLL is more highly conserved between human and shark than is SCL or CBFβ. p53, Rb, Rag-1 and RAG-2, did not show evidence of specific cross-hybridization between mammalian and elasmobranch species (Table 1). All these human probes showed specific cross hybridization with mouse genomic DNA that served as an internal positive control.

Table 1: Southern Zoo Blot Autoradiograph Results

GENE	CONSERVED
SCL	positive
MLL	positive
CBFβ	positive
P53	negative
Rb	negative
RAG-1	negative
RAG-2	negative

DISCUSSION

Since the SCL, MLL, and CBFβ are conserved in *M. canis* there are some remaining areas of study that need to be addressed to determine if these genes of interest are expressed similar to their patterns in mammals. Since the proto-oncogenes are found in *M. canis*, the smooth dogfish has the potential to develop cancers associated with these genes should they become dysregulated. In humans these tumors are very detrimental. How these genes are expressed may show how the elasmobranch fights cancer in its body.

The lack of hybridization of the Rb tumor suppressor gene was somewhat surprising. According to Bernards (1989), sharks do have an Rb gene. Inability to detect specific cross hybridization in *M. canis* may be due to one of several possibilities. There may have been differences in hybridization conditions, or differences in the Rb probes employed. Moreover, due to the degenerate nature of the genetic code, it is possible that while Rb is conserved at the amino acid level, it is not well conserved at the nucleic acid level. RAG-1 and RAG-2 also resulted in a lack of hybridization in this study. Litman (1996) shows that sharks have use of V(D)J recombination to fight infection but it is arranged much differently than mammals. The inability to detect RAG-1 and RAG-2 may also be due to the degeneration of the genetic code and the level that these genes

2013

are expressed.

Sharks have an immune system which, at first glance, is organized in a fashion similar to mammals, with discrete V ("variable"), D ("diversity"), and J ("joining") segments. However, more detailed study has indicated that in the shark, each V and D segment is associated with a specific J segment, as opposed to mammalian immunoglobulin loci, where a cluster of 50-100 V segments is located upstream of relatively few D and J segments (Bartl et. al., 1994). Recent research has found all four classes of mammalian T cell antigen receptors in skates. This finding leads to the high probability that they will be found to be conserved in all elasmobranchs. In Elasmobranchs T cell receptors seem to have undergone no tangible evolutionary changes since the shark's divergence from the mammals (Litman, 1996). Until more is known about the shark and how its immune system works and what genes are conserved, its putatively low malignancy rate will still be a mystery.

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REFERENCES

Aplan, P. et. al. 1996. Site-specific DNA cleavage within the MLL breakpoint cluster region induced by Topoisomerase II inhibitors. Blood, v87: 2649-2658.

Bartl, S. et. al. 1994. Molecular evolution of the vertebrate immune system. Proc. Natl. Acad. Sci. USA, v91: 10769-10770.

Beardsley, T. 1993. Sharks do get cancer. Scientific American, v269: 24-25.

Bernards, R. et.al. 1989. Structure and expression of the murine retinoblastoma gene and characterization of its encoded protein. Proc. Natl. Acad. Sci. USA, v86: 6474-6478.

Cho, Y. et. al. 1994. Crystal structure of a p53 tumor suppressor-DNA complex: Understanding tumorigenic mutations. Science, v265:346-354.

Friend, S. 1994. p53: A glimpse at the puppet behind the shadow play. Science, v265:334-335.

Litman, G. 1996. Sharks and the origins of vertebrate immunity. Scientific Américan, v275:67-71.

O'Brien, S.; Clegg, M. 1993. Genomes and evolution, Editorial overview. Current Opinion in Genetics and Development, v3: 835-836.

Schatz, D. et.al. 1989. The V(D)J recombination activating gene, RAG-1. Cell, v59: 1035-1048.

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AN ANALYSIS OF LIPID BILAYER STUDIES OF SINGLE ION CHANNELS USING M2 AS AN EXAMPLE

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The rapid fluctuations among sets of open and closed states as revealed in the phospholipid bilayer studies of single biological ion channels are key to understanding detailed dynamics of these complex syslems. A progressive analysis of the M2 protein ion channel from influenza A is presented as a model for obtaining insight into these channel dynamics. The Markovian or chaotic character of the system is determined by obtaining carrying capacities and Hausdorff dimensions for the channel current as a time function. By binning the currents (pA) the frequencies of transitions among various channel states are determined. Finally, the kinetics of transitions from these states are obtained. This progressive analysis provides a definitive characterization of single channel dynamics, which is presently being employed in the study of channels common to picornaviruses.

INTRODUCTION

In simplest form the biological ion channel is a hydrophilic pore formed by the linking of a number of membrane spanning alpha helices from one or more membrane proteins [Hille, 1992]. Channels may be spontaneously created and annihilated by the linking and disengaging of such helices resulting in the rapid time variation in channel currents or may possibly be permanent structures with the rapid gating resulting from the dynamics of the ion flow and changes in the protein state [Hille, 1992].

By incorporating proteins, or vesicles containing these proteins into phospholipid bilayers it is possible to study the currents of individual channels under distinct conditions imposed by solutions in the bathing media. The current passing through the channel at a fixed potential impressed across the bilayer is recorded. Bilayer data are gathered on a scale of 0.25 mS and over periods of 1S. In the example considered in this paper data were gathered over 40 such 1S periods at different times.

Figure 1 provides typical results from such an experiment. Channel activity is characterized by a very rapid change in current from one level to another. The channel currents appear in discrete, almost quantum levels with dwelltimes which may be milliseconds. These levels are evidenced in panel B of the figure.

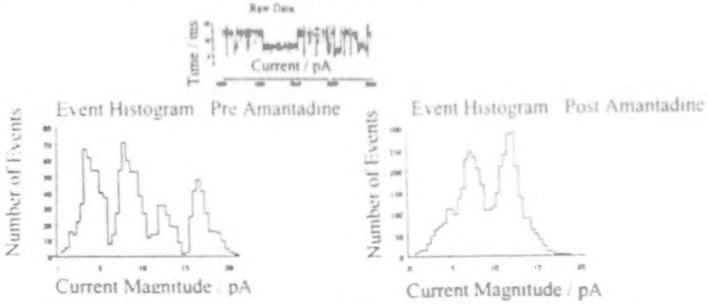


Figure 1. Panel A shows a current versus time trace gathered in a bilayer experiment. The channel activity appears as rapid large transitions among sets of current levels. Panel B provides event histograms, which are plots of the occurrences of a current against the current magnitude, for the three traces: prior to and after exposure to amantadine (see text).

In dynamical character the channel may be Markovian, in which the channel lacks memory and each state change is dependent only on the present state, or chaotic, in which the channel is a nonlinear dynamical system with memory. Because of the role played by channels in biology and because of the desire to pharmacologically combat many viruses whose life cycles depend on such channels, the question of the form of the channel dynamics is of practical importance.

This paper outlines a sequence of steps which have been undertaken to establish the basic character of the channel dynamics using the M_2 protein channel of influenza A, which is blocked by the drug amantadine [Pinto, et al., 1992], as an example. The chaotic nature of the channel dynamics is established through analysis of the time dependence of the channel current under conditions of exposure of the channel to amantadine. A study of the transition frequencies between current levels introduces the concept of a frequency landscape, in which the initial and final levels form a grid in the horizontal plane and the transition frequency is plotted on the vertical axis. The form of this landscape and its variation under different conditions provides insight into the details of channel behavior. For chaotic channels a final step may be undertaken which establishes the fractal dimension for the self-similar dynamics. This provides understanding of the transition pathways out of a given state.

MATERIALS AND METHODS

The data were collected from a single channel from purified M_2 protein prior to and 20 and 50 minutes after exposure to amantadine. The records each consisted of 40,000 mS traces. In the experiments the bilayer membrane consisted of phosphatadylethanolamine and phosphatadylcholine in a ratio of 75:25 and a concentration of 50 mg/ml. The salt solution in the two chambers was Sodium Methane Sulfonate. The data are gathered on time scales which are neither those of the protein nor of the ions, which are to be considered in any molecular understanding of the channel dynamics.

ANALYSIS

The analysis treats only the raw data files for current as a function of time. No curve fitting is involved until the step 4 in the analysis. The first two steps establish the Markovian or chaotic character of the data. The third provides a graphical picture of the transition frequencies among the various current levels. The fourth step is only undertaken if the dynamics prove to be chaotic, as is the case for M_2. This fourth step provides a quantitative description of the transition from a given level in terms of fractal dimension, which may be interpreted in terms of pathways out of the corresponding state.

Step 1 is a box counting procedure [Bassingthwaighte, et al., 1994]. The data are read at times (t), (t+T), ..., (t+nT), where T is a characteristic time for the system and (n+1) is the dimension of the analysis. This produces (n+1) sequences defining (n+1) axes for the representation. The axes are gridded with a grid size r defining cubes of volume r^{n+1}. If N(r,A) is the number of cubes required to cover the data A in the given space, then the carrying capacity is defined as

$$Cap\ A_{n+1} = \limsup_{r \to 0} \frac{\ln N(r,A)}{\ln(1/r)} \tag{1}$$

For chaotic systems equation (1) has a limit as the space dimension increases, but is limitless for Markovian systems, for which the representative points fill all volumes regardless of volume size.

Eckmann and Ruelle [Eckmann and Ruelle, 1985] have pointed out that the Hausdorff dimension is a more reliable quantity for analyzing data. Obtaining a Hausdorff dimension is the second step in the analysis. The data are read at the same times as in the box counting. Each time point, t_j, serves to define a vector of dimension $m = (n+1)$ as

$$X(j) = [I(t_j), I(t_j+1), \ldots, I(t_j+m-1)] \tag{2}$$

for N such vectors the quantity $C_N^m(r)$ is defined as

$$C_N^m(r) = \frac{1}{N^2}\{\ \textit{number of ordered}\ [X(i), X(j)]\ \textit{such that}\ d[X(i), X(j)] \le r\ \} \tag{3}$$

where

$$d[X(i), X(j)] =$$
$$\{(I(i+1) - I(j+1))^2 + (I(i+2) - I(j+2))^2 + \quad \cdots \quad + (I(i+m-1) - I(j+m-1))^2\}^{1/2} \tag{4}$$

is the Cartesian distance between $X(i)$ and $X(j)$. The Hausdorff dimension is then

$$\beta_m = \lim_{m \to \infty} \lim_{r \to 0} \frac{\ln C_N^m(r)}{\ln(r)} \tag{5}$$

Again the existence of the limit in (5) implies a chaotic basis for the data.

Independently of the dynamics, frequencies for transitions among current levels are of interest. These are easily evaluated from the raw data by determining the occurrence of consecutive levels "p" and "q" in the data. This defines frequency of the transition $(p \to q)$. In the landscape the levels p and q form the two axes defining the horizontal plane and the frequency is plotted on the vertical axis. The high values of frequency appear as mountain peaks on the landscape. If the dynamics are Markovian the number of times a particular current level occurs is proportional to the number of configurations of the channel (channel states) that result in that current. This is reflected in the event histogram, which provides directly the number of times a current level appears. In a Markovian system the transition from one state to another is strictly probabilistic so the transition frequencies for a given level should resemble the histogram. Chaotic dynamics would produced a non-symmetric pattern.

Step 4 in the analysis is only undertaken if the steps 1 and 2 indicate that the underlying dynamics are chaotic. Here the analysis is based on time self-similarity characteristic of chaos. The Ansatz is made that at the time (t) the rate at which transitions from a current level α occur is given by

$$\frac{d\rho_\alpha(t)}{dt} = -k_\alpha(t)\rho_\alpha(t) \tag{6}$$

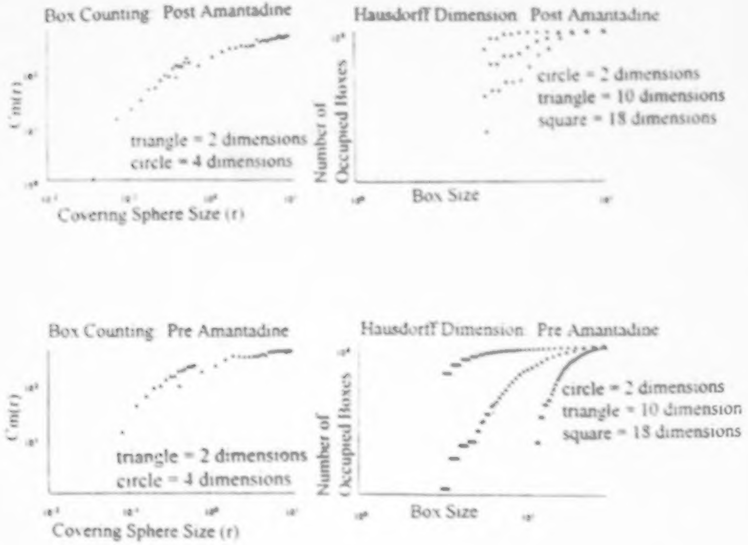
where $\rho_\alpha(t)$ is the number of channels in the membrane containing the channels of interest, in the current state α at the time (t). The rate coefficient, $k_\alpha(t)$, models the nonlinear dynamics of the underlying protein. For time self-similarity $k_\alpha(t)$ has the form

$$k_\alpha(t) = A_\alpha t^{1-D_\alpha} \tag{7}$$

where A_α is a constant and D_α is the fractal dimension for the dynamics. Liebovitch and Toth [Liebovitch and Toth, 1991] have shown that the fractal dimension is a measure of the structure of the pathways for the transition from a given (protein) state. If the protein is in one of the states (say α_p) which result in the current level α and undergoes a transition from that state, then there are a number of other states(say the set $\{\beta_q\}_{q=1}^{N}$) which are possible for the final state producing the next current level β. A transition of the protein $(\alpha_p \to \beta_q)$ is a possible pathway from the state α_p. These pathways have a density which determines the fractal dimension. The procedure to be undertaken to find D_α from the raw data files has been provided elsewhere [Qiao, 1995].

DISCUSSION

In Figure 2 the results of analysis steps 1 and 2 for the M_2 channel prior to and at two stages after the addition of amantadine to the bathing solution



Box Counting: Post Amantadine

Hausdorff Dimension: Post Amantadine

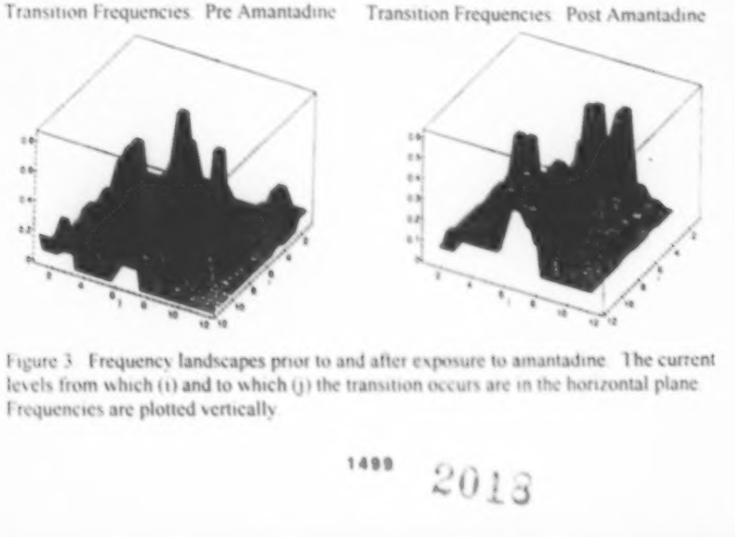
Box Counting: Pre Amantadine

Hausdorff Dimension: Pre Amantadine

Figure 2. Carrying capacity (Panel A)and Hausdorff dimension (Panel B) plots for the M_2 channel prior to and after amantadine exposure

A strong indication of chaotic behavior is evidenced prior to the addition of amantadine while a loss of chaotic structure appears particularly 50 minutes after the addition of amantadine. The event histograms (not shown) reveal that the channel is still active having lost only the top level(s).

The frequency landscapes in Figure 3 indicate a change from a rich and varied structure for the transition frequencies prior to the addition of amantadine to a less varied structure after exposure. That is there are more transition pathways available prior to the addition of amantadine than after.



Transition Frequencies: Pre Amantadine

Transition Frequencies: Post Amantadine

Figure 3. Frequency landscapes prior to and after exposure to amantadine. The current levels from which (i) and to which (j) the transition occurs are in the horizontal plane. Frequencies are plotted vertically.

The plots of Figure 2 establish that the M_2 channel is chaotic, at least prior to the application of amantadine. Therefore, step 4 in the analysis was undertaken for this system. The results are presented in Table 1. In this table the current levels indicated by A, B,.. are defined in the event histograms of Figure 1.

Initial State	Fractal Dimension
Pre Amantadine:	
Top (A)	1.87
Central (C)	1.62
Bottom (D)	1.35
Post Amantadine	
Top (A)	1.45
Bottom (B)	1.45

Based on the ideas of Liebovitch and Toth, the variation in fractal dimension indicated is consistent with the structural change indicated by the landscapes. The landscapes indicate a more limited accessibility as a result of the application of amantadine. After the addition of amantadine, the rich and varied form with many peaks becomes a more limited clustering of peaks. The peaks indicate possible transitions. A decrease in the number of peaks, then, in the language of a density of transition pathways, corresponds to a density with a reduced range, which is consistent with the expectations of Liebovitch and Toth for a decrease in fractal dimension.

The present example of the behavior of the M_2 protein channel has indicated the consistent understanding of the basic character of the dynamics of a very complicated channel system using the procedure proposed. Of course the details remain opaque, as does the actual molecular structure of the channel itself. But such a study of the dynamics based on raw data is a necessary step toward the successful modeling of a channel and a model is necessary for logical design of pharmaceutical approaches to the problems of disease control.

The procedure outlined here is presently being pursued by CSH in the study of the channels of picornaviruses and plant viruses (Southern Bean Mozaic Virus) as well as endogenous channels in the oocytes of *Xenopus Laevis*. These systems reveal multiple states and variation in dynamics under application of acids and antibodies.

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REFERENCES

Bassingthwaighte, J.B., L.S. Liebovitch and B.J. West, Fractal Physiology, Oxford University Press (1994).
Eckmann, J.-P. and D. Ruelle. "Ergodic Theory of Chaos and Strange Attractors," Reviews of Modern Physics, 57, 3, 617-656 (1985).
Grassberger, P and I. Procaccia, "Measuring the Strangeness of Strange Attractors," Physica 9D, 189- 208, 1983.
Hille, Bertil. Ionic Channels of Excitable Membranes, Sinauer, Sunderland, MA (1992).
Qiao, Y., "Kinetic Studies of the Ionic Current Through the M_2 Channel in the Influenza A Virus," Proceedings NCUR IX, 794-798, 1995.

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Metal Regulated Gene Expression in *Pseudomonas fluorescens*

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Heavy metals, which accumulate in the environment, pose a threat to animal and human health. Microorganisms are also affected, and must constantly adapt to these harsh conditions in order to survive. We are interested in identifying genes that are regulated in order for common soil bacteria to facilitate metal tolerance. Utilizing transposon mutagenesis, and the *lacZ* reporter gene, we have identified seventeen *P. fluorescens* ATCC 13525 mutants that express differential gene activity in the presence of cadmium. We have characterized twelve mutant strains that display higher gene activity after metal exposure, whereas five mutant strains showed reduced gene activity. Several mutant strains have shown at least a five-fold increase in gene activity as a result of cadmium exposure. Additionally, several mutant strains have shown similar differential gene expression in the presence of copper or zinc.

INTRODUCTION

As a result of industrial pollution and poor methods of waste disposal, many toxins, including metals, have accumulated in the environment. Once in the soil, heavy metals may contaminate water supplies, including those used for drinking water (Paasivirta, 1991). Subsequently, metals may enter the food chain if they have the ability to accumulate inside organisms. Cadmium, for instance, may enter the environment as a by-product of fertilizers or industrial wastes, or directly through mining processes. Cadmium is also used in rechargeable batteries, pigments, plastics and electroplating (Ron et al, 1992).

Microorganisms must constantly adapt to their external environment to survive in their specific ecological niche. Such adaptations include modifying gene expression to optimize survival opportunities in a harsh environment. While some bacteria have the ability to express metal resistance genes, which are commonly carried on plasmids, others might not contain these plasmids. We would like to understand how common soil bacteria react to elevated levels of toxic metals.

The purpose of this study is to identify genes in *P. fluorescens* ATCC 13525, which are differentially induced or repressed in the presence of cadmium. Once we have identified several genes that show differential expression, identification of their specific function will allow us to determine if these genes indeed aid in metal tolerance. In general, this information may identify mechanisms, that may be used by bacteria to cope with elevated levels of heavy metals. For example, the gene may encode for metal accumulation within the cell, reactions that change the oxidation state of toxic elements, or efflux mechanisms. Eventually, this information will benefit bioremediation efforts that aim at using biological organisms to clean up contaminated sites.

METHODOLOGY

A convenient way to monitor gene expression in bacteria is through a reporter gene system. For our study, the *lacZ* reporter gene, encoding the β-galactosidase enzyme, has been selected. If a transposable element containing the *lacZ* gene is inserted downstream of an active promotor, the level of enzyme activity will represent the gene activity directed by that promotor. *Lac* activity is identifiable as β-galactosidase production through various colorimetric assays. Specifically, we are interested in characterizing genes that are expressed little or none on a control medium, but highly expressed in the presence of cadmium, or vise versa.

Transposon Tn*5*-B20 carries the promotorless *lacZ* reporter gene as well as the *nptII* gene conferring kanamycin resistance (Km^R). Conjugation between donor strain *E. coli* S17-1 [pSUP102/Tn*5*-B20] and recipient strain *P. fluorescens* ATCC 13525 assured the creation of *P. fluorescens* mutants. Since suicide vector pSUP102 cannot replicate outside of *E. coli*, Tn*5* will transpose into the *P. fluorescens* genome and create true mutants. At that point, isolation of *P. fluorescens* Km^R mutants occurred on a medium that counterselected against *E. coli*.

A common colorimetric method used to identify β-galactosidase activity is to grow the bacteria on a medium supplemented with the substrate X-Gal (5-Bromo-4-Chloro-3-indolyl-β-D-galactoside). X-Gal is cleaved by β-galactosidase to yield an indigo precipitate, e.g. the darker the blue, the higher the enzyme activity.

Southern blot analysis and the hybridization experiment were performed according to the procedure specified by the manufacturer, Boehringer Mannheim (Indianapolis, IN). The hybridization probe was labeled using a digoxigenin (DIG) DNA labeling kit. Detection for hybridizing fragments utilized luminescent techniques as specified by the manufacturer.

To quantitatively determine the level of gene activity for each tagged gene, another enzyme assay was used. ONPG (ortho-nitrophenol-β-D-galactoside) is a substrate that is hydrolyzed by β-galactosidase to yield ONP which has a characteristic yellow color. The amount of ONP can be measured readily in a spectrophotometer as the optical density (OD) at a 420 nm wavelength (OD_{420}). Additionally, the culture density of a sample may be measured in a spectrophotometer at a 600 nm wavelength (OD_{600}). Utilizing a protocol from Miller (1989), the enzyme assay was performed with minor modifications. Experimental cultures were grown in rich liquid media overnight either in the presence or absence of cadmium. The enzyme activity was calculated as Miller Units (see equation 1).

$$\text{Miller Units} = \frac{1000 \times OD_{420}}{t \times v \times OD_{600}} \qquad t = \text{reaction time, } v = \text{reaction volume} \qquad (1)$$

RESULTS AND DISCUSSION

Identification of MIC

In order to identify a suitable concentration to screen for genes which are influenced by elevated levels of metal, the minimum inhibitory concentration (MIC) of several metals was identified for *P. fluorescens* ATCC 13525 (see Table 1). The MIC is defined as the "lowest concentration of toxic element which inhibits the formation of colonies" (Mergeay, 1991). Our goal was to select a metal concentration that would challenge bacterial growth, but still allow sufficient growth for experimental purposes. Table 1 shows the results of our experiments establishing the MIC concentrations for different metals.

Table 1. MIC values *P. fluorescens* ATCC 13525 on an agar medium

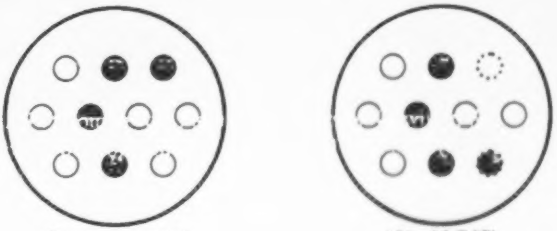
Metal	Medium	Minimum Inhibitory Concentration
$CdCl_2$	rich	200.0 µM
	minimal medium	50.0 µM
$HgCl_2$	rich	5.0 µM
	minimal medium	2.0 µM
$ZnSO_4$	rich	2.0 mM
$CuSO_4$	rich	2.0 mM

Creation of *P. fluorescens* Tn*5*-B20 mutant bank

Using the mutagenesis protocol outlined in methodology, a mutant bank of 5000 *P. fluorescens* strains containing random insertions of Tn*5*-B20 was generated.

Identification of metal-regulated genes

All five-thousand mutant strains were screened on a rich medium containing Km and X-Gal, and parallel plates supplemented with 150 µM $CdCl_2$ (150 µM was selected as a challenging concentration because it is just below the *P. fluorescens* $CdCl_2$ MIC). Figure 1 shows an example of the phenotypic change in color indicating that a mutant colony contained a differentially expressed gene on the metal medium. For example, the colony in the upper right hand corner (top row) shows reduced activity in the presence of cadmium. This change is evident by the change in colony color from dark (blue) on the control medium to light (white) on the medium containing cadmium. The opposite effect is seen for the lower right hand colony (bottom row) which shows an increase in gene activity in the presence of cadmium.



Control, no metal

150 µM $CdCl_2$

Fig 1 Diagram depicting X-Gal screening of *P. fluorescens* Tn*5*-B20 mutants for differential gene expression on rich media supplemented with Km and X-Gal. Colonies on the metal medium show an increase or decrease in gene activity, detectable by a change in color.

Seventeen mutant strains were identified that displayed differential gene activity on the metal medium. Specifically, thirteen mutant strains displayed a higher level of gene expression and four a lower level of gene expression in the presence of $CdCl_2$. Two additional mutants containing either a constitutively expressed or repressed gene were also isolated as positive and negative controls.

Determination of Tn*5*-B20 transposon insertion sites

To prove that the Tn*5*-B20 transpositions were random and single events in each mutant strain, a hybridization experiment was performed. The total chromosomal DNA from the seventeen *P. fluorescens* mutants, and *P. fluorescens* ATCC 13525 (wild type) was digested with *Eco*R1 and separated by agarose gel electrophoresis. The gel was blotted and hybridized with the 2.2-kb *Eco*R1/*Sac*1 DNA fragment of pMC1403 containing the *lacZ* gene, labeled with digoxigenin.

Of the seventeen mutant strains, each contained only one hybridizing fragment clearly visible at a unique location in the chromosome. This observation proved that the transposon insertions were random and single events. Additionally, the wild-type (negative control) showed no hybridizing fragments.

Quantitative determination of metal-regulated gene activity

In order to obtain quantitative values for metal regulated gene expression, we performed the β-Galactosidase enzyme assay. Figure 2 shows the results obtained for the seventeen mutant strains, plus two control mutants, in the presence of 75 µM $CdCl_2$.

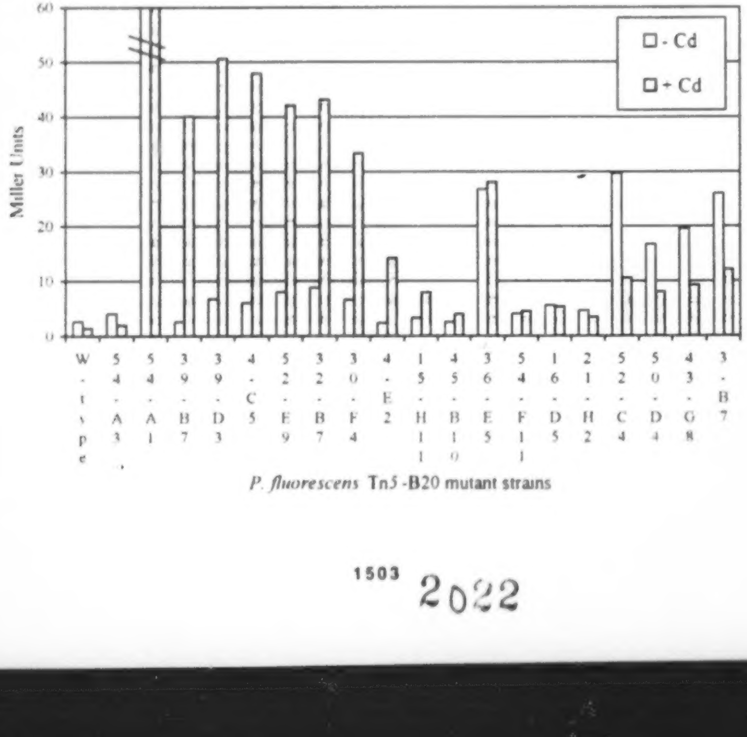


Fig 2 (previous page) β-galactosidase activity (expressed as Miller Units) of *P. fluorescens* Tn5-B20 mutant strains in the presence and absence of 75 μM $CdCl_2$

Several mutant strains show a significant increase or decrease in the presence of cadmium The negative control, mutant 54-A3, did not exhibit a high level of gene expression The positive control, 54-A1, on the other hand had enzyme activity that went off the graph (actual ~877 units) The gene activity of mutant strain 39-B7 was approximately 20 times higher in the presence of cadmium Other mutant strains, 32-B7, 39-D3, 4-C5, 52-E9, 30-F4 and 4-E2 had gene expression at least five times higher when grown in cadmium than without the metal

Four mutant strains, those furthest to the right on the graph, showed a distinct decrease in gene activity when grown in a medium containing cadmium These four mutants, 52-C4, 50-D4, 43-G8 and 3-B7, indicate that the tagged gene is repressed in the presence of metal Other colonies (36-E5, 54-F11, 16-D5, 21-H2) did not show a significant change in gene expression, if any, at a concentration of 75 μM cadmium

Response of mutant strains to copper and zinc

In order to determine if the mutant strains contain a gene that may be differentially expressed in the presence of other metals, each mutant was screened on media supplemented with copper or zinc For both metals, a 1 mM concentration was selected (just lower than the predetermined MIC, table 1)

On the medium containing $ZnSO_4$, seven mutants were identified that displayed differential activity similar as on the medium containing cadmium, three were induced, and four were repressed On the medium containing $CuSO_4$, six mutants were identified that displayed differential gene activity similar as on the medium containing cadmium, two were induced, and four were repressed as a result of metal exposure It is important to note that the same four mutants were repressed on all three metal mediums

Phenotypic growth experiment

It is important to point out that the tagged gene of each exconjugant is mutated as a result of the Tn5-B20 insertion Thus, if a gene is actually involved in metal tolerance, the mutant should show a decreased ability to grow in the presence of cadmium In order to determine the phenotype of the mutant strains, each mutant was grown in the presence and absence of cadmium in full liquid media The specific growth rate of each mutant strain was determined and compared to the growth rate of the *P. fluorescens* wild type Specifically, only one mutant, 45-B10, showed a significant decrease in growth rate when compared to the wild-type control in a medium containing 150 μM $CdCl_2$ (Fig 3)

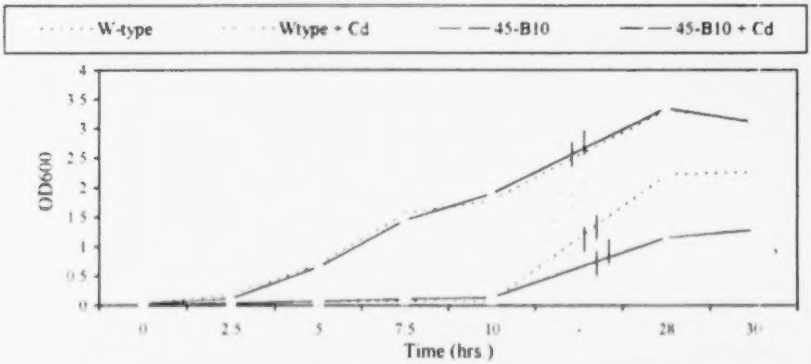


Fig 3 Graph comparing the growth rate of *P. fluorescens* mutant strain 45-B20 and *P. fluorescens* ATCC 13525 wild type in rich media supplemented with 150 μM $CdCl_2$

CONCLUSION

We have succeeded in identifying seventeen *P. fluorescens* Tn5-B20 mutant strains containing genes that were differentially expressed in the presence of cadmium Several of these mutants also showed differential gene activity in the presence of either copper or zinc Finally, one mutant strain showed a significant decrease in the ability to grow in the presence of cadmium when compared to the wild-type strain

Cloning and sequencing of the tagged gene from each of the seventeen *P. fluorescens* mutant strains will further elucidate the possible role and function of these genes By comparing the gene sequences to public databases, homologous sequences may be identified and provide a hint on the role of each gene responding to metal exposure This information will be helpful in understanding the adaptations a common soil bacterium may undergo as a result of heavy metal stress

ACKNOWLEDGEMENTS

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REFERENCES

Mergeay, M 1991 Towards an understanding of the genetics of bacterial metal resistance Tibtech 9 17-24

Miller, J H 1989 Experiments in molecular genetics Cold Springs Harbor Laboratory Cold Springs Harbor, NY

Paasirvirta, Jaakko 1991 Chemical Ecotoxicology Michigan Lewis

Ron, E Z, D Minz, N P Finkelstein, and E Rosenberg 1992 Interactions of bacteria with cadmium Biodegredation 3 161-170

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The Development of a PCR-Based Test to Identify the Red Factor Coat Color Genotype in Horses by RFLP Analysis

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A PCR-RFLP test (polymerase chain reaction-restriction fragment length polymorphism) was conducted on hair samples from 371 horses and serum samples from 31 horses to investigate the robustness of a DNA-based test to diagnose the red factor coat color allele (*e*) at the extension (*E*) locus. DNA from the serum and extracted hair roots was amplified by PCR. After DNA amplification, the samples were digested with Taq I and analyzed by gel electrophoresis to detect the mutation. Our data were matched with the color reported to us for each horse and confirmed that the PCR-RFLP based protocol appears to be a good candidate test for diagnosing the presence of the recessively inherited coat color in horses. Each horse breed was in Hardy-Weinberg equilibrium for this gene, with the frequency of the E allele being .30 for Paints, .28 for Quarter Horses, and .42 for Miniature Horses.

BACKGROUND

For breeders of many domestic animals, coat color is an important characteristic that often contributes significantly to the value of the animal. An ability to predict what coat colors will result from particular breedings would be an invaluable tool for breeders. Although control of coat color is multilocus, an animal's ability to produce black pigment can be traced back to a single locus of control, the MSHR gene (MC1R). A missense mutation of a thymine to a cytosine in the coding sequence leads to a dysfunctional MSHR, thus a horse lacking the ability to produce black pigment may result in a chestnut coat color due to the synthesis of the red/yellow pigment phaeomelanin.

The chestnut coat color is a predominant color variant in horses. It is inherited in a simple Mendelian fashion with the phenotype characteristic of an entire red coat that lacks both brown and black pigmentation. It is the extension locus (*E*) along with the agouti (*A*) locus that controls the amount of phaeomelanin and eumelanin produced. Data show that the chestnut color is controlled by the bottom recessive allele (*e*) at the (*E*) extension coat color locus. The extension locus encodes the melanocyte-stimulating hormone receptor (MSHR). Animals with functional MSH receptors are able to receive the melanocyte stimulating hormone (MSH) which induces a switch from the production of phaeomelanin to eumelanin. Once a mutation occurs at the extension locus, the production of phaeomelanin remains constant due to a dysfunctional MSH receptor that can no longer switch to synthesize eumelanin. Since the expression of MSHR is dominant, it is denoted with an (*E*) where as the recessive mutant type is denoted by (*e*). As is characteristic of Mendelian inheritance, red coat color is phenotypically seen only when the genotype is homozygous (*ee*). (Marklund et al., 1996)

MATERIALS AND METHODS

Three sets of primers were used to determine the genotypes of 371 domestic horses (Paints, Quarter Horses, and Miniature Horses) and 31 Przewalski's horses DNA and serum samples from these animals were provided by the Veterinary Genetics Lab. PCR was carried out in 25 ul reactions containing 2.5 ul of 10X buffer (Promega), 1.5 mM $MgCl_2$, 0.15 mM each dNTP, 10 pmol of each primer and 1 U Taq polymerase (Promega). PCR was performed on M J Research PTC-100 with a 10 minute- 95°C "hot start" at which time our master mixes were added to the samples. This step is followed by 95°C- 60 sec., 34 cycles of 94°C- 60 sec., 62°C- 30 sec., 72°C- 45 sec., and 72°C- 10 min. After amplification, the PCR products were digested for two hours at 65°C with 10 U Taq 1 (Promega) followed by a gel electrophoresis in which 5-

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15 ul of the digested PCR product was added to each well on a 1.6% or 3.0% agarose gel run at 80 volts for 2-4 hours.

RESULTS

Data collected from the 371 DNA samples and 31 serum samples are represented in the charts below.

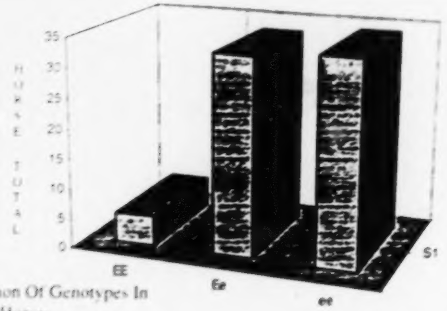

Figure 1: Distribution Of Genotypes In Paint Horses

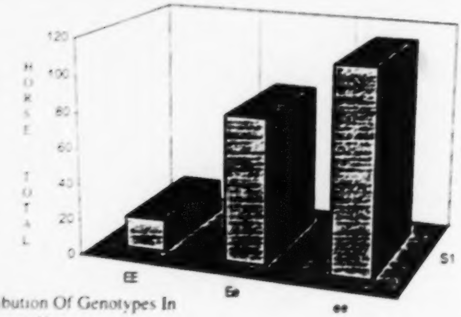

Figure 2: Distribution Of Genotypes In Quarter Horses

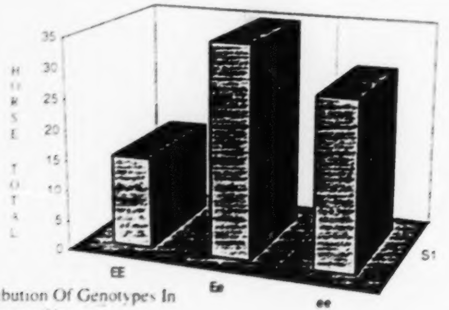

Figure 3: Distribution Of Genotypes In Miniature Horses

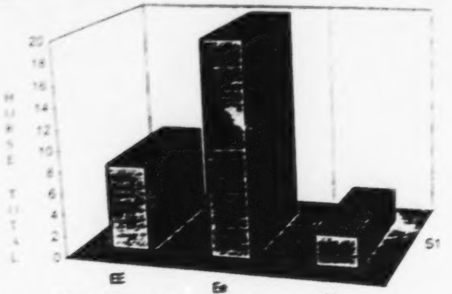

Figure 4: Distribution Of Genotypes In Przewalski's Horses

DISCUSSION

The data accumulated through the hair and serum samples were accurate in correlating the genotype of the horse to its phenotype. Results obtained were consistent with color information provided. All chestnuts, sorrels, palomino's, and red duns typed as (*ee*). All horses with a black phenotype (black, bay, brown) typed as (*E*) or (*Ee*). All three primer sets provided the same results. The most efficient, specific and easiest to read was primer set 3. There seemed to be fewer non-specific bands and a sharper product compared to the results when either primer set 1 or 2 was used. The Hardy-Weinberg equilibrium equation was used to establish the frequency of the (*E*) allele in the horse populations. The following results of .30 for Paints, .28 for Quarter Horses, and .42 in Miniature Horses established that the observed phenotypes correlated to the frequency expected in a random mating population. In Przewalski's horses the frequency of the (*E*) allele (.58) was not in Hardy-Weinberg equilibrium, probably due to a small sample size.

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REFERENCES

Marklund, L., Johansson Moller, M., Sandberg, K., Andersson, L., "A missense mutation in the gene for melanocyte-stimulating hormone receptor (MC1R) is associated with the chestnut coat color in horses", Mammalian Genome, 7(12), 895-899 (1996).

Differentiation and Classification of *Bdellovibrio bacteriovorus* using Random Amplified Polymorphic DNA (RAPD) Analysis

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Polymerase chain reaction (PCR)-based methodology, entailing random amplified polymorphic DNA (RAPD) analysis was used to assess the genetic similarities and differences among 16 different *Bdellovibrio* strains. Bdellovibrios are gram negative predatory bacteria on which there is little taxonomic information. Genomic DNA from prey-independent strains was isolated using the boiling method of Mazurier, et al. (1992). Four 10 base primers were determined to produce distinct amplification products for the bdellovibrios tested. The banding patterns of the different strains illustrated a common ancestry among the strains as well as a distinction between strains. These results suggest that the RAPD technique of generating DNA fingerprints could be used as a valuable tool for the rapid and inexpensive identification of *Bdellovibrio* isolates.

INTRODUCTION

Bdellovibrio bacteriovorus is a gram negative predatory bacterium. Its life cycle consists of an attack phase and a growth phase. The attack phase is characterized by attachment to and penetration of the outer layer of the prey cell. The growth phase is initiated following penetration, whereby the attacked cell is transformed into a spherical bdelloplast in which the *Bdellovibrio* elongates. Eventually, lysis of the prey cell leads to release of the progeny bdellovibrios.

Bdellovibrios are ubiquitous, existing in freshwater, sewage, and marine habitats. They exhibit phenotypic similarities but are genetically diverse. The current classification is inadequate and relies only on the biochemical and morphological characteristics and neglects the genetic diversity of bdellovibrios.

Genetic similarities and differences of distinct bacterial strains can be detected by Random Amplified Polymorphic DNA (RAPD) analysis (Welsh and McClelland, 1990). This method is based on the use of single arbitrary primers in a polymerase chain reaction (PCR) of low stringency to amplify segments of the genomic DNA. The primer is mixed with genomic DNA in the presence of a thermostable DNA polymerase, and then subjected to temperature cycling conditions. The resulting amplified fragments function as polymorphisms for DNA fingerprinting. RAPD markers have been used successfully to identify strains of various bacterial genera, such as *Camplyobacteria* (Mazurier,et al., 1992), *Haemophilus* (Myers,et al.,1993), *Streptococcus* and *Lactococcus* (Cancilla, et al.,1992). The pattern of the amplified sequences obtained is primer and strain specific, with different strains generating different amplification products which can be visualized in agarose gels. Amplification reactions are repeated using several different primers.

MATERIALS AND METHODS

Bacterial Strains

The following prey independent *B. bacteriovorus* strains were used: 109JA, 109D, Xty, Sa109, 110, 114, 100, E, 120, SaD3, Xpf2, UKi1, UKi2, WJ, 2484, A3.12.

DNA Preparation and Isolation

Nine milliliters of peptone yeast extract (PYE) were inoculated with 1 milliliter of the desired *Bdellovibrio* strain and incubated at 30°C with shaking overnight. The culture was centrifuged (12,000 rpm for 10 min.) and the pellet was washed in saline solution, then pelleted by centrifugation. The supernatant was discarded and the cells were suspended in one milliliter of sterile distilled water. The cell suspensions were then incubated for 10 minutes in a boiling water bath and then centrifuged at 12,000 rpm for 5 min. (Mazurier,et al., 1992). The supernatant was adjusted to an O.D $_{260}$ of 0.15 in sterile distilled water.

Amplification Conditions

Amplification reactions using random primers were accomplished in a reaction mixture (final volume ~ 25 μl) containing: 10 μM Tris-HCl, pH 8.3, 50 μM KCl, 3.0 μM MgCl$_2$, 200 μM each of dATP, dCTP, dGTP, dTTP, 1.0 μM of a single 10-mer, 5units/100 ml of Taq DNA polymerase, < 1mg/100 ml genomic DNA. Four primers with the following sequences were determined to produce distinct amplification products for the bdellovibrios tested: TGCCGAGCTG (OPA2), AGTCAGCCAC (OPA3), AATCGGGCTG (OPA4), AGGGGTCTTG (OPA5) obtained from Operon Inc.

Amplification was carried out in a thermal cycler programmed for 1 cycle for 2 min. at 94°C, followed by 30 sec. at 38°C, 30 sec. at 72°C, and 30 sec. at 94°C, followed by 45 cycles of 30 sec. each at 94°C, 38°C, and 72°C.

The amplification products were separated by gel electrophoresis in 1.8 % Metaphor agarose gels with 1/2 X TAE buffer at 150 volts for 1.5 hours. Banding patterns were visualized by an ultraviolet transilluminator after ethidium bromide staining. A 50-1000 bp DNA ladder (FMC) was used as the size marker. Gels were documented using a Stratagene Eagle Eye II Gel Documentation System equipped with a CCD video camera.

Analysis

The banding patterns were analyzed using Scanalytics RFLP Scan software to generate PAUP reports. The output from this program was utilized to construct dendrograms from TREECON software. (Van de Peer, De Wachter, 1994)

RESULTS

A total of twenty different 10-mer primers were assessed for the RAPD analysis of 16 prey-independent bdellovibrio strains. Four of these primers were used routinely based on their ability to produce consistent banding patterns. Amplification of bdellovibrio genomic DNA using random primers resulted in unique banding patterns for each strain. Figures 1 and 2 illustrate representative gels using OPA2 and OPA3 as random primers.

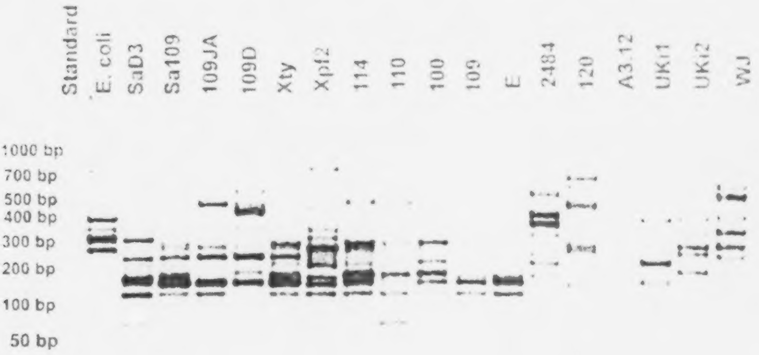

Figure.1. RAPD profiles of Bdellovibrio strains using primer OPA2. DNA standard, lanes 2-18: E. coli, SaD3, Sa109, 109JA, 109D, Xty, Xpf2, 114, 110, 100, WG, E, 2484, 120, A3.12, UKiI, UKi2, WJ

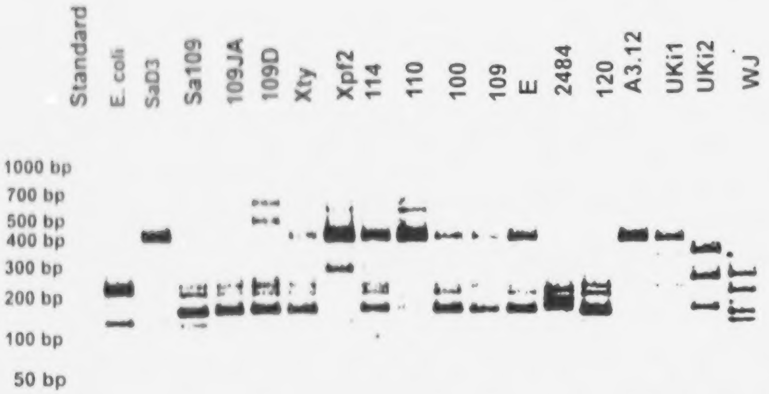
Standard
E. coli
SaD3
Sa109
109JA
109D
Xty
Xpf2
114
110
100
109
E
2484
120
A3.12
UKi1
UKi2
WJ
1000 bp
700 bp
500 bp
400 bp
300 bp
200 bp
100 bp
50 bp

Figure 2. RAPD profiles of *Bdellovibrio* strains using primer OPA3. Lane 1: DNA standard, lanes 2-19: E. coli, SaD3, Sa109, 109JA, 109D, Xty, Xpf2, 114, 110, 100, WG, E, 2484, 120, A3.12, UKiI, UKi2, WJ

Banding patterns generated using all four random primers were analyzed using RFLP Scan (Scanalytics, Inc.), results were combined and used to generate a dendrogram illustrating the relatedness of the various *Bdellovibrio* strains (Fig 3). Strains fall into seven major groupings.

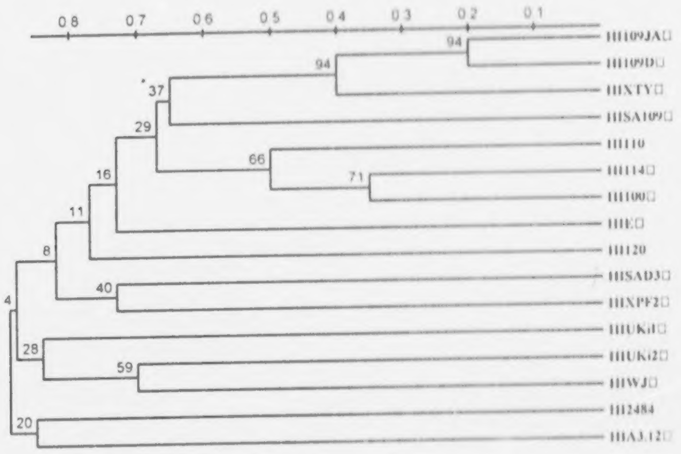
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
94
94
37
29
66
71
16
11
8
40
4
28
59
20
III109JA□
III109D□
IIIXTY□
IIISA109□
III110
III114□
III100□
IIIE□
III120
IIISAD3□
IIIXPF2□
IIIUKi1□
IIIUKi2□
IIIWJ□
III2484
IIIA3.12□

Figure 3. Taxonomic analysis of RAPD profiles of 16 prey-independent *Bdellovibrio* strains

DISCUSSION

Random amplified polymorphic DNA analysis can be used as an easy and reliable method for assessing genetic similarities and differences between different strains of *Bdellovibrio bacteriovorus*. It was demonstrated that reproducible amplification products could be obtained with primers OPA2, OPA3, OPA4, and OPA5. The RAPD products generated were dependent upon the primer and strain used. Different primers resulted in

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different banding patterns Combining the data generated from each primer, and using those data to generate a dendrogram resulted in seven major groups represented by these strains The relatedness of individual strains to one another is similar to that found by others using different techniques For example, Diedrich, et al showed that strains 100, 114, 109D, 109, 109J were very closely related and distant from strains W, A3 12, and UKi2 which were distantly related to one another Analysis of base composition (% GC) by Seidler, et al showed strains A3 12 and W were very different from all other strains tested Schelling and Conti (1983) showed, using serotyping, that strains 100, Xty, Sa109, 109, 109D, and 109J represented a single serogroup Whereas strains W, UKi1, A3 12, UKi2, SaD3, E, and 2484 were antigenically distinct from other members tested The patterns of relatedness as determined by RAPD analysis are consistent with these previous results and are extended to include additional strains RAPD analysis has therefore been shown to be a simple and effective method to differentiate bdellovibrio strains

ACKNOWLEDGMENTS

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REFERENCES

Cancilla, M.R., I.B. Powell, A.J. Hillier, B.E. Davidson 1992 Rapid genomic fingerprinting of *Lactococcus lactis* strains by arbitrarily primed polymerase chain reaction with 32P and fluorescent labels Appl Environ Microbiol 58 1772-1775

Donze, D., J.A. Mayo, D.L. Diedrich 1991 Relationships among the Bdellovibrios revealed by partial sequences of 16S Ribosomal RNA Current Microbiol 23 115-119

Mazurier, S, A van De Giessen, K Heuvelman, K Wernarst 1992 RAPD analysis of *Camplyobacteria* isolates DNA fingerprinting without the need to purify DNA Letters in Applied Microbiology 14 260-262

Myers, L.E., S.V.P.S Silva, J.D Procunier, and B.P Little 1993 Genomic Fingerprinting of "*Haemophilus somnus*" Isolates by Using a Random Amplified Polymorphic DNA Assay J Clin Microbiol 31 512-517

Schelling, M.E., S.F Conti 1983 Serotyping of bdellovibrios by agglutination and indirect immunofluorescence Internat J Syst Bacteriol 33 816-821

Seidler, R.J., M Mandel, J.N Baptist 1972 Molecular heterogeneity of the bdellovibrios Evidence of two new species J Bacteriol 109 209-217

Torrella, F., R Guerrero, R.J Seidler 1978 Further taxonomic characterization of the genus *Bdellovibrio* Can J Microbiol 24 1387-1393

Van de Peer, Y., De Wachter, R (1994) TREECON for Windows a software package for the construction and drawing of evolutionary trees for the Microsoft Windows environment Comput Applic Biosci 10 569-570

Welsh, J., M McClelland 1990 Fingerprinting genomes using PCR with arbitrary primers Nucl Acids Res 18 7213-7218

QTL Mapping of a Genetic Marker for Longevity in *Drosophila melanogaster*

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Biogerontology research has shown that longevity is a polygenic character. The objective of this study was to identify small chromosomal regions that are associated with long life span in *Drosophila melanogaster*. Using the quantitative trait loci (QTL) mapping technique, the *D. melanogaster* genome was screened for genetic markers associated with extended longevity. Long-lived lines were screened for polymorphic markers distinct from two control lines. The screening procedure involved 150 oligonucleotide primers of arbitrary sequence in the polymerase chain reaction (PCR). Twenty-three primers consistently produced a band that appeared in the long-lived lines and was absent in the controls or vice versa. A backcross population was created to test whether these markers would segregate with the long-lived trait. Only one of these primers, N14, gave a marker that was associated with longevity. The distinguishing band was extracted from the gel, purified, and sequenced. The resulting 709 base pair DNA fragment was used in biotinylated DNA in situ hybridization by Dr. Tatar. This fragment hybridized to band 64B on the left arm of the third chromosome. Sequence homology was searched for against current DNA and protein databases with no significant matches found. Computer analysis suggests that this DNA fragment is non-coding, but is located near a gene or genes influencing longevity. In conclusion, a small chromosomal region has been found that seems to be strongly associated with long life, and experiments are in progress to search for other genetic markers in this area.

INTRODUCTION

Life span is determined by various environmental, epigenetic, and genetic components. Environmental factors such as high larval density in *Drosophila melanogaster* have been shown to increase longevity (Khazaeli et al., 1997). Low temperatures and dietary restriction also increase life span in vertebrate organisms. Regulation of gene expression can also contribute directly to life span changes in *D. melanogaster*. Rogina and Helfand (1995) found that the expression of a gene was altered in direct proportion to the animal's life expectancy. In addition to environmental and epigenetic factors, the genotype of an organism plays a major role in determining longevity (Curtsinger et al., 1995). Identifying individual genes that increase longevity in organisms is a task within reach. Single genes involved in longevity have been found in the worm *Caenorhabditis elegans* (Friedman and Johnson, 1988).

Genetic changes affecting the physiological or metabolic mechanisms of organisms can alter their longevity. Changes in genes involved in maintenance and repair of the organism may increase life span by maintaining the optimal functioning of the genetic machinery of an organism. Genes involved in determining an organism's metabolic capacity and stress responses are thought to be key players in determining longevity. The metabolic capacity of long-lived flies is increased at any temperature (Arking et al., 1988). Therefore, genes that increase metabolic capacity in an organism may increase its life span. Selection for stress resistance in *Drosophila* has been shown to increase longevity; therefore, alleles that increase stress resistance may also increase longevity (Rose et al., 1992).

Further evidence of the importance of genes involved in the determination of longevity is exemplified by the selection of *Drosophila* for extended longevity. The genetic variance within a population allows for selection of individuals exhibiting certain phenotypes. If these traits are heritable, they will be passed on to the next generation at a high frequency and eventually a population will emerge with a genotype favoring a selected phenotype. Initial selection for late reproduction over 13 generations resulted in two lines of *D. melanogaster* with a mean longevity 27% greater than the control lines (Luckinbill et al., 1984). These lines have been maintained in our lab since that time, and the mean longevity of the selected lines is now 40% higher than the control lines (Fukui et al., 1995).

Because *D. melanogaster* can be selected for extended longevity, the frequency of the genetic factors favoring longevity would increase in the long-lived lines. We set out to identify these genetic factors using a polymorphism assay. Products defining the polymorphism exhibit Mendelian inheritance and can be used as genetic markers (Ellsworth et al., 1993). RAPDs (randomly amplified polymorphic DNA) are markers detected by amplifying random DNA segments using PCR and oligonucleotide primers of arbitrary sequence. QTL (quantitative trait loci) are genes that influence a quantitative trait. In our case, the extended longevity phenotype is the characteristic we are trying to localize. QTL analyses using RAPDs can be used to identify linkage between polymorphic markers and a particular trait. This study seeks to find regions in the *D. melanogaster* genome associated with longevity.

MATERIALS AND METHODS

Successful selection for over 50 generations of *D. melanogaster* with extended longevity has been accomplished using selection for late reproduction (stocks supplied by Dr. Leo Luckinbill of Wayne State University). These stocks include two independently maintained outbred control lines (LD_1 and LD_2) and two independently maintained outbred long-lived fly lines (LA and LB) derived from the wild-type controls. The long-lived lines live 40% longer than the control lines (the mean longevity of long-lived lines is 70 days, and the mean longevity of the control lines is 50 days).

DNA was extracted for use in PCR using the Engles' method (Engles et al., 1990). Single flies were macerated in a 0.5 ml tube for 10 seconds with a pipette tip containing 100 µl squishing buffer. The squishing buffer contained 10 mM Tris-Cl [pH 8.2], 1 mM EDTA, 25 mM NaCl, and 200 µg/ml Proteinase K. The tubes were incubated at 37°C for 24 hours. The Proteinase K was inactivated by heating the tubes to 95°C for 2 minutes. The extracts were then centrifuged for 2 minutes and diluted with 100 µl autoclaved nanopure water. The DNA preparation was stored at 4°C.

One hundred and fifty arbitrary oligonucleotide primers were screened for markers distinct for longevity in the four lines. One fly per line underwent initial screening. PCR amplification was carried out in a total of 25 µl with 10 mM Tris-HCl [pH 8.3], 50 mM KCl, 5.0 mM $MgCl_2$, 400 µM dNTPs, 0.7 µM primer, 20 units of AmpliTaq DNA Polymerase-Stoffel Fragment, and 10 ng of DNA template. Prior to amplification, 28 µl Nujol mineral oil was overlaid on each reaction mixture to prevent evaporation. DNA amplification suggested by Burt et al. (1994) was performed with modification for a Hybaid Omnigene Thermal Cycler. After 2 minutes at 94°C, the reaction mix was subjected to 40 cycles of 94°C/ 36°C/ 72°C for 0.5 min./ 0.5 min./ 2 min. The amplification cycles were followed by a 30 minute final extension at 35°C. The products were resolved by electrophoresis for 3 hours at 100 Volts in gels composed of 1.4% agarose in 1X TAE buffer (0.04 M Tris-acetate and 0.001M EDTA). DNA fragments were visualized and photographed under UV light after staining with Ethidium Bromide.

If a band was present in the two long-lived lines and absent in the two control lines (or vice versa) during the initial screening procedure, additional screening followed using 10 flies per line to verify that the trait the band represents was fixed in the long-lived (or control) lines. If the primer consistently showed a distinguishing band in either the long-lived or control lines, it was analyzed further to determine if the desired QTL would segregate with the marker associated with it.

The long-lived flies (LA males, geneotype +/+) were crossed with control lines (LD_1 female virgins -/-). Virgin F3 generation females (+/+; +/-; -/-) from the previous cross were backcrossed with LD_1 males (-/-) to create the backcross fly population (+/-; -/-). The crosses were done by Dr. Hank Fukui. These crosses will maximize the amount of recombination at the site of the marker. The backcross fly population was grown up in two separate cohorts in a cage at 24°C and collected and saved as they died using the methods of Fukui et al. (1993).

The backcross flies underwent PCR analysis using the primers giving distinct banding patterns in the screening procedure. Each fly from the backcross population was tested. Its date of death and presence or absence of the marker was noted. A survivorship curve was created with the data from the backcross male and female progeny. If the backcross flies with the marker showed a significant positive shift in survivorship from the flies without the marker, the band was extracted from the gel and purified using the technique from Li and Ownby (1993). The DNA fragment was then amplified and sequenced using an automated gene sequencer at the Advanced Genetic Analysis Center at the University of Minnesota. The resulting DNA fragment was used in biotinylated DNA in situ hybridization with *D. melanogaster* polytene chromosomes from the LA line by Dr. Marc Tatar (Ashburner, 1989).

Computer analysis of this fragment's sequence was completed using the Advanced Biosciences Computing Center at the University of Minnesota. DNA and protein sequence homology was searched for against the fragment's sequence. Probable protein coding sequences within the fragment were searched for.

RESULTS

Of the 150 primers screened, 23 passed the initial and additional screening procedures by producing a band in either the long-lived or the control lines. The backcross was performed and flies were collected and tested for the markers as they died. A survivorship curve for both males and females was constructed from these data.

Only one primer, N14, had a distinguishing band (Figure 1) and showed a significant shift in the survivorship curve in the flies with the marker. The individuals with the N14 marker in the male survivorship curve for two cohorts had a mean longevity 30% greater than the flies lacking the marker (Figure 2). The curve from flies with the marker in the female survivorship curve did not deviate significantly from the curve from flies without the marker in two cohorts. The distinguishing band was isolated from the gel and sequenced. The DNA fragment was subject to in situ hybridization and found to be on band 64B of the left arm of the third chromosome.

This fragment's sequence underwent computer analyzation for sequence homology and protein coding probabability. No nucleotide sequences were found with a significant match to the sequence. Protein databases were also searched for a match to the DNA fragment, but no significant match was found. Two programs were used to identify possible protein coding regions of the DNA sequence. A stretch of 130 nucleotides in the second reading frame was placed into the uncertainty region for coding for a protein. Most likely this 709 base pair DNA fragment is non-coding.

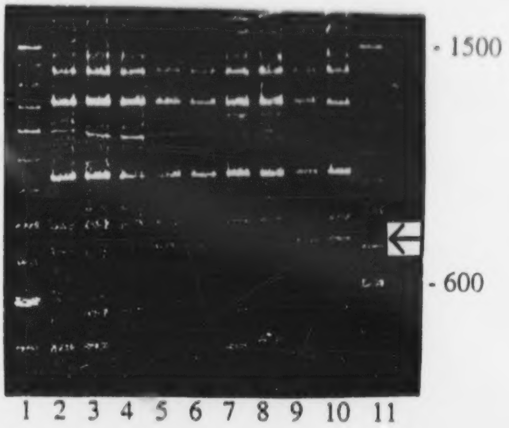

Figure 1. PCR-RAPD results of N14 10-mer
The N14 primer consistently produced a band at 709 bp (arrow) in the long-lived fly lines (LA and LB), and the band was absent in the control lines (LD_1 and LD_2). Lanes 1 and 11: 100 bp DNA ladder; Lane 2: LA female; Lane 3: LD_2 female; Lane 4: LD_2 male; Lane 5: LB female; Lane 6: LB male; Lane 7: LD_1 female; Lane 8: LD_1 male; Lane 9: LA female; Lane 10: LA male. Size marker at right is in base pairs.

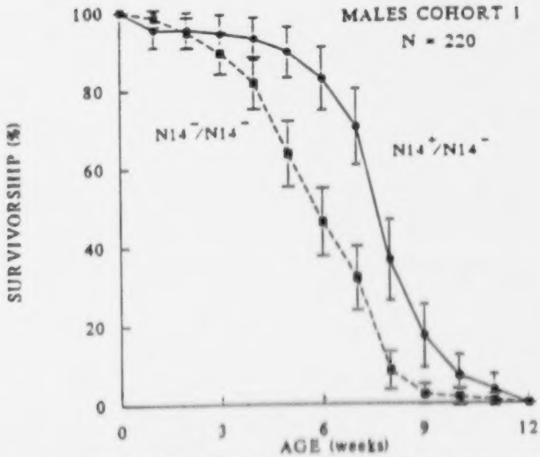

Figure 2. Male survivorship curve for the first of two replicate cohorts from the backcross fly population.
The backcross male flies with the N14 marker (genotype $N14^+/N14^-$) have a significant increase in life span compared to flies without the marker (genotype $N14^-/N14^-$).

CONCLUSION

Our results indicate that we have found a genetic marker associated with the extended longevity phenotype exhibited by the long-lived strain of flies. The similar survivorship curves for both of the male backcross cohorts indicate that this marker is closely linked with a gene influencing longevity in males. Computer analysis suggests the N14 fragment is non-coding and probably lies near a QTL affecting longevity.

There is strong evidence that the QTL associated with the marker was fixed by selection for longevity and not by chance. The long-lived lines were selected for longevity independent of one another. Because both long-lived strains have the N14 marker, the two lines fixed this region of the genome independently. Assuming the frequency of the allele marked by N14 in the population is 0.5 and that the allele is neutral, the probability of the allele fixing in the two long-lived lines and being lost from the two control lines is 0.06. Therefore, the allele associated with the N14 marker did not fix by chance and is useful as a marker. If our marker is indeed detecting a life span associated gene, the two long-lived lines used this same genetic mechanism to extend longevity. The data from the backcross males is further evidence that the region N14 marks is influencing longevity in the flies and is due to selection.

Sex differences exist in this QTL's influence and expression. The survivorship curve from the backcross flies demonstrates that the males with the N14 marker increase their probability of survival at all chronological ages. The survivorship curves for the female backcross flies does not show an association between extended longevity and presence of the N14 marker. A possible reason for this sex difference is that life span extension may utilize different mechanisms in males and females. Luckinbill et al. (1988) found that the genes determining longevity in *D. melanogaster* appear to differ between males and females in a chromosomal substitution study. This study found evidence for differences in the influence of certain genetic elements influencing longevity between males and females, and also, the genetic controls for longevity themselves differed between the sexes in some instances. This phenomenon has also been observed in the expression of bristle number in *D. melanogaster* (Mackay et al., 1992). In this study, they found chromosomal regions strongly associated with bristle number in females were not the same chromosomal regions utilized by males.

Localization of the N14 fragment to the third chromosome is consistent with other studies involving the genes participating in longevity. Buck et al. (1993) found that mean longevity is influenced primarily by the third chromosome. Luckinbill et al. (1988) also found that the third chromosome was the most powerful contributor in the control of longevity using a chromosomal substitution experiment.

The 23 primers that did not show significant effects in the survivorship curves with the backcross population may still influence longevity, but may only have a small effect. This effect may have been lost more easily through recombination because of its small role. Another interpretation to consider is that the marker may have been too far away from the gene influencing longevity, and the marker may have been lost by recombination events. These primers may also amplify regions of the genome which had fixed by chance in either the selected or control lines.

The next step is to identify, characterize, and isolate other markers involved in the expression of extended longevity in our invertebrate model organism. When more QTL markers have been defined and studied, analogous aging processes can be searched for that may occur in vertebrates if the genes exhibit evolutionary conservation. Further studies to unravel life span determining processes could link our marker to its specific function. Also, the sequencing of the *Drosophila* genome and subsequent elucidation of DNA function may lead to understanding the genetic significance of the N14 fragment.

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REFERENCES

Arking, R., S. Buck, R.A. Wells, R. Pretzlaff, Metabolic rates in genetically based long lived strains of *Drosophila*. Experimental Gerontology 23(1): 59-76; 1988.

Ashburner, M., *Drosophila* A Laboratory Manual (Cold Springs Harbor Laboratory Press, NY 1989).

Buck, S., R.A. Wells, S.P. Dudas, G.T. Baker 3rd, and R. Arking, Chromosomal localization and regulation of the longevity determinant genes in a selected strain of *Drosophila melanogaster*. Heredity 71(Pt 1): 11-22; 1993.

Burt, A., D.A. Carter, T.J. White, and J.W. Taylor, DNA sequencing with arbitrary primer pairs. Molecular Ecology 3(5): 523-525; 1994.

Curtsinger, J.W., H.H. Fukui, A.A. Khazaeli, A.W. Kirscher, S.D. Pletcher, D.E.L. Promislow, and M. Tatar, Genetic variation and aging. Annual Review of Genetics 29: 553-575; 1995.

Ellsworth, D.L., K.D. Rittenhouse, and R.L. Honeycutt, Artifactual variation in randomly amplified polymorphic DNA banding patterns. BioTechniques 14: 214-216; 1993.

Friedman, D.B. and T.E. Johnson, A mutation in the age-1 gene in *Caenorhabditis elegans* lengthens life and reduces hermaphrodite fertility. Genetics 118(1): 75-86; 1988.

Fukui, H.H., L. Xiu, and J.W. Curtsinger, Slowing of age-specific mortality rates in *Drosophila melanogaster*. Experimental Gerontology 28:585-599; 1993.

Fukui, H.H., S.D. Pletcher, and J.W. Curtsinger, Selection for increased longevity in *Drosophila melanogaster*: A response to Baret and Lints. Gerontology 41: 65-68; 1995.

Genetics Computing Group, Program Manual for the Wisconsin Package, Version 8, Madison, WI, Sept. 1994.

Khazaeli, A.A., L. Xiu, and J.W. Curtsinger, Egg density and longevity in *D. melanogaster*. submitted 1997.

Li, Q. and C.L. Ownby, A rapid method for extraction of DNA from agarose gels using a syringe. Biotechniques 15(6): 976-978; 1993.

Luckinbill, L.S., R. Arking, M.J. Clare, W.C. Cirocco, and S.A. Buck, Selection for delayed senescence in *Drosophila melanogaster*. Evolution 38(5): 996-1004; 1984.

Luckinbill, L.S., J.L. Graves, A.H. Reed, and S. Koetsawang, Localizing genes that defer senescence in *Drosophila melanogaster*. Heredity 60:367-374; 1988.

Mackay, T.F.C., R.F. Lyman, and M.S. Jackson, P element insertions on quantitative traits in *Drosophila melanogaster*. Genetics 130: 315-332; 1992.

Rogina, B. and S.L. Helfand, Regulation of gene expression is linked to life span in adult *Drosophila*. Genetics 141(3): 1043-8; 1995.

Rose, M.R., L.N. Vu, S.U. Park, and J.L. Graves Jr., Selection on stress resistance increases longevity in *Drosophila melanogaster*. Experimental Gerontology 27(2): 241-50; 1992.

Stability of Heterochromatin in Voles from Chernobyl

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BACKGROUND

The 26 April 1986 meltdown of reactor 4 at the Chernobyl Nuclear Power Plant is the world's worst nuclear power plant disaster. Over 50 million Curies were released into the environment, and the regions surrounding the reactor remain highly polluted both with radioactivity and other meltdown related contaminants (Mourad and Snell, 1987; Powers et al., 1987). The Ukrainian government maintains two exclusion zones surrounding the reactor with radii of 10 and 30 km. The 10 km zone includes the most radioactive regions, and human activity is kept to a minimum). The abundance and diversity of small mammals within the exclusion zones is equal to or greater than that of similar areas outside the contaminated regions (Baker et al. 1996). The abundance of small mammals within the exclusion zones is probably largely attributable to the absence of human activity in those areas.

Two species of voles, *Microtus arvalis* and *M. rossiaemeridionalis*, are among the most common rodents living in both the experimental and control regions. Data from *Microtus* suggest that at least some individuals living in the zone would receive doses ranging from 370 to 960 Rads in a six month period. (Chesser et al., submitted manuscript). Although numerous studies have shown that acute exposure to high radiation doses induces chromosomal breaks and rearrangements, no significant difference in the frequency of chromosomal breaks between experimental and control populations has been observed in any of the small mammal species examined from the Chernobyl region (Baker et al., 1996). A reciprocal translocation in a single individual of *Microtus oeconomus* collected from the Chernobyl area has been reported (Nadzhafova et al., 1994), but as only single individuals from both the contaminated and control regions were examined, the evidence to attribute the presence of the rearrangement to the radioactive environment at Chernobyl is limited. The *M. oeconomus* study utilized differential staining of chromosomes to reveal a small structural change in a single individual, whereas the Baker et al. (1996) study focusing on gross karyotypic changes did not reveal significant increases in the frequency of rearrangements. Because the chronic radiation doses (lifetime total of internal and external) received by voles at Chernobyl are comparable in magnitude to the acute radiation doses which have been shown to induce significantly increased frequencies of chromosomal breaks and rearrangements in *Microtus* (Cooper and Hsu, 1971), we have tested for the presence of more subtle chromosomal effects that might not be revealed by analysis of gross karyotypic morphology.

Heterochromatin has been shown to be a dynamic genomic element which may undergo significant changes between closely related taxa as well as among individuals in a single population (Hamilton et al., 1990). Therefore, we have analyzed the stability of heterochromatin in voles from the most radioactive regions at Chernobyl. If the radioactive environment is having an effect on the chromosomal structure and organization in voles from Chernobyl, we would expect to see differences in amounts and positional arrangement of heterochromatin between the experimental and control populations. If the radioactive environment is not affecting the chromosomal architecture in voles (the null hypothesis) we would expect to see no significant differences in heterochromatin position and arrangement between the zone and control populations.

The experimental design was to isolate DNA fragments that in the representative karyotypes of both *Microtus arvalis* and *M. rossiaemeridionalis* correspond to heterochromatic regions. Fragments were preferentially chosen that were either unique to one of the two species or that showed the greatest differences in copy number between the two species. We assumed that DNA fragments showing the greatest differences between these two closely related species of *Microtus* would be more dynamic than those conserved between these species, and thus more likely to reveal any recent environmentally induced changes.

MATERIALS AND METHODS

Library Construction

Plasmid libraries were constructed from genomic DNA isolated from a male specimen collected from the native vole populations in the most radioactive regions at Chernobyl (*Microtus arvalis*, TK 44564; *M. rossiaemeridionalis* TK 44575) (see Baker et al., 1996 for collection details). Genomic DNA was partially digested with *Sau*3AI and visualized on an agarose gel stained with ethidium bromide. The size fragments ranging from 6-8 kb were removed from the gel and isolated by electroelution following the procedures of Sambrook et al. (1989). DNA fragments were ligated into Bluescript (BSSK-) cut with *BamH*I and dephosphorylated with calf alkaline intestinal phosphatase following the manufacturer's instructions (New England Biolabs) and transformations were accomplished using electroporation with ElectroMax competent cells (DH10B) (Gibco BRL) following the manufacturer's instructions. Colonies were selected by color using X-gal and IPTG as described in Sambrook et al. (1989). Colonies (1920 for *M. arvalis*, 960 for *M. rossiaemeridionalis*) were picked and archived

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into 96-well microtiter plates.

Library Screening and Isolation of Clones
Membranes were inoculated with all archived clones from each library and hybridized with the genomic DNA of both species of *Microtus* following the procedures of Van Den Bussche et al. (1995). Clones which showed either hybridization with genomic DNA of only one species or which showed the greatest differences in signal intensity between the two species were used as probes for fluorescent in situ hybridization.

Karyotypic Procedures
Individuals were collected from natural populations and karyotypes were derived from bone marrow preparations as described in Baker et al. (1996).

Fluorescent in situ hybridization
Probes for fluorescent in situ hybridization were labeled by standard nick-translation with biotinylated dUTP using the Clontech Biotin-21-dUTP nick translation kit following the manufacturer's instructions. Hybridization followed the procedures of Hamilton et al. (1990). At least 10 complete spreads per individual were analyzed using an Olympus Epi-fluorescent microscope.

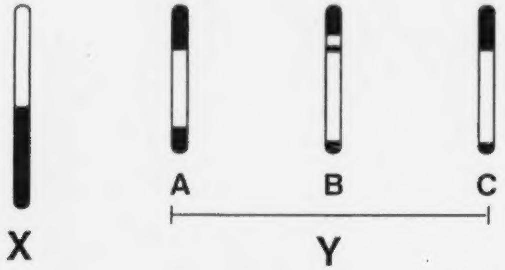

Figure 1--Diagrammatic representation of the sex chromosomes of *M. rossiaemeridionalis* hybridized with the clone pMr1TT. Hybridization is indicated by black.

RESULTS

One variable clone was isolated from *M. rossiaemeridionalis*. This clone, designated pMr1TT is specific to the sex chromosomes of *M. rossiaemeridionalis*. The hybridization occurs as a large block on the X chromosome and with blocks arranged in one of three patterns on the Y chromosome (Fig. 1). The relative proportions of these three patterns are shown in Table 1.

Clone pMr2TT is another sex associated *M. rossiaemeridionalis* fragment which hybridizes to the centromeres of every chromosome of *M. rossiaemeridionalis* except the Y. No variance in this pattern of hybridization has been observed (12 individuals examined: 9 experimental, 3 control).

Clone pMa1TT hybridizes to the centromeres of eighteen small chromosomes of *M. arvalis*. No variation in the hybridization pattern of this probe has been observed (8 individuals examined: 6 experimental, 2 control).

Table 1--Number of individuals with each of the three patterns of heterochromatin on the Y chromosome.

	A	B	C
Control	7	6	1
Experimental	8	6	2

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CONCLUSION

Intra-populational variation in heterochromatin arrangement was observed with the DNA fragment designated as pMr1TT. However the distribution of the three patterns of heterochromatin on the Y chromosome does not differ significantly different between the experimental and control populations Table 1). Therefore, this variation is most likely a natural polymorphism.

With the analysis of three different DNA fragments corresponding to heterochromatic regions in *Microtus arvalis* and *M. rossiaemeridionalis*, no differences in pattern of heterochromatin arrangement have been observed between the experimental and control populations. It is unclear why this data set failed to reveal chromosomal breaks and rearrangements as had been reported previously in *Microtus* exposed to significant radiation doses (Cooper and Hsu, 1971; Nadzhafova et al., 1994). Perhaps in the Chernobyl vole populations differences in the arrangement of heterochromatin do exist which have not been revealed with the heterochromatic sequences used in this analysis. The absence of detectable chromosomal rearrangements in voles from the Chernobyl region could be due to sampling error. Another possible explanation is that the voles currently living near the Chernobyl reactor have undergone selection for more efficient repair mechanisms than would be present in naive mice without a genetic background of more than ten years of chronic exposure to high levels of radiation.

This data along with the absence of gross karyotypic changes suggest that the long term chromosomal effects of the Chernobyl disaster are not as great as might have been predicted by previous laboratory studies. If long term chromosomal effects are present, more sensitive methods will be required to interrogate them.

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REFERENCES

Baker, R.J., M.J. Hamilton, R. A. Van Den Bussche, L.E. Wiggins, D.W. Sugg, M.H. Smith, M.D. Lomakin, S.P. Gaschak, E.G. Bundova, G.A. Rudenskaya, and R.K. Chesser, Journal of Mammalogy, Small mammals from the most radioactive sites near the Chornobyl nuclear power plant, Vol 77, 1996, pg. 155-170.

Chesser, R.K., D. W. Sugg, M.H. Smith, M. D. Lomakin, R. A. Van Den Bussche, J.A. DeWoody, C.H.Jagoe, C. E. Dallas, F. W. Whicker, and R.J.Baker, submitted manuscript, Concentrations of radiocesium and internal dose estimates for small mammals at Chernobyl.

Cooper, J.E.K., and T.C. Hsu, Experimental Cell Research. Radiation-induced deletions and translocations of *Microtus agrestis* sex chromosomes in vivo, Vol 67, 1971, pg. 343-351.

Hamilton, M. J., R. L. Honeycutt, and R.J. Baker, Chromosoma. Intragenomic movement, sequence amplification, and concerted evolution in satellite DNA in harvest mice, *Reithrodontomys*: Evidence from in situ hybridization, Vol 99, 1990, pg. 321-329.

Mourad, R. and V. Snell, Transactions of the American Nuclear Society, Source term and radiological consequences of the Chernobyl accident, Vol 54, 1987, pg. 226-228.

Nadzhafova R.S., N. Sh. Bulatove, A. I. Kozlovskii, and I.N. Ryabov. Russian Journal of Genetics Identification of a structural chromosomal rearrangements in the karyotype of a root vole from Chernobyl.

Powers, D.A., T.S. Kress, and M.W. Jankowski, Nuclear Safety, The Chernobyl source term, Vol 28, 1987, pg 10.

Sambrook, J, E.F. Fritsch, T. and T. Maniatis, 1989, Molecular Cloning: A Laboratory Manual (Plainview, NY: Cold Spring Harbor Laboratory Press).

Van Den Bussche, R. A., J. L.Longmire, and R.J. Baker, Mammalian Genome, How bats achieve a small C-value: frequency of repetive DNA in *Macrotus*, Vol 6, 1995, pg. 521-525.

Isolation and Functional Analysis of three Non-human Primate CXCR4 Genes

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ABSTRACT

CXCR4 has recently been identified as one of the chemokine receptors that function as a coreceptor for HIV entry into CD4+ human cells. The goal of these experiments is to study the interaction of CXCR4 with HIV-1 envelopes. We have isolated the CXCR4 genes from the chimpanzee, rhesus macaque, and the African green monkey. We compared the ability of human, rat, and these newly isolated non-human primate CXCR4s to mediate HIV-1 infection. Only the human and non-human primate CXCR4s mediated the entry of a vector expressing the V1-V3 domains of an SI strain of HIV-1. The predicted amino acid sequence comparison among human, rhesus, and rat CXCR4s showed a small amount of variation in the transmembrane and intracellular domains. The extracellular domains of the rat showed significant variation with respect to the primate sequences.

INTRODUCTION

Human Immunodeficiency Virus (HIV) is the etiological agent of Acquired Immunodeficieny Syndrome (AIDS). HIV-1 infects T lymphocytes, monocytes, dendrytic cells, and microglia (Gartner et.al. 1986, Koenig et.al. 1986, Pope et.al 1994, Weisman et.al 1995). The initial step in the HIV lifecycle is entry into the host cell, which requires binding of the viral envelope glycoprotein, gp120, to the amino terminal domain of CD4 (McDougal et.al. 1986, Helseth et.al 1990). The cell surface expression of CD4 is therefore required for HIV-1 entry (McDougal et.al. 1986, Maddon et.al. 1986), but is not sufficient for fusion of the viral envelope and the host plasma membrane (Maddon et.al. 1988, Hoxie et.al 1988, Clapham et.al 1992, Dragic et.al. 1995). The fusion reaction requires additional host cell factors, which determine the specificity exhibited by HIV-1 variants in fusing with particular subsets of CD4 positive cells (Ashorn et.al. 1990). Two groups of HIV isolates an be identified based on their tropism. The majority of virus isolates present in the beginning of an infection are macrophage-tropic, nonsyncytium-inducing (Zhu et.al. 1993). These strains appear to be responsible for sexual transmission, and predominate during the asymptomatic phase of infection. T-tropic, syncytium inducing strains appear later in the course of the infection in 50% of AIDS patients, often preceding the onset of AIDS symptoms (Termette et.al. 1989).

HIV-1 tropism is largely determined by differences in the third variable region of the viral envelope glycoprotein (Cheng-Mayer et.al. 1990, O'Brien et.al. 1990, Hwang et.al 1991, Westervelt et.al 1991, 1992, Chesebro et.al 1992, Willey et.al 1994). Extensive homology has been found among the sequences of the V3 hypervariable region of macrophage-tropic isolates. In contrast, the V3 sequences of T cell-tropic strains show heterogeneity. Because the sequence variability among clones derived from individual patients was found to be low compared to the variability among different patients, it can be concluded that sequence diversity must arise independently in each individual (Chesebro et.al 1992). Amino acid substitution experiments indicate that V3-induced changes in viral tropism are accompanied by physical and functional modifications of the viral envelope (Willey et.al 1994).

As a result of differences in the V3 domain of the envelope glycoprotein, the two subsets of HIV-1 isolates utilize two different molecules for cell fusion and entry (Cocchi et.al. 1996). The cell fusion and entry of macrophage-tropic strains is mediated by CCR5 (Alkhatib et.al. 1996, Choe et.al. 1996, Deng et. al. 1996, Doranz et. al. 1996, Dragic et. al. 1996, Feng et.al. 1996), while cell fusion and entry of T-tropic strains is mediated by CXCR4 (Feng et.al. 1996). Both CXCR4 and CCR5 are chemokine receptors, which are seven-transmembrane GTP-binding protein coupled molecules, which respond to ligand binding by transducing an intracellular signal that results in the mobilization of intracellular calcium.

Chemokines are a family of proteins that play a role in the selective activation and recruitment of a large variety of cell types in inflammation. They are subdivided into two groups based on the spacing of cysteine residues at the N-terminal. CXC chemokines have an intervening amino acid separating their first and second cysteine residues, while in CC chemokines these first two residues are adjacent. Most CXC chemokines activate neutrophils but not monocytes. In contrast, CC chemokines show reciprocal activity, and activate monocytes, lymphocytes, basophils, and eosinophils but not neutrophils (Baggiolini et.al 1994, Schall and Bacon 1994).

Here we compare the function of human CXCR4 receptor with various non-human primate and rat CXCR4-R's. By comparing the sequences of these clones and their ability to mediate HIV infection we hope to identify the parts of the CXCR4 receptor that are involved in the interaction with the HIV-1 envelope glycoprotein during the fusion reaction.

MATERIALS AND METHODS

Cell lines: COS-CD4 cells (Camerini, Planelles, Chen 1994), HeLa-CD4 cells (Camerini, Seed 1990), and 293T cells obtained from Dr. Judith White (University of Virginia), were grown in Dulbeco's Modified Eagle's medium containing 10% bovine serum.

CXCR4 plasmids: All non-human primate and human CXCR4 genes were cloned by PCR from stimulated T-cell cDNA libraries (Camerini and Seed 1990, Camerini et.al. 1989) into the plasmid CDM8 (Seed 1987) using the Hind-III (5') and Not-1 (3') restriction sites. The rat CXCR4 gene cloned into the vector pCDNA were a kind gift of Dr. Jeff Harrison (University of Florida). The construction of the CD7 expressing vector piH3 has been described in Aruffo and Seed 1987. HIV-Luc construct: The construction of the NL-Luc Env$^-$ Vrp$^-$ HIV-1 luciferase vector was described in Connor et.al. 1994 (Figure 1).

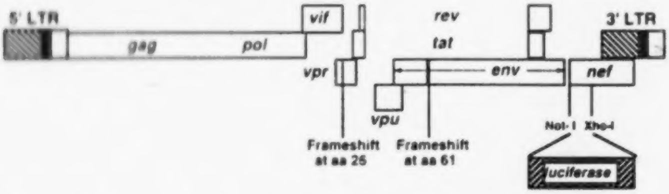

FIGURE 1. Diagram of NL-Luc Env$^-$ Vpr$^-$, a defective HIV-1 Luciferase vector. The vector is based on the infectious molecular clone of HIV-1, NL4-3, but has inactive vpr, env, and nef genes due to frameshift mutations at amino acids 26 and 61, and the insertion of the luciferase gene at the Not-1 and Xho-1 sites of nef.

Envelope vectors: The VSV-G gene cloned into the expression vector piLGPYI is described in Aruffo and Seed (unpublished). The construction of the vector pLET expressing the LAI envelope has been described in Emerman 1989., and was a kind gift of Dr. Francoise Bachelerie, Pasteur Institute. The JR CSF envelope gene (Koyanagi et.al. 1987) and the JR CSF Pt.A V1V3 envelope gene (Camerini et.al. manuscript in preparation) cloned into the vector pCMV were a kind gift of Nathalie Chazal.

Electroporation: 50% confluent 15cm plates of COS-CD4 cells were trypsinized and washed with 10% fetal bovine serum. 30 μg of plasmid DNA was added to 20,000,000 cells in 0.5 ml of 20% fetal bovine serum. After a 10 minute incubation on ice, cells were electroporated with 250V, and after another 10 minute incubation on ice they were plated onto a 10cm plate. 24 hours after electroporation, cells were trypsinized and replated into 6-well plates at a concentration of 200,00 cells/well. 48 hours later, cells from one well were detached by treatment with Phosphate Buffered Saline (PBS) and 0.5mM EDTA. The cell suspension was washed with PBS and resuspended in FACS staining buffer. CXCR4 transfected cells were incubated with anti-CXCR4 monoclonal antibody (Mab), followed by fluorescence conjugated IgG fraction of goat-antimouse MAb (12G5) (Endres et.al. 1996) and anti CD4 Mab (Caltag, San Fransisco, CA). CD7 transfected cells were incubated with CD7 Mab (Caltag, San Fransisco, CA). The levels of CD4 and CXCR4 or CD7 were measured by FACS analysis.

Viral infection assay: Viral stocks were generated by CaPO$_4$ precipitate transfection of subconfluent 15cm plates of 293T cells with 21μg of HIV Env vector DNA and 7 μg of HIV-Luc vector. Supernatants were collected 72 hours post-transfection and were diluted 1:3 with 10% bovine serum. 3 ml aliquots were used to infect 200,000 COS-CD4 cells 3 days post-electroporation. 3 days after infection, cells were lysed, fixed, and luciferase activity was measured according to Analytical Luminescence Laboratory' s Luciferase Assay Kit.

RESULTS

Flow cytometric analysis of transfection efficiencies. COS-CD4 cells transfected with primate CXCR4s showed 25-35% CXCR4 expression. Rat CXCR4 expression could not be measured by this method due to the lack of a reaction with the monoclonal antibody 12G5. Because the plasmid vector expressing the rat CXCR4 gene has the same promoter, enhancer, and SV40 replication origin as the vectors carrying the primate CXCR4s, we expect a similar level of expression. We will measure mRNA levels to verify this assumption. Figure 2 shows a typical result of the flow cytometric analysis.

All of tested primate CXCR4s, but not rat CXCR4 allowed entry of the JR-CSF Pt. A SI V1-V3 Env pseudotyped HIV-1 Luciferase vector into COS-CD4 cells. To investigate whether various CXCR4s were able to function as a coreceptor and mediate viral entry at the COS-CD4 cell plasma membrane, we tested whether they allowed infection by an HIV-Luc vector pseudotyped with different envelopes. We measured the level of infection by measuring luciferase activity 3 days after infection. COS-CD4 cells do not normally express CXCR4. Supernatants from 293T cells cotransfected with NL-Luc E R HIV-1 vector (Figure 1) and a panel of envelope expressing vectors were used to infect COS-CD4 cells. The supernatants contained HIV-1 Luc virions bearing the cotransfected envelope. A VSV-G expressing vector was used as a positive control for infection. VSV-G interacts with phosphatidyl serine, and thus CXCR4 is not required for entry into the cell. A HIV-1 JR-CSF envelope expressing vector was used as a negative control for infection. HIV-1 JR-CSF is a macrophage-tropic, non-syncytium inducing strain of HIV that uses CCR5 as a coreceptor. CXCR4 cannot mediate entry of virions bearing this envelope. An HIV-1 JR-CSF envelope carrying the V1-V3 region of a TLCL-tropic, syncytium inducing, HIV-1 isolate from patient A, was used to test the coreceptor function of the non-human primate and rat CXCR4s. Results of the luciferase assays showed that all non-human primate CXCR4s allowed entry of the JR-CSF Pt.A SI V1-V3 Env pseudotyped HIV-1 luciferase vector into COS-CD4 cells, but did not allow entry of the JR-CSF Env pseudotyped HIV-1 luciferase vector. Rat CXCR4 did not allow the entry of virions bearing either envelope. The VSV-G pseudotyped HIV-1 Env, however, entered both primate and rat CXCR4 transfected cells, showing that all cells were competent to support the other stages of the viral lifecylce necessary for luciferase expression. (Figure 2)

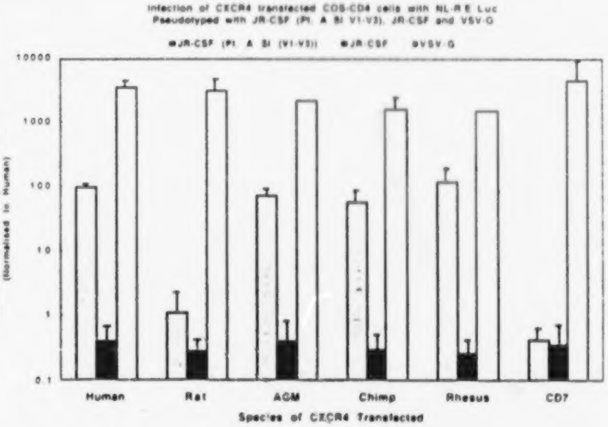

FIGURE 2. Luciferase assay of NL-Luc E R infected COS-CD4 cells. All non-human primate CXCR4s allowed entry of the JR-CSF Pt. A SI V1-V3 Env pseudotyped HIV-1 luciferase vector into COS-CD4 cells, but did not allow the entry of HIV-1 JR-CSF Env pseudotyped HIV-1 luciferase vector. Rat CXCR4 did not allow the entry of virions bearing either envelope. VSV-G pseudotyped HIV-1 Luc entered both primate and rat CXCR4 transfected cells.

Analysis of CXCR4 amino acid sequences. The amino acid sequences of human, rhesus, and rat CXCR4s were obtained from Genbank. Comparison of the three sequences showed a small amount of variation in the transmembrane and intracellular domains of the three species. In contrast, the extracellular domains of the rat sequence showed significant variation from the primate sequences.

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               1                                                   50
HUMAN CXCR4    MEGIS        T  M        M       E  AN  K        S
RHESUS CXCR4   MEGIS        T  M        I       E  AH  R        S
RAT CXCR4      ---ME        S  V        N       D  EN  R        F
Consensus      -----IYTSD NY-EE-GSGD YDS-KEPCFR -EN--FN-IF LPTIY-IIFL

               51                                                 100
HUMAN CXCR4                                                       V
RHESUS CXCR                                                       V
RAT CXCR4                                                         M
Consensus      TGIVGNGLVI LVMGYQKKLR SMTDKYRLHL SVADLLFVIT LPFWAVDA-A

               101                                                150
HUMAN CXCR4    N    N        V                                  RP
RHESUS CXCR4   N    N        V                                  KP
RAT CXCR4      D    K        I                                  SA
Consensus      -WYFG-FLCK AVH-IYTVNL YSSVLILAFI SLDRYLAIVH ATNSQ--RKL

               151                                                200
HUMAN CXCR4        V                  F   N  EA  D      F   ND  V
RHESUS CXCR4       V                  F   S  EA  D      F   ND  V
RAT CXCR4          A                  I   D  QG  G      L   DS  M
Consensus      LAEK-VYVGV WIPALLLTIP D-IFA-VS-- D-RYICDR-Y P--LW-VVFQ

               201                                                250
HUMAN CXCR4                  V
RHESUS CXCR4                 D
RAT CXCR4                    V
Consensus      FQHIMVGLIL PGI-ILSCYC IIISKLSHSK GHQKRKALKT TVILILAFFA

               251                                                300
HUMAN CXCR4          I            I         NT
RHESUS CXCR4         I            I         NT
RAT CXCR4            V            V         SV
Consensus      CWLPYY-GIS IDSFILLE-I KQGCEFE--V HKWISITEAL AFFHCCLNPI

               301                                                350
HUMAN CXCR4               T      T V
RHESUS CXCR4              T      T V
RAT CXCR4                 S      N M
Consensus      LYAFLGAKFK -SAQHAL-S- SRGSSLKILS KGKRGGHSSV STESESSSFH

               351
Consensus      SS
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FIGURE 3. Predicted amino acid sequence alignment of human, Rhesus macaque, and rat CXCR4s. The amino acid sequences were obtained from Genbank. The seven transmembrane domains are underlined. Consensus among the three sequences is shown on the bottom line.

DISCUSSION

The aim of our study was to isolate and analyze the function of several non-human primate CXCR4 genes. Our results indicated that while all of the non-human primate CXCR4s successfully functioned as a coreceptor, and mediated the entry of JR-CSF Pt. A SI V1-V3 Env pseudotyped HIV-1 luciferase vector into COS-CD4 cells, the rat CXCR4 did not. None of the CXCR4s allowed the entry of the CSF Env pseudotyped HIV-1 luciferase vector, confirming that the V3 domain of this envelope cannot interact with CXCR4 to mediate fusion and entry into cells.

Predicted amino acid sequence analysis of human, rhesus, and rat CXCR4s showed that transmembrane and intracellular domains are conserved among these three species, displaying mostly conservative variation. Extracellular domains of the rat sequence show significant variation with respect to the primate sequences (Table 1). Further experiments will be performed to identify which of these amino acid residues may be involved in interacting with HIV-1 to facilitate viral entry.

TABLE 1. Percentages of amino acid sequence variability. Intracellular and transmembrane domains of human, rhesus, and rat CXCR4s show only a small amount of mostly conservative variation among the three species. Extracellular domains of the rat sequence show significant variation with respect to the primate sequences.

Percentages of Amino Acid Sequence Variability Between Human, Rhesus, and Rat CXCR4s

	Extracellular Domains		Transmembrane Domains		Intracellular Domains	
	%Variation	%Significant Variation	%Variation	%Significant Variation	%Variation	%Significant Variation
Rat to Human	24	12	4	0.7	4.8	0
Rhesus to Human	4	0.9	0.7	0.7	0.9	0

LITERATURE CITED

Alkhatib et.al. 1996. CC CKR5: A RANTES, MIP-1 alpha, MIP-1 beta receptor as a fusion cofactor for macrophage-tropic HIV-1. Science 272:1955-8.

Aruffo, A., Seed, B. 1987. Molecular cloning of two CD7 (T-cell leukemia antigen) cDNAs by a COS cell exression system. EMBO journal Vol.6 No.11.

Ashorn, P. A., Berger, A., Moss, B. 1990. Human Immunodeficiency Virus Envelope glycoprotein/ CD4-mediated fusion of nonpromate cells with human cells. J. Virol.64:2149-56.

Broder, C. C., Berger, E. A. 1995. Fusogenic selectivity of the envelope glycoprotein is a major determinant of human immunodeficiency virus type 1 tropism for CD⁺ T-cell lines vs. primary macrophages. Proc. Natl. Acad. Sci. 92:9004-8.

Camerini, D. et.al. 1989. Leu-8/TQ1 is the human equivalent of the Mel-14 lymph node homing receptor. Nature 78:342.

Camerini, D., Seed, B. 1990. A CD4 domain important for HIV-mediated synctium formation lies outside the principal virus binding site. Cell 60:747-754.

Camerini, D., Planelles, V., Chen, I.S.Y. 1994. Murine cell lines bearing CD4 and CD26 are not susceotible to HIV-infection or synctium formation. Science 264:1160.

Camerini, D. et.al. Manuscript in preparation. Pathogenesis of syncytium-inducing and non-syncytium-inducing HIV-1 isolates, molecular clones and chimeras in CSID-hu mice.

Cheng-Mayer et.al. 1990. Viral determinants of human immunodeficiency virus type-1 T-cell or macrophage-tropism, cytopathogenicity, and CD4 antigen modulation. J. Virol. 64:4390-8.

Chesebro et.al. 1992. Macrophage-tropic human immunodeficiency virus isolates from different patients exhibit unusual V3 envelope sequence homogeneity in comparison with Y-cell tropic isolates: definitio of critical amino acids involved in cell tropism. J. Viirol. 66:6547-54.

Choe et.al. 1996. The beta-chemokine receptors CCR3 and CCR5 facilitate infection by primary HIV-1 isolates. Cell 85:1135-1148.

Clapham et.al. 1992. Human immunodeficiency virus type 2 infection and fusion of CD4-negative cell lines: induction and enhancement by soluble CD4. J.Virol. 66:3531-7.

Cocchi, F. et.al. 1996. The V3 domain of the HIV-1 gp120 envelope glycoprotein is critical for chemokine-mediated blockade of infection. ???

Connor, R. I. et.al. 1995. Vpr is required for efficient replication of human immunodeficiency virus type-1 in mononuclear phagocytes. Virology 206:935-44.

Deng et.al. 1996. Identification of a major co-receptor for primary isolates of HIV-1. Natue 381:661-6.

Dragic et.al 1995. HIV-1 entry into CD4⁺ cells is mediated by the chemokine recepttor CC-CKR5. Nature 381:661-73.

Dragic et.al. 1996. Proteinase-resistant factors in human erythrocyte membranes mediate CD4-dependent fusion with cells expressing human immunodeficiency virus type 1 envelope glycoproteins. J. Virol. 69:1013-18.

Emerman, M., Vazeux, R., Peden, K. 1989. The rev gene product of the human immunodeficiency virus affects envelope-specific RNA localization. Cell 57:1155-65.

Endres, M.J. et.al. 1996. CD4-independent infection by HIV-2 is mediated by fusin/CXCR4. Cell 87:745-56.

Feng et.al 1996. HIV-1 entry cofactor: functional cDNA cloning of a seven-transmembrane, G protein-coupled recepotr. Science 272:872-7.

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